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NUMBER 31

# Life Histories of Central American Birds

FAMILIES FRINGILLIDAE, THRAUPIDAE, ICTERIDAE  
PARULIDAE AND COEREBIDAE

By

ALEXANDER F. SKUTCH

ILLUSTRATED WITH DRAWINGS BY DON R. ECKELBERRY



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FEMALE AND MALE  
SCARLET-RUMPED BLACK TANAGER

GOLDEN-MASKED TANAGER  
SILVER-THROATED TANAGER

BLUE TANAGER

To

CHARLES HERBERT LANKESTER

For over half a century a student of the flora  
and fauna of Costa Rica

## FOREWORD

Naturalist-travellers who have had the good fortune to know the wonderful bird-life of tropical America for more than one hundred years have gathered collections of specimens with enthusiasm and much profit to our science of ornithology. Museum trays overflow with skins, and skeletons, of the almost bewildering variety of avian species of this area of the New World, and the work of securing further material continues in remoter areas, formerly accessible with difficulty, to aid in our understanding of the details of distribution and variation in the myriad species found from México down through the South American continent.

Such studies have built a framework of understanding of the avifauna of the vast area under discussion, but in general they have afforded details of the manner of life of only a few of these feathered beings that are such an attractive means of interpretation of the laws of life.

Alexander Skutch, gifted naturalist and observer, unlike most others, has given his undivided attention for many years to painstaking observation and study of living birds, years that have brought him a wealth of detail on the life cycles of many kinds. His information in this field now undoubtedly is greater than that of any other ornithologist, and, happily, this facility for gathering data is coupled with an unusual ability in its presentation through the means of the written word.

We have seen a steady flow of papers from Skutch's pen in our ornithological journals. In this present volume we find assembled his painstaking studies on some of the most interesting of tropical species. Skutch is a careful biographer of his avian friends, and his works will remain for many decades as a sound source of information and as a basis for further studies. His contribution to our science in its entirety is on a par with that of such great systematists as Sclater, Salvin, Ridgway, Hartert, and Hellmayr, to whom we owe so much in the drier, more technical field.

One who has worked in southern forests will find in these pages many memories of happy days of tropical travel, while those to whom these delights have been denied may through them sense, in a less intimate way, the varied pleasures of observation in a completely strange and unknown world.

ALEXANDER WETMORE

Edited by

ALDEN H. MILLER

and

FRANK A. PITELKA

at the

*Museum of Vertebrate Zoology*  
*University of California, Berkeley*

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## INTRODUCTION

Lying between two great continents each with its peculiar avifauna, the thousand-mile-long isthmus known as Central America has a wonderfully rich bird life. The greater part of the region is comprised in the Caribbean lowlands, where the rainfall is high and rather uniformly distributed through the year and the forests tall and heavy. The colorful bird life of these warm and humid lowlands is closely related to that of northern and eastern South America. Nearly all the genera, and the majority even of the species of these Caribbean birds, are found also in the southern continent; many of the species extend across the tropics to Paraguay and northern Argentina. On the Pacific side of the Cordillera, in southern Costa Rica and adjacent Panamá, lies another area of low elevation and heavy rainfall, where the forests resemble those of the Caribbean region and the avifauna is much the same, although there are numerous forms endemic to this section and many of the Caribbean types fail to occur. In the drier country stretching along the Pacific coast from the Gulf of Nicoya in Costa Rica to the Isthmus of Tehuantepec in México, and in deep arid valleys in the rain shadow of the mountains on the Caribbean side of northern Central America, there is found a quite distinct group of birds of varied origins, many of which appear to be derived from the north rather than from the south. Only a few of the wider-ranging and more adaptable species of birds dwell in the most humid as well as the most arid sections of the Central American lowlands.

The high mountains in the interior of the Central American isthmus fall naturally into two divisions, separated by the belt of low country that stretches from coast to coast along the Río San Juan and Lake Nicaragua—the so-called Nicaraguan Gap. The northern highlands center in Guatemala, where they culminate in the Volcán Tajumulco (13,600 feet). To the northwest the massif stretches through the Mexican state of Chiapas to the Isthmus of Tehuantepec; to the southeast it becomes lower but extends through Honduras and El Salvador into Nicaragua. In these northern highlands of Central America are found many birds of north temperate origin, including kinglets, brown creepers, juncos, towhees, and jays. The southern or Andean element is here relatively small. The far less extensive southern highlands center in Costa Rica, where they reach their climax in the Cerro Chirripó (12,580 feet) and stretch eastward into Panamá. Here the avifauna contains a rich representation of southern or Andean types, while the northern element is comparatively weak. When it is recalled that the whole of Central America is only slightly greater in area than France and smaller than the state of Texas, and that the four contrasting divisions—humid and arid lowlands, northern and southern highlands—lie at no great distance from each other, it will be understood that this great isthmus offers exceptional advantages for becoming acquainted with a wide variety of birds, without long or exhausting travel.

### SUMMARY OF THE AUTHOR'S FIELD WORK

My own interest in the birds of Central America began in 1928 and 1929, when I passed half a year at the former research station of the United Fruit Company situated on Changuinola Lagoon about twenty miles from the port of Almirante on the Caribbean coast of western Panamá. Although the primary purpose of this, my first, visit to the mainland of tropical America was botanical research, the station at Farm 6 pro-



vided such exceptional advantages for bird study that it would seem impossible for anyone susceptible to the influences of nature as a whole not to have taken a growing interest in the birds around him. The palms, ornamental shrubbery and fruit trees surrounding the house attracted a variety of the wide-ranging birds of the clearings, whose sweet songs or raucous cries obtruded themselves upon our conversation at meal times and whose colorful plumage inevitably captured our eyes. From February until my departure in June, they built their nests conspicuously all about us, where the least observant of men could hardly have failed to discover a number of them. The variety and complexity of form of these structures, greatly exceeding anything to be found among an equal number of northern birds with their far simpler architecture, stimulated and delighted the newcomer from the north. The lagoon which passed close in front of the dwelling, and meandered with many a sharp twist and turn down to the coastal swamps of magnificent silico palms, supported, especially during the months of the northern winter, a large and varied population of waterfowl. Forest birds, it is true, were not abundant in the immediate vicinity; yet it is hard to imagine a more propitious spot for beginning to become familiar with the Central American birds. Although other occupations left little time for intensive bird watching, I made somewhat detailed studies of the nest life of the Rieffer Hummingbird and the Black-crowned Tody Flycatcher.

On my return to the United States, I searched the libraries for information about the birds I had seen in Panamá. I soon learned that although the birds of tropical America had been rather thoroughly collected, described and classified, little was known about their ways of life. Here and there, in the long lists of species which made up the reports on collections, a brief note threw a fleck of light on the habits of a bird; here and there a nest was described, with perhaps a few hasty observations on the behavior of the parents, which usually ended their careers in the collector's basket. Detailed studies of behavior, such as were now beginning to be made for an increasing number of birds in Europe, North America, and the British Dominions, were almost nonexistent for tropical American species. The most illuminating and readable accounts of the habits of neotropical birds were those published long before by W. H. Hudson on the birds of the La Plata region and those more recently published by Beebe and his colleagues on the birds of British Guiana. The excellent studies by Chapman and others on the birds of Barro Colorado Island in the Panamá Canal Zone were just beginning to come off the press. For innumerable species of neotropical birds, the very form of the nest and color of the eggs had never been recorded in print. For whole families there was not, and in many instances there still is not, a reasonably adequate account of the life history of a single species.

Gradually there grew upon me the determination to learn what I could about the habits of the birds of tropical America. There appeared to be no other field of scientific endeavor in which I was so likely to contribute something of worth. To study the habits of *all* the birds of Central America, or even of a division of it like Guatemala or Costa Rica, was obviously too great an undertaking for a single individual. Soon I made it my goal to work out the life history of one or more representatives of each of the families of Central American birds. That goal is still unattained; of some families I have been able to study numerous species, but of others I have so far been unable to find a single favorably situated nest.

The year after my visit to Panamá I returned to Central America, this time to the Lancetilla Experiment Station of the United Fruit Company, a few miles inland from the port of Tela on the northern coast of Honduras. Here I resided from April until November, 1930, and while continuing studies of the anatomy of the banana plant, extended my acquaintance with the bird life that swarmed amid the plantations of the

station and in the low second growth that had sprung up over the abandoned banana lands of the valley floor. Here the population of birds appeared to be denser, as to individuals if not as to species, than in the magnificent lofty rain-forest that clothed the steep surrounding mountain slopes. The birds which chiefly occupied my atten-

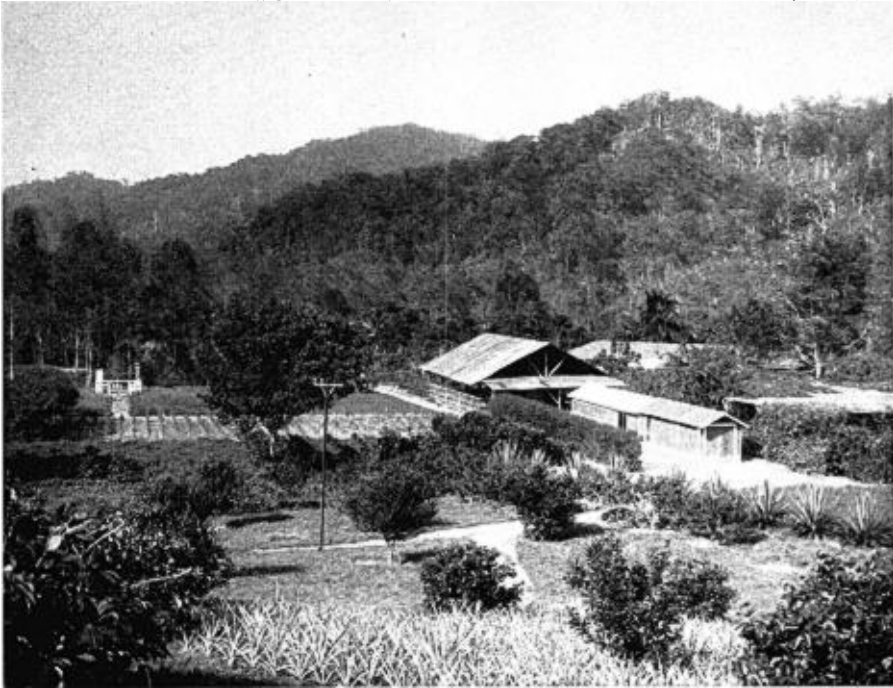


Fig. 1. View in the Lancetilla Valley, Honduras, showing some of the buildings and plantings of the Tela Railroad Company's experiment station as they appeared in 1930 when the author worked there. The cleared land in the foreground was inhabited by White-collared Seedeaters, Variable Seedeaters, Scarlet-rumped Black Tanagers, Blue Tanagers, Lesson Orioles, and Giant Cowbirds.

tion at Lancetilla were the Amazon Kingfisher, Turquoise-browed Motmot, Pauraque, Groove-billed Ani, Rufous-breasted Castle-builder, Royal Flycatcher, and Montezuma Oropéndola.

After the failure of attempts to enlist institutional support of continued studies of Central American bird life, I decided to carry on independent work for a period. Returning to Central America in February, 1932, I settled for the next four months on "Alsacia" Plantation, a big banana and cattle farm extending from the steep forested foothills of the Sierra de Merendón, on the Guatemala-Honduras boundary, down to the level valley lands of the Río Morjá, a small tributary stream which flowed into the Río Motagua opposite Quiriguá, Guatemala. Occupying a strip of territory then in dispute between the two sister republics, "Alsacia" was in many respects an independent principality, ruled by the Finnish overseer with whom I dwelt. Here I made studies of the Green Kingfisher, Ringed Kingfisher, Citreoline Trogon, Black-chinned Jacamar, Golden-fronted Woodpecker, Rough-winged Swallow, Yellow-bellied Elaenia, White-tipped Brown Jay, Melodious Blackbird, and Boat-tailed Grackle, and I was able to add to my information on the Amazon Kingfisher, Turquoise-browed Motmot, Groove-

billed Ani, Rufous-breasted Castle-builder and several other birds. In June, after the rains had become so hard at "Alsacia" that field work was carried on under a great handicap, I moved up the Motagua Valley to El Rancho, in an arid region of cacti and thorny scrub where the bird life was strikingly different from that which I had been studying in the humid lower valley not many miles distant. Here I began to make the acquaintance of the Central American arid avifauna; but soon a severe attack of influenza put an end to field work for the season.



Fig. 2. View at "Alsacia" plantation in the Motagua Valley of Guatemala, where the author worked in 1932. Boat-tailed Grackles and Melodious Blackbirds nested in the trees about the house on the hilltop and foraged along the Rio Morjá in the foreground in company with Giant Cowbirds and Red-eyed Cowbirds.

On leaving Honduras in November, 1930, I had spent a month in the high mountains of Guatemala, a fascinating region for a naturalist. In 1933 I was able to pass the entire year in this region, on the beautiful estates of "Chichavac" and "Santa Elena," lying between 8000 and 10,000 feet above sea level in the mountains above Tecpán (or Tecpám) in the Department of Chimaltenango. Up to about 9000 feet the forests were largely of oaks (a bewildering variety of species), lofty alders, arbutus, a number of other dicotyledonous trees, and pines. The upper thousand feet of the mountain was largely covered by magnificent cypress trees (*Cupressus Benthamii*) in nearly pure stand. On the open fields and pastures frost formed every clear and windless night from November through March. The bird life was a stimulating admixture of northern forms with such distinctly "tropical" species as trogons, motmots, woodhewers, and honeycreepers. The chief studies made here were of the Blue-throated Green Motmot, Mexican Trogon, Black-eared Bushtit, Banded Cactus Wren, White-breasted Blue Mockingbird, Russet-headed Nightingale-thrush, Pink-headed Warbler, Slaty Flower-piercer, Rose-throated Becard, White-eared Hummingbird, and Violet-eared Hummingbird.

In the following year, 1934, I journeyed widely through the highlands of Guatemala, collecting plants for the Arnold Arboretum of Harvard University, and incidentally increased my familiarity with the bird life of that country. At the termination of this

commission, I went to Panamá, where I made my third and longest visit to Barro Colorado Island, remaining from early February until the beginning of June. This forested island of nearly four thousand acres in Gatún Lake, and the excellent opportunities it provides for bird study, have been so well described by Chapman (1929) that little can be added to his beautifully written accounts. Among the birds which chiefly engaged my attention here were the Smooth-billed Ani, Black-throated Trogon, White-flanked Antwren, Spotted Antbird, Streaked Flycatcher, Crimson-backed Tanager, Bananaquit, and Yellow-rumped Cacique. Conditions in the lowland rain-forest, with its great variety of species of birds, the difficulty of finding many nests of any one species, and the very high

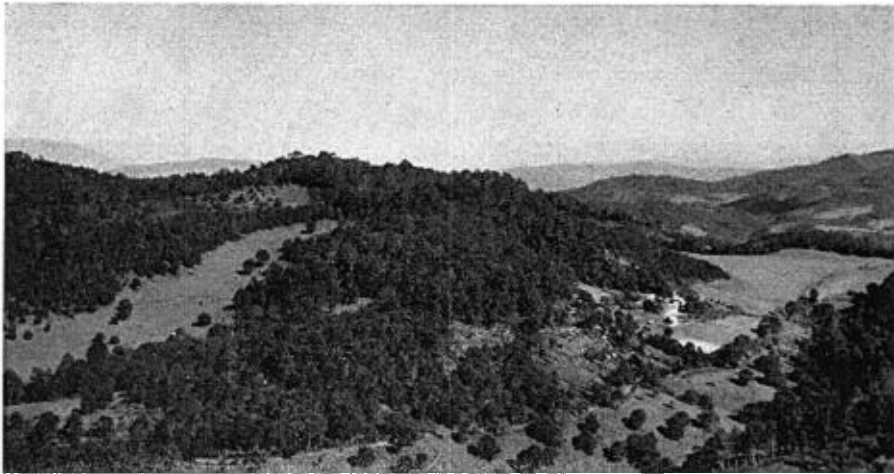


Fig. 3. A general view of "Chichavac," above Tecpán, Guatemala, where the author worked in 1933. The terrain in the foreground is between 8000 and 9000 feet above sea level. The woodland is dominated by oaks of several species, with an admixture of pine, alder, arbutus and many other species. In the woods and brushy openings occur Pink-headed Warblers, Hartlaub Warblers, Slate-throated Redstarts and Slaty Flower-piercers .

mortality of nests, were such that they encouraged the undertaking of many studies, few of which could be completed in a single season.

On leaving Barro Colorado Island I returned to Guatemala and spent the period from June 23 to August 8 on the hospitable Finca "San Diego," a coffee plantation near Colomba on the Pacific slope of the Department of Quezaltenango, about 3000 feet above sea level. The nesting season for the majority of birds was already drawing to an end; but observations were made on the Rufous-winged Talpacoti Dove, the Spotted-breasted Oriole, and other birds.

Costa Rica is a country peculiarly attractive to the ornithologist. It is doubtful whether any other area of equal extent contains a greater variety of birds; Carriker (1910) lists 753 resident and migrant forms for the 23,000 square miles of Costa Rican territory. My attempt to settle, early in 1934, on the Caribbean side of the country had failed through lack of capital and experience. But in August, 1935, I returned to Costa Rica, and since that date by far the greater part of my ornithological work has been done here. After a few months passed in and near San José and devoted to writing, I went, at the end of November, 1935, to El General, which is the name applied to the expanded basin at the head of the Río Grande de Térraba (called Diquis on older maps) on the Pacific slope south of the Gulf of Nicoya. This was a very isolated section that was

reached from the center of the country by a journey of three or four days, on horseback or afoot, along a rough and narrow forest trail which passed for miles along the continental divide and over the eleven-thousand-foot summit of El Cerro de la Muerte—the Mountain of Death—so called because so many inadequately equipped travellers had made their last bivouac on this bleak, open summit. But taking advantage of a recently established airplane service, I landed in El General about forty minutes after leaving the Capital. In this recently settled district a great deal of unspoiled forest remained about the principal village, San Isidro. Never before, except on Barro Colorado Island and at Lancetilla, had I reached the tropical forest so swiftly and easily.



Fig. 4. Looking west over the author's farm in the valley of El General, 2500 feet, Costa Rica, in 1941. The Río Peña Blanca is hidden by second-growth trees in the foreground. To the south of the pasture is primary rain-forest.

After the exhaustion of the small personal savings which for two years had supported my studies of the Central American birds, I had come to depend upon the collection and sale of botanical specimens as a means of subsistence, pursuing this occupation through much of the year, but reserving the chief nesting season, from March through June, for work with the birds. I preferred botanical to ornithological collecting not only as more congenial, but as making the greater contribution to science as a whole, the birds of most parts of Central America having been quite adequately collected, whereas many new species and even genera of plants remained, and still remain, to be discovered here. I found in El General an ideal location for carrying on my joint occupations of collecting the plants and studying the habits of the birds. Within a few days of my arrival, I acquired the use of a somewhat ruined cabin at Rivas, a straggling settlement about six miles north of San Isidro in the valley of the Río Buena Vista. But the framework of the cabin was sound; an oxcart-load of rough boards, and some repairs to the roof thatched with sugar-cane leaf, made it habitable; and from early December, 1935, until June, 1937, this was where I dwelt and worked.

Eager to study the habits of the Quetzal and other birds found only at higher altitudes, at the beginning of July, 1937, I took possession of a rented cottage about two miles below Vara Blanca, on the northern slope of the Cordillera Central of Costa Rica, at an altitude of 5500 feet. The lofty, epiphyte-laden forests of this district supported numerous Quetzals and other birds of the subtropical zone. In November I made a three weeks' excursion to Guanacaste, to become acquainted with the bird life there, thaw

out my blood, and escape some of the chilling winds and rains of the wettest region in which I have ever dwelt. Then followed a visit to Buenos Aires in southern Costa Rica. But early in January I returned to Vara Blanca, where I continued field work until the following August. The birds chiefly studied here were the Quetzal, Blue-throated Toucanet, Prong-billed Barbet, Golden-olive Woodpecker, Allied Woodhewer, Highland Wood Wren, Blue-and-white Swallow, Slate-throated Redstart, Collared Redstart, and Turquoise-naped Chlorophonia.

During the autumn of 1938 I visited the United States for the first time since June, 1934. In December of the same year I returned to El General and for the next six months worked near San Isidro. The latter half of 1939 was largely taken up with a visit to

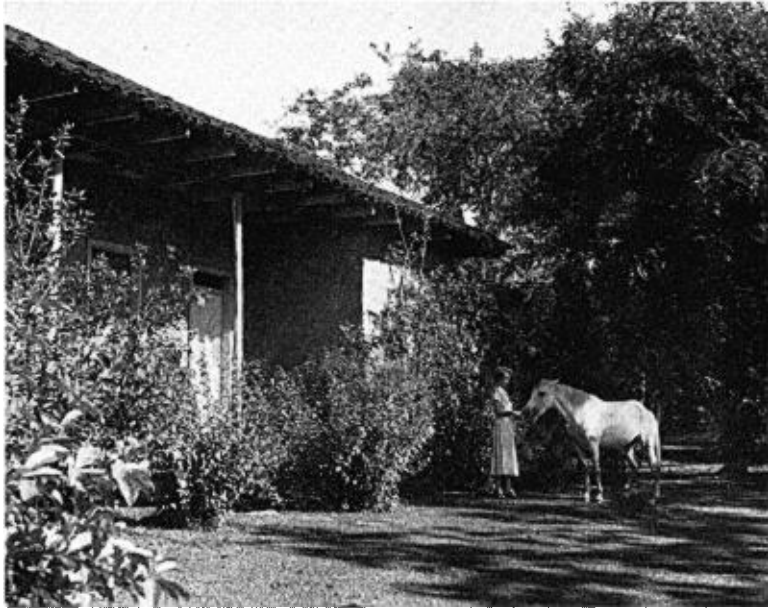


Fig. 5. The author's residence at Quizarrá in the valley of El General. In the shrubbery about the house nest Yellow-faced Grassquits, Variable Seedeaters, Song Tanagers, Bananaquits, and many other birds of the Tropical Zone.

Ecuador, where I spent most of my time at Puyo, at an altitude of about 3000 feet amid the humid forests east of the Andes, and at Baños. I had high hopes of studying life histories of South American birds; but my visit to Puyo was made at the wrong season for nests, and the Plumbeous Kite was the only species I studied in any detail. In January, 1940, I entered the service of the Museo Nacional of Costa Rica as botanist, and from February until June of that year worked in the interest of this institution in El General, this time in the district of Santa Rosa in the valley of the Río Pacuar. In July, 1940, I returned to South America as botanist of one of the rubber survey parties sent out in that year by the United States Department of Agriculture. We travelled extensively on the Río Marañon and its great tributaries in transandean Perú, and in the Pacific littoral of Ecuador and Colombia, most of the time too rapidly to form more than the most superficial acquaintance with the marvellous bird life of the regions through which we passed.

Weary of so much homeless wandering, after our return from South America I bought a farm, newly carved from the wilderness, beside the Río Peña Blanca on the northern side of the basin of El General, at an elevation of about 2500 feet above sea level. This has been my residence since 1941, and here my studies of bird life have been continued. Of my sixteen nesting seasons with the Central American birds, nine have been passed in El General, and five of these at my present abode. Hence the greater part of the information upon which the present work is based was gathered in this region. The remaining years were divided as follows: two seasons in the lowlands of Panamá, one each in the Caribbean lowlands of Honduras and Guatemala, one on the Caribbean slope of Costa Rica, at 2000 feet, one in the highlands of Costa Rica and one in the high mountains of Guatemala.

Finally, a few words may be said about methods of study. Although I began each season with the hope that I might discover the nest and work out the life history of this species or that, I nearly always studied my nests as I found them, giving preference, when a number had been located, to those birds least likely to be seen again. In brief, I became an opportunist; but in a region where so much remained to be discovered about the habits of practically all the birds, from the rarest to the most common, this course appeared preferable to spending much time in a stubborn search for the nest of some previously selected species—a quest that often proved fruitless because I lacked information on the season of breeding and the nest site. Whenever there was a suspicion that my presence might influence the activities of the nesting birds, I watched from a cloth blind or other concealment. In making these studies, I never felt justified in destroying, in my effort to gather information, the birds, their eggs or their young, but did everything in my power to help them bring their nesting to a successful conclusion.

#### SCOPE OF THE WORK

The purpose of the present work is to present fairly complete life histories of a relatively small number of Central American birds. From the outset I felt that this endeavor would be more richly rewarding than the attempt to learn something about the habits of all the birds of the region or any portion thereof—a project impossible of realization by one man, and which could lead only to the accumulation of a miscellaneous pile of random notes. Such fragments signify little unless integrated in a larger and more complete whole. Because I have already published in *The Auk*, *The Condor*, *The Wilson Bulletin* and *A. C. Bent's Life Histories of North American Birds* a much larger proportion of my material on the non-passerines than on the passerine species, it has been decided to begin the publication of the present series of life histories with the most highly evolved rather than the most primitive species, which is to follow the British rather than the North American order of treating the families of birds in handbooks and similar works. The present volume is devoted to song birds of families from the Fringillidae to the Coerebidae according to the arrangement of Wetmore (1940). It is hoped that this first volume will be followed by a second on the remaining song birds of which I have material and the Tyranni or non-singing division of the passeriform birds, and ultimately by a third on the non-passerine families.

In a number of instances I have made observations on two or more forms of a single species. It has been difficult to decide just how to treat these cases; yet on the whole it has seemed best to discuss under a single heading all those races too similar in appearance to be readily distinguished in the field, but to devote separate subsections to those subspecies or races, of which there are many in the modern polymorphic species, which are readily recognizable by their distinct coloration. Many of these readily separable sub-

species were until quite recently considered to be good species. My treatment in this respect has not been quite consistent, depending to some extent upon the amount of information available for the several races. In all events, the mention of locality will permit the interested student to discover to which race an observation refers.

The delineations of plumage are intended merely to furnish the reader a picture of the bird, with which he might not be familiar. To give more detailed descriptions would be to repeat those found in Ridgway's "Birds of North and Middle America," and other taxonomic works, and moreover might defeat the purpose for which they are included; for a few bold strokes will often leave a sharper image in the mind than the long, detailed account essential in works of descriptive ornithology. Likewise ranges are given only in the most general terms; greater details are available in standard systematic works. Unless definitely stated to the contrary, all dimensions of eggs given in this book are based on measurements made by the author at the nest, without taking the eggs away. Statements of the percentage of time spent on the nest by incubating or brooding birds are, unless for obvious reasons to the contrary, calculated from the formula  $T = S \div (S + R) \times 100$ , where T is the per cent of time on the nest, S the average length of the sessions in the nest timed by the observer, R the average of the recesses or periods away from the nest. Unless the observer has chanced to time an equal number of completed sessions and recesses, this formula gives a more exact index of assiduity in incubation than a calculation based on the total time spent on and off the nest. If only a small and unequal number of sessions and recesses have been recorded, the latter mode of calculation may lead to large errors. Incubation periods were measured from the laying of the last egg of the set to the hatching of the last nestling.

#### THE USE OF ENGLISH NAMES

In the preparation of this volume, considerable attention has been given to the English names of the species treated. Although the aboriginal inhabitants of America appear to have possessed distinctive names for at least the larger and more brilliantly colored of the birds about them—and many of these names, as toucan and tanager, have passed into current modern use, or have been Latinized as generic or specific designations—the vocabulary of the present Spanish-speaking inhabitants of tropical America is remarkable for its poverty in bird names. A few well-worn Iberian names, such as *faisán*, *pavo*, *calandria* and *gorrión*, have been in America applied to diverse birds for the most part quite unrelated to the originals of these designations. How absurd to attach the word *gorrión* (sparrow) to the hummingbirds! And what a lack of observation it shows to apply this single misnomer, unmodified, to all the scores of species of Trochilidae which inhabit Central America! Similarly, *carpintero* (carpenter) is the single unmodified appellation of all the woodpeckers, large and small, bright and dull. Only exceptionally, as in *quetzal* and *chachalaca*, have we a good indigenous name for some of the more conspicuous members of the avifauna; and these should be carefully preserved in modern usage.

In the absence of truly indigenous names for the birds they treated, Gould, Sclater, Sharpe, Seebohm, and other authors of great illustrated monographs of bird families wholly or in part American, of which England during the Nineteenth Century was so prolific, undertook to supply the deficiency with English names of their own invention. The task of providing pseudo-vernacular names for the birds was completed, so far as Middle American species are concerned, by Robert Ridgway in his monumental "Birds of North and Middle America." But with little or no acquaintance with the living birds, these authors were cut off from the sources of some of the most apt of the genuine



vernacular names of birds, namely, voice and mannerisms. Where peculiarities of coloration or structure suggested a name, it was in many instances felicitous; otherwise, it was often forced—a geographical designation equally applicable to a score of other species; a collector's or describer's name used in the possessive case; or the Latinized generic name employed as an "English" name without modification.

The English names were applied to the subspecies rather than to the species. "Giraud Flycatcher" and "Colombian Flycatcher" are races of *Myiozetetes similis* so similar that few bird watchers can distinguish them in the field; how confusing, then, to give them these entirely unrelated names! Analogous cases might be cited *ad nauseum*. With the appearance of Cory's and Hellmayr's "Catalogue of the Birds of the Americas," and the inclusion of larger numbers of subspecies in polymorphic species, the confusion created by the old method of naming subspecies of the same species independently of each other became even greater. English names are given in the "Catalogue," leaning heavily upon Brabourne and Chubb's "Birds of South America" for the forms inhabiting that continent, but often showing strange disregard for Ridgway's names of Middle American birds; and this was done so carelessly that the identical name is at times applied to two entirely distinct species; also obvious misprints abound.

Rules of zoölogical nomenclature do not apply to "vernacular" names; and the disregard which the several originators of these names have shown for the inventions of their predecessors would seem to leave the lists open to anyone bold enough to enter them. In preparing the present work, I have attempted to find an English, or indigenous, name applicable to each species as a whole; although in the case of some of the more heterogeneous Hellmayrian "species," extreme forms differ so strikingly in appearance that this seems an almost hopeless task. Whenever a satisfactory designation was already available I have retained it, for I deplore the multiplication of names. But where familiarity with the living bird suggested a name based on voice or habits to replace a rather forced book-name, I have ventured to use the innovation. Once a really good species name has been found, the designation of the subspecies is nearly always a simple matter—a geographic name, the collector's or describer's name, or an adjective referring to the distinctive peculiarity of the race, is prefixed to the species name. The invention of names for a large series of slightly differing objects is no easy matter; Ridgway feelingly bemoaned his difficulties on this score, and I know from personal experience that they were great. Yet when one writes or speaks about birds in English, the advantage of having English names is obvious.

#### ACKNOWLEDGEMENTS

To give the names of all those persons who over a period of eighteen years have in one way or another helped a wandering naturalist on his way, would lead to too long a list. Many of the names, although not the acts of kindness, have been forgotten; and many no doubt can no longer recall the name of the wanderer they befriended. Yet a few have helped along my studies in such large measure that it is a pleasure to be able to acknowledge here my indebtedness to them. At the United Fruit Company's experimental station at Farm 6, Almirante, back in 1928 and 1929, Mr. Joseph H. Permar, then in charge, helped in countless ways to further my studies, both botanical and ornithological. The following year, Dr. Wilson Popenoe and Mr. Alfred F. Butler were equally co-operative at the Lancetilla Experiment Station of the same company. At "Alsacia" Plantation, in 1932, Mr. Eugene Pellman, the overseer, was most tolerant of the vagaries of his guest whose comings and goings were regulated by the activities of the birds rather than by the customs of his household. The hospitality of the late Axel Pira, senior, and his

family made possible an exceedingly profitable year devoted to natural history in the high mountains of Guatemala. The late William Crawford, while manager of the Pejivalle Coffee Plantation near Turrialba, Costa Rica, was most helpful to the wandering naturalist at a difficult period in his peregrinations. On several visits, long and short, to the Barro Colorado Island Biological Laboratory, Mr. James Zetek has spared no effort to make my sojourn pleasant and scientifically productive. Through the hospitality of Mr. and Mrs. Cecil J. Hazard at the Finca "San Diego," and of Mr. and Mrs. Gordon P. Smith at the Finca "Mocá," I was able to extend my studies of bird life to the Pacific slope of Guatemala. But for the understanding kindness of Señor Juan Schroeder F., of San Isidro del General, I doubt whether I should ever have become established in El General; and during more than a decade of friendship, he has helped to smooth over many a rough place. Dr. Herbert Friedmann, Curator of Birds at the United States National Museum, has helpfully responded to repeated calls for advice and information; and during a summer at the Museum of Zoölogy of the University of Michigan, Dr. Josselyn Van Tyne was a sympathetic host and guide. By arranging for the identification and distribution of my botanical collections, Dr. William R. Maxon, Emeritus Curator of Plants at the Smithsonian Institution, made it possible for me to continue field work over a number of years.

Studies leading to the completion of the manuscript were made at the Museum of Zoölogy of the University of Michigan while the writer held a Fellowship of the John Simon Guggenheim Memorial Foundation of New York.

#### COMPLETION OF THE WORK

This work was completed in essentially its present form, and the preceding paragraphs of the introduction written, at the end of 1946. Early the following year, my farm was rudely invaded by a band of ignorant men who had been led by communist agitators to believe that they could gain possession of it. Nobody could foretell to what extremes of violence and destruction such lawless action might lead, and as a precaution I hastily sent the typescript to San José with my friends Mr. and Mrs. Roger T. Stone, who kindly had it bound and forwarded it to the United States, and to whom I here express my gratitude. During the following six years I have continued to dwell, peacefully enough since the anxieties of the terrible revolution of 1948, in the same spot, surrounded by many of the birds whose histories appear in this volume. Additional information about them has accumulated, and where this seemed of sufficient importance it has been incorporated in the accounts already written. In particular, those of the Buff-throated Saltator and the Gray-headed Tanager have been considerably expanded; and minor additions or changes have been made in a number of others. For all those species for which I have records of nests from the same locality extending over a number of years, I have added, at the end of the section on the eggs, a statement of the distribution of these nests according to the month when laying began. Thus a nest of a small passerine found with nestlings on the tenth of the month would be entered under the preceding month, as would a nest found with three eggs on the second of the month. Continued experience has convinced me that this is the most compact and illuminating way of giving the season of reproduction. It will be noted that these statements of the distribution of sets of eggs, which take account of nests found in 1952, are often based on a larger number of records than were available when the life history was written and statements made concerning the height of nests, size of eggs, and the like. Since the reworking of this considerable body of data would in most instances lead only to minor changes in numerical values, I have as a rule not undertaken it when the earlier statements were

based on a fairly large number of records. Four additional life histories, those of the Blue-black Grosbeak, Orange-billed Sparrow, Black-striped Sparrow and Red Ant Tanager, were written early in 1953. Finally, I might call the reader's attention to certain papers that I have published concerning some of the more general aspects of Central American bird life, which but for lack of space might have been treated as an introduction to the present work. These are cited in the bibliography at the end of this volume.

Finca "Los Cusingos,"  
San Isidro del General,  
Costa Rica,  
January 12, 1953.

## FAMILY FRINGILLIDAE

### VARIABLE SEEDEATER

#### *Sporophila aurita*

Almost everywhere in the lowlands of tropical and subtropical America, the savannas, grassy openings in the forest, and roadsides are frequented by flocks of very small finches with short and thick bills, which feed on the seeds of grasses. In the genus *Sporophila*, the males are clad in black, black and white, or black and chestnut, while those of the genus *Tiaris* are olive and yellow. In both genera the dull females are olive or buff. Often the same species shows pronounced variation in plumage from region to region.

In Costa Rica, one of the most common of these small finches is the Variable Seedeater. It is a bird slightly less than four inches in length. In the population (*Sporophila aurita aurita*) of the Pacific slope of southern Costa Rica and southward through Panamá and the Pacific littoral of Colombia almost to Ecuador, the male is mostly black with a white rump, a small white patch on each wing, a white half-collar which is narrowest on the throat and broadens on the sides of the neck, and a white abdomen, shaded with gray except in the center. The white collar on the foreneck is separated from the white abdomen by a broad black band across the chest. In Panamá, this seedeater has a black plumage phase in which white is restricted to a small isolated patch on either side of the neck and to the abdomen. On the Caribbean slope of Central America from Panamá northward, the species is represented by a race (*S. a. corvina*) entirely black in plumage, except for some white on the wings. In both races the female is olive above, paler olive on the breast and buffy on the abdomen. In both sexes, the eyes, the short, thick bill, and the feet are dark.

On the Pacific slope of southern Costa Rica the Variable Seedeater is very abundant and ranges from sea level upward to at least 5000 feet. These little birds are at home in all sorts of open, bushy or cultivated areas where grasses abound, and they often swarm along grassy roadsides and in the larger clearings, where they form loose flocks, often in company with the Blue-black Grassquit, the Yellow-faced Grassquit, and the Lesser Rice Grosbeak. Even in the breeding season they are somewhat sociable, their territories being small and loosely defended.

#### FOOD

The Variable Seedeaters subsist chiefly on the seeds of grasses. About my house in El General they eat principally those of the tuvarrá, a species of *Paspalum*, alighting on the slender stalks that nod gracefully beneath their slight weight and stripping the tiny flat seeds from the long, thin, one-sided spikes. They vary their diet with the seeds of Compositae, and I have seen them enter thickets to gather the flat achenes of the yellow-flowered *Zexmenia frutescens*. They remove the embryos from the flat, bristle-rayed achenes of *Heliocarpus*, a rapidly growing tree that springs profusely on cleared lands. They cling to the thick, dangling fruiting catkins of the guarumo (*Cecropia*) trees and tear off billfuls of the little crowded green fruits, sharing this food with a multitude of other birds, including tanagers, honeycreepers, orioles, toucans and larger finches. At times they eat freely the small green or orange fruits of mistletoes (Loranthaceae). Insects of various sorts are also included in their diet, and many are gathered for their young.

#### ROOSTING

In 1935, the Variable Seedeaters that dwelt in the narrow clearing cut into the forest which covers Barro Colorado Island in Gatún Lake, a score or more in number,

gathered in the evening to roost in a patch of tall grass at the lower side of a banana plantation on the shore of the lake. The grass, shoulder-high, grew in a dense mass on marshy ground at the water's edge or floated in the adjoining shallows. After sunset the seedeaters would drift into their roost, a few at a time, pausing to gather grass seeds on the way. As the twilight deepened they kept up a constant little chatter from the depths of the grass, until in the dark they dropped into silence and to sleep. In later years, in Costa Rica, I found many Variable Seedeaters roosting in a small field of sugar-cane.

#### SONG

The male seedeater sings from a bush or tree, usually at no great height. At its best, his song is varied and long-continued, beginning with a hurried, breezy prelude that leads up to a rushing climax and then tapers off in chaffy trills. It is a production admirable for its long duration, variety and intensity rather than for richness of tone, and to my ear is inferior to the song of the White-collared Seedeater of northern Central America.

The breeding season of the Variable Seedeater is determined by the abundance of grass seeds and is at its height later in the year than that of most of the birds among which it dwells. Hence the male seedeaters are in fullest song at a time when other songsters are performing less or becoming silent. Although in wet years Variable Seedeaters may sing a little in March, it is usually mid-May before they are heard with frequency; and when in the early months of the year the dry season has been long and severe, they may not come into full song until past the middle of June. In late May, June and July the seedeaters often produce more music than any other species in cultivated areas of the Térraba Valley. In normal years, in late July, the seedeaters' singing begins to diminish, yet it is still occasionally heard in fine weather through August; in September it ceases. In December and January there is another period of moderate song, associated with a subsidiary period of breeding at the beginning of the dry season.

The seedeater's most common call is a low, mournful, whistled monosyllable. It also utters a drier, more nasal call which at times consists of several syllables.

#### INITIATION OF THE BREEDING SEASON

Variable Seedeaters reproduce in the period of the year when their food is most abundant. During the dry season, which in the Térraba Valley is at its height in January and February and sometimes continues through March, the grasses grow slowly, or, in a year of especially severe drought, may dry up entirely. With the return of rains they spring up anew, but many weeks must pass before their seeds ripen. Accordingly there is an interval of two months or more between the beginning of the rainy season and the start of nesting by seedeaters; but the earlier the rains fall, the earlier these birds begin to breed. A similar relationship has been observed between the onset of the wet season and the nesting of the Yellow-faced Grassquit. Other birds which do not subsist upon grass seeds, as, for example, the Song Tanager, breed earlier in a wet than in a very dry year; but their response to the first showers is almost immediate, not delayed as in the seedeaters and grassquits.

In 1936, when I lived in the valley of the Río Buena Vista on the northern side of the basin of El General, the dry season was fairly severe and did not come to an end until late in March. The first nests of the Variable Seedeater were found at the beginning of July, when they already contained eggs, indicating that building had started about the last week in June. In 1937, 1939 and 1940 my field work in El General ended between the middle and last of June, and I discovered no nests of this species. In 1942

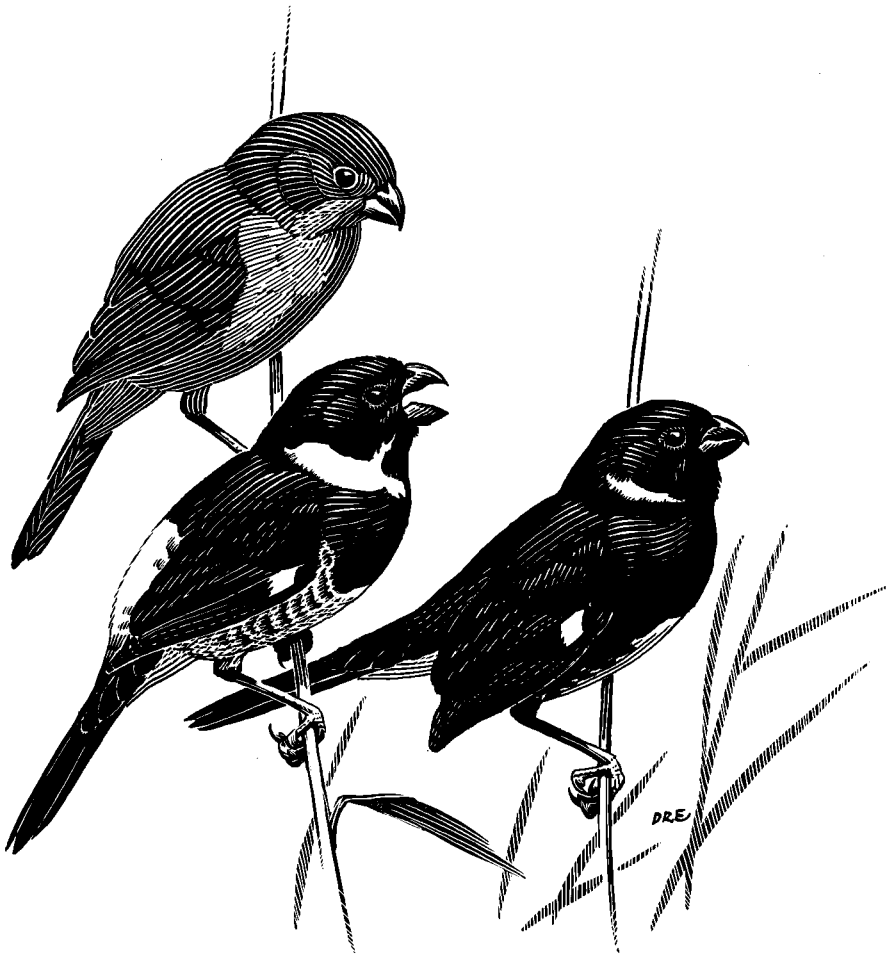


Fig. 6. Variable Seedeaters. Above, female; lower left, normal male of race *Sporophila aurita aurita*; lower right, black phase of same race.

and subsequent years, I resided on my farm in the district called Quizarrá, in the valley of the Río Peña Blanca. The dry season of 1942 was short; there were occasional showers in January and February; soaking rains fell early in March, and the pastures were lush throughout the year. A seedeater was seen building on April 28, and two nests with eggs were found on May 13 and 14. The early months of 1943 and 1944 were somewhat drier, and showers did not fall with regularity until later in March; but the pastures remained green. In 1943 a nest with eggs was found on June 10. The following year, a female was building on May 15, and a nest with eggs was discovered on May 27. But in 1945 the dry season was severe. The pastures became parched and brown. Although there were a few showers late in March, the drought was afterward renewed; and it was nearly mid-April before the soil was wet enough to permit the growth of grasses and herbs. I discovered no evidence of nesting by the seedeaters until June 17. In 1946, another dry year, the earliest nest was found on June 27 and contained its first egg the following day. Thus, in the same locality, the date of the initiation of nesting

may vary by about two months, from late April in a wet year like 1942 to late June in severely dry years like 1945 and 1946.

#### THE NEST

The slight, open nest of the Variable Seedeater is placed in a tree or bush, usually in a crotch amid sheltering foliage. The nest tree may stand in a dooryard, shady pasture, coffee plantation, hedgerow, or an open copse or grove. Often it is at the edge of the woody growth, beside a pasture or grassy field. Perhaps because they are so abundant in the areas where I have studied these birds, the guava (*Psidium guajava*) and species of citrus are the most favored nest trees. Of the 82 nests I have recorded, 16 were in guava trees, 20 in orange or lemon trees, 5 in calabash trees (*Crescentia cujete*), and 10 in coffee bushes. The orange, with its dense, dark foliage and long, sharp, projecting spines, is a favorite nest site of numerous kinds of birds; but the guava, with its more open foliage which provides poor concealment, and with smooth, slippery bark that makes attachment difficult, is avoided by most nesting birds. Yet seedeaters find the guava adequate for the attachment and concealment of their slight nest structures. Three nests were built in the widely branched tassel or staminate inflorescence of maize plants.

An unexpected situation for a seedeater's nest was the center of a bunch of green bananas hanging in a small plantation. Here it was so well concealed that I did not become aware of its presence until after I had cut the bunch of bananas and was about to carry it home, when the sharp cries of the half-grown nestlings drew my attention. It was too late to restore the fallen banana plant; but I removed the little cup—which I could extract from its snug niche only after breaking away some of the green fruits—and set it on top of the high stump of the banana stem, where it was roofed by a bent-over leaf-sheath. Here the parents found it and continued to attend their offspring.

Eighty nests of the Variable Seedeater ranged in height from 35 inches to 30 feet above the ground. Twenty-seven of the nests were between 35 inches and 6 feet above the ground, five between 20 and 30 feet up, and the remaining 48 between 6 and 20 feet.

Nests are usually completed and in use before one finds them, hence I have no adequate observations on nest building. So far as I have seen, they are made by the female alone. Once I saw a male sit in and shape an unfinished nest, but I detected no material in his bill as he came to it. The finished nest is an open cup composed largely of wiry, fibrous rootlets, with an admixture of bast or other fibers, lined with a few strands of horsehair, and fastened to the forked branch with cobweb. At times a few tufts of green moss are attached to the outside, but the general color of the nest is usually dark brown. The walls and bottom are thin and of a texture so open that the eggs can be seen through them; yet the structure, for all its seeming frailness, is strong and enduring. What W. H. Hudson (1920:46) wrote of the Screaming Finch, or Screaming Seedeater, as we should call it, is equally true of the Variable Seedeater; it "has successfully solved the problem of how to construct the most perfect nest for lightness, strength, and symmetry with the fewest materials." A nest of the Variable Seedeater now before me measures 3 inches in over-all diameter by 2 inches in height. The interior is  $1\frac{3}{4}$  inches in diameter by  $1\frac{1}{2}$  inches deep. The rim is slightly incurved, the better to protect the eggs from falling out.

#### THE EGGS

The eggs are laid early in the morning. Five of which I timed the laying were deposited between 5:30 and 6:50 a.m.; two were laid before 6:30, and three after 6:10. They are laid on consecutive days.

Sixty-seven nests contained two eggs or nestlings, and a single nest held three nestlings. Sets of two appear to be the rule among the tropical species of *Sporophila*; but I found one nest of *Sporophila aurita corvina* with three eggs. Two nests of the White-collared Seedeater (*S. torqueola*) from the Pacific slope of Guatemala contained three eggs; but more numerous nests of this species from Caribbean Central America held sets of two. Cherrie (1916:188) records two sets of three eggs of *S. grisea* from the Orinoco region, and Belcher and Smooker (1937:540-544) found occasional sets of three in nests of *S. intermedia*, *S. plumbea*, *S. nigricollis* and *S. bouvronides*. Beyond the tropics, the Screaming Seedeater lays three eggs in the La Plata region of Argentina (Hudson, 1920:46).

The eggs of the Variable Seedeater are pale gray or blue-gray, finely speckled or more coarsely blotched with shades of brown, varying from cinnamon to dark brown. Some eggs bear also a few fine or heavy spots and scrawls of black. The dark markings are usually densely crowded on the thicker end of the egg, while the remaining surface may be lightly or heavily spotted. The measurements of 23 eggs average 17.4 by 13.0 millimeters. Those showing the four extremes measured 19.1 by 13.1, 17.5 by 13.5 and 16.3 by 12.7 millimeters.

The distribution by month of laying of 77 nests in the valley of El General, 2000 to 3000 feet above sea level, is as follows: May, 5; June, 27; July, 25; August, 17; December, 1; January, 2.

#### INCUBATION

The female Variable Seedeater incubates with no help from the male. I have devoted a total of about 31 hours to studying incubation at four nests. The results of these observations are summarized in table 1.

Table 1

Attentiveness of the Female Variable Seedeater at the Nest During Incubation

Nest number	Hours of record	Number	Sessions			Number	Recesses			Per cent of time on eggs
			Shortest	Longest	Average		Shortest	Longest	Average	
7	8	14	2*	99*	24.9*	14	2*	26*	8.3*	75.0
30	9	5	29	148	74.2	5	8	22	17.2	81.2
44	6	15	7	32	14.9	15	4	10	7.7	66.0
45	8	12	12	33	22.5	12	7	22	14.4	60.9

\* Minutes.

These seedeaters varied surprisingly in their rhythm of incubation and the proportion of the time they devoted to covering their eggs. At some nests, the same individual showed great variability in her incubating according to the time of day and the weather.

This was especially true of the owner of nest 7, which I watched on July 23, 1936, 9 days after the set of eggs was complete. This bird's sessions on the nest decreased from 96 minutes in the chill dampness of the early morning to 2, 3 or 4 minutes in the late morning and early afternoon, when the sun was beating down through a thin mist of clouds and the air had become warm, then lengthened abruptly to 99 minutes in the late afternoon, when a hard rain fell. With such great and abrupt variations, averages as given in the table signify little.

Nest 30, situated in a coffee bush, was watched for 6 hours on the morning of August 14, 1943, and for 3 hours in the late morning and early afternoon of August 16. The period of incubation was drawing to a close, for the eggs hatched on August 19. During the entire morning of August 14 the sky was heavily overcast and the air rather cool. The female seedeater took two long sessions, lasting 148 and 128 minutes, and two recesses lasting 18 minutes each, these two sessions and two recesses together occupying nearly the entire morning. During the late morning of August 16 the sun shone brightly and the air was warm. After midday the sky was overcast and the atmosphere sultry; the



seedeater panted while sitting. Under the conditions her sessions were 30, 36 and 29 minutes, her recesses 20, 8 and 22 minutes. I ended my vigil as the afternoon shower usual at this season began to fall. During the cool morning this seedeater had devoted 88.4 per cent of her time to incubation; in the warm middle of the day her time on the eggs fell to 65.5 per cent.

Nest 44 was watched during 6 hours of the morning of July 7, 1945, 11 days after the set of eggs was completed and the day before they hatched. The dawn was dark and cloudy, with a fine drizzle falling. Between 7 and 10:30 the sun shone brightly, then the sky clouded over again. The length of this seedeater's sessions varied in no orderly manner; the longest, lasting 32 minutes, was taken in the middle of the morning, in fair weather. Her recesses were fairly constant in length.

Nest 45 was studied on July 2, 1945, the penultimate day of incubation. There was some bright sunshine in the early morning, but after 9 o'clock the sky clouded over and the air became cool. During the early afternoon there were intermittent sunshine and showers. This female sat the least constantly of all. Although her sessions on the eggs averaged substantially longer than those of her neighbor at nest 44, her absences were nearly twice as long; and this greatly reduced her total time on the nest.

The female sits deeply in her little cupped nest. At times only the tip of her tail shows above the rim. If the weather is warm, she may sit higher so that her eye is visible over the nest's edge. But many nests are of such open construction that the outline of the bird's head and back appear through the meshwork, and at times even her glittering eye may be caught through a gap in the fabric. Upon approaching her nest she often utters her low, full, mournful whistle. A human visitor often causes both male and female to protest with repetition of these plaintive notes while they perch at a respectful distance from the intruder.

While I watched nest 7, which was situated ten feet above the ground in a *Cestrum* bush growing in a thicket close by a river, my blind was invaded by big, black army ants that crawled over the walls and caused my temporary withdrawal. When at the end of half an hour they had passed on, I resumed observations. Now the ant horde had flowed in the direction of the nest, and many crawled up the supporting branch and over the rim. But the female seedeater continued to cover her eggs closely while the ants swarmed about her. Soon they departed, apparently having done her no injury and none to the eggs.

The female of nest 44 from time to time left her eggs to do something to the outside of the nest—an activity I have seldom witnessed among incubating birds. For several minutes at a time she would hang beside the nest and bill the fabric; but I could not satisfy myself as to just what she was trying to accomplish. Once she examined the outside, then stood on the rim and bent down her head inside, then again gave attention to the outside, then once more the inside, and finally resumed incubation. This behavior suggested that she might be trying to capture an ant or other tiny insect that crawled through the meshes of the nest, which was so thin and open that while sitting she might detect such a small creature through the walls or bottom. On the day her eggs hatched, the seedeater of nest 45 devoted much time to the same activity, once spending seven minutes continuously billing the outside of her nest while she clung to the foliage beneath it.

The behavior of the males while their mates incubated varied considerably from nest to nest. At four of the nests the male sang more or less, among neighboring trees. At both nests 7 and 30, which were watched for a total of 17 hours, the male did not once come near. At nest 45, once during the course of eight hours, the male flew rapidly over the nest, pursuing his mate as she returned to her eggs, but otherwise he also did not come near. But at nest 44, the male came to perch on the rim twice in the course of a morning. As he arrived on his first visit the female flew away. He stood on the rim, lowered his head into the bowl, and worked his bill; but I could not actually distinguish food in it. He seemed to be anticipating the hatching of the nestlings—offering food to them while

they were still tightly enclosed in the shells. On his second visit, the female remained sitting and took the food he regurgitated.

After nest 20 had been repaired for the second brood, but before, I believe, the first egg was laid in it, I saw the male approach with grass seeds on the outside of his bill and apparently more in his throat. Perching on the rim, he bent down his head and went through the motions of feeding nestlings. The second egg was not laid and incubation was not begun in this nest until two days later. At this nest, too, the male fed the female while she covered the eggs. At a nest of *S. a. corvina* the male repeatedly came with food during the course of incubation. If the female was present he fed her; otherwise, he went through the motions of feeding the eggs.

The period of incubation varies from 12 to 13 days. At three nests both eggs hatched on the twelfth day after the second was laid; at two nests, on the thirteenth day. At several nests an effort was made to ascertain the length of the incubation period in hours. At nest 44, the second egg was laid between 6:10 and 6:50 a.m. on June 26 and hatched between 1:25 and 4:05 p.m. on July 8, giving an incubation period between 12 days, 6½ hours and 12 days, 10 hours. At nest 50, the second egg was laid between 6:15 and 6:50 a.m. on July 28 and hatched between 6 p.m. on August 9 and 5:30 next morning, giving a period between 12 days, 11 hours and 12 days, 23 hours. At nest 51, the second egg was laid between 5:50 and 6:40 a.m. on August 13 and hatched between 5:45 and 7:00 a.m. on August 25, giving an incubation period of 12 days within a margin of one hour.

#### THE NESTLINGS

At 6 p.m. on July 3, one of the eggs in nest 45 was pipped. At dawn next morning I began to watch this nest. At 5:36 the female ate part of an empty shell, and 9 minutes later she devoured the other part. When at 5:53 she flew from the nest, I examined it. The single, tiny, blind, pink-skinned nestling bore sparse gray down and the interior of its mouth was red. Returning at 6:00, the female gave the newborn nestling its first meal, then brooded. At 6:16 she again flew from the nest, and at 6:19 the male came and fed the nestling. Five minutes later he again brought food. This prompt feeding by the male seedeater was wholly unexpected, for in eight hours of watching two days earlier, I did not once see him come to the nest to inspect its contents. When male birds neglect to make visits of inspection while the eggs are being incubated, they are generally slow in learning that they have hatched. How had he discovered so promptly that the nestling was hatched? Possibly by seeing his mate gather food for it.

I continued my watch of this nest until 11:30. The second egg hatched before the middle of the morning. During the course of the morning the male seedeater brought food 12 times. If the female was brooding when he came, he delivered it to her and she rose to pass it to the nestlings. Once after taking some food from him, she flew from the nest, leaving him to give the nestlings the remainder of what he had brought. At other times she left as he approached. From 8:46 to 10:24 he remained away from the nest, inexplicably.

The female fed the nestlings 14 times. She brooded 15 times for periods ranging from 3 to 37 minutes, and averaging 12.5 minutes. Her 15 absences varied from 7 to 16 minutes in length, averaging 9.7 minutes. She devoted 56.5 per cent of the morning to brooding. During the same hours on the morning of July 2, she had incubated 61.7 per cent of the time.

Because the male had twice brought food to nest 44 on the last day of incubation, I had expected that he would feed the nestlings no less promptly than the male of nest 45; but it turned out quite otherwise. The first egg in this nest hatched between 7:00 and 9:15 a.m. on July 8. Between 9:15 and 12:15 p.m. the female seedeater brooded 19

times, for periods ranging from less than 1 to 11 minutes, averaging 4.9 minutes. She took 18 recesses, from 1 to 9 minutes in length, also averaging 4.9 minutes. She devoted 50 per cent of the time to brooding. As well as I could see, she fed the nestling at each return to the nest, or a total of 19 times.

The second egg in nest 44 hatched on the afternoon of July 8. On July 9, I watched the nest for 3 hours more, divided between the morning and afternoon. The female fed the 2 nestlings 18 times—no more than she had fed the single newly hatched nestling the previous morning. The time she devoted to brooding was considerably decreased. She covered the nestlings 14 times, for periods ranging from 1 to 7 minutes and averaging 4.5 minutes. The 12 absences that I timed in full ranged from 3 to 15 minutes, averaging 7.4 minutes. She spent only 37.8 per cent of the 3 hours on the nest.

By 2 p.m. on July 9, I still had not seen this male seedeater feed the nestlings; but early on the morning of July 11 he was bringing food regularly. Hence he began to feed the nestlings between one and three days after they were hatched, whereas the male at the neighboring nest 45 brought food to the first nestling 40 minutes after his mate had eaten the shell from which it escaped. The long delay in feeding the nestling on the part of the male seedeater who had from time to time brought food to the nest while it contained eggs is explicable only on the hypothesis that such visits during the period of incubation occurred at irregular and usually long intervals, perhaps not at all on some days, but on other days twice or more.

The food intended for the nestlings is carried almost wholly in the parent's mouth or throat and delivered by regurgitation. Only rarely is a small portion of a green caterpillar or other insect seen projecting from the parent's bill as it approaches the nest. Alighting upon the rim, it proceeds to place successive portions into the red interiors of the two mouths widely gaping in front of it. Often the same nestling receives several mouthfuls in succession; at other times the two are fed alternately. Usually both of the young birds receive food at each of the parents' visits to the nest. At a nest with half-grown nestlings the parents delivered from 3 to 11 portions at each visit. At another nest with young birds on the point of departure, the number of feedings per visit ranged from 4 to 19, although only rarely more than 12 were delivered at a single visit.

It is difficult to learn the nature of the nestlings' diet. When the parents come to the nest they often have grass seeds adhering to the outside of their bills, suggesting that this is what they have been gathering. But small insects apparently also form an important part of the young birds' fare.

Older nestlings raise a shrill chorus, audible at a good distance from the nest, each time food is brought to them.

Some rates of feeding of nestlings of various ages are given in table 2. The rate of bringing food to the nest increases as the nestlings grow older. Apparently also older nestlings receive a greater amount of regurgitated nourishment each time the parent comes to the nest, but it is not practicable to measure this with accuracy. Maximum rates of slightly more than 8 feedings per nestling per hour were recorded at nests containing young on the point of departure. It is of interest that the rate per nestling was very nearly the same at nest 42 with 3 nestlings as at nest 45 with 2 nestlings, although the rate for the nest as a whole was greater for the bigger brood. After the departure of the first nestling from nest 45, the rate of feeding the stay-at-home fell to 6.25 per hour; but it is probable that the first, which promptly vanished amid the herbage, was receiving the greater share of its parents' attention.

In nest 44, however, the last nestling to leave was fed more frequently than any other. In an hour and a quarter, which began while this young seedeater showed the restlessness which presaged its departure from the nest, and ended when it disappeared into the hedge half an hour after it flew from the nest-tree, this fledgling was fed 15

Table 2

Nest number	Number of nestlings	Age of nestlings	Rates of Feeding of Nestling Variable Seed eaters				Feedings per hour	
			Hours watched	Number of feedings By male	By female	Total	Total	Per nestling
45	1-2	just born	6	12	14	26	4.3	
44	1	just born	3	0	19	19	6.3	6.3
44	2	just born	1	0	6	6	6	3
44	2	1 day	3	0	18	18	6	3
4	2	6 days	2	6	18	24	12	6
42	3	12 days	1	13	12	25	25	8.3
45	2	12 days	2	14	20	34	17	8.5
45	1*	12 days	4	6	19	25	6.25	6.25
44	1*	13 days	1.25	15	0	15	12	12

\* Other nestling has left.

times, or at the rate of 12 times per hour, entirely by the male. The female was doubtless giving all her attention to the young which had left the nest the preceding day.

Both parents take substantial shares in feeding the nestlings, but the female as a rule brings food somewhat more often than the male. At nest 45 on July 16, 1945, the female not only came more often with food, but seemed to bring more at each visit, if the number of feedings per visit may be taken as an indication of this.

At the age of ten days the nestling seedeaters are fairly well feathered, and those of both sexes wear the olive plumage of the adult female. They are then no longer brooded by day in fair weather; but at nest 45 the female covered her twelve-day-old nestling while it rained, even after its nest mate had flown from the nest. She was not, however, consistent in shielding the single nestling from the intermittent afternoon showers; and for this the restless young seedeater was itself partly to blame. She brooded for 13 minutes while rain fell hard, then left to bring food in the rain. When the downpour increased in intensity, she tried to cover the youngster again; but it rose up, begging for food, and would not be sat upon. She flew away, but returned in a moment and brooded, remaining for ten minutes, but flying off before the rain had stopped.

At nest 34, the female brooded her two twelve-day-old nestlings through their last night in the nest, possibly because it was raining at nightfall. They flew away early next morning. At nest 45, the female covered her nestlings during the last night that both were together in the nest. After the departure of the first, at the age of 12 days, the second, which lingered in the nest a day longer, was not brooded through the night. At nest 44, the female brooded the nestlings on the next-to-last night that both were together in the nest, but not on the last night. Hence the second nestling, which departed at the age of 13 days, passed two nights in the nest unattended, the first with its nest mate, the second alone.

On the day before they leave the nest, the young seedeaters may hop upon the rim, then return to the bottom of the cup. As the time for taking flight draws near, they become more restless, often jumping up on the rim, preening and exercising their wings. At this stage they are very easily frightened from the nest by the approach of a man or other intruder. I have witnessed, while watching continuously from partial conceal-

ment, the departure of five fledglings from three nests. All flew from the nest quite spontaneously, without the least urging by the parents. One, however, left when the parents came together bringing it food.

The first flight of the young birds reveals considerable strength and skill. One, starting from a nest 7 feet up, covered about 20 feet before it came down in the grass. Another, frightened from the nest when only 11 days old, flew surprisingly well. As a thirteen-day-old nestling flew from its nest to a neighboring tree, its father flew almost in contact with it—a habit not uncommon among parent birds.

About the time it leaves the nest, the young seedeater's voice undergoes a notable change. Its notes now acquire a peculiar nasal twang resembling one of the call notes of the adults, strikingly different from the shrill cries of a nestling. One fledgling began to call in this fashion as soon as it had flown from the nest and its loud cries soon brought the parents to its side with food. Upon hearing these nasal notes, the nest mate, apparently the member of the brood which was the younger by a few hours, began to call from the nest in the same manner, repeating these nasal notes from time to time until its departure next morning.

One nestling left, apparently spontaneously, when only 11 days old. Three nestlings left at the age of 12 days, and 9 at the age of 13 days. I know the approximate hour of departure of 15 nestlings. Only 2 of these left in the afternoon. The other 13 flew from the nest in the morning. Most left early in the morning, 11 before 8:30, and at least 5 of these before 6:30 a.m.

After the first nestling abandons the nest, it may claim the entire attention of one of the parents, while the other continues to feed the one that remains behind. At nest 44, as we have seen, the male alone fed the second nestling during its last morning in the nest, the female apparently devoting herself exclusively to the young bird that had departed the preceding afternoon. But at nest 42, which held three nestlings, the male was not seen to bring food after the exit of the second. In the slightly more than three hours which intervened between the departure of the second nestling and the flight of the third, I saw only the female visit the nest. At nest 45, however, both parents continued to feed the second nestling until its departure, nearly 23 hours after the first went off.

The division of the fledglings between the two parents, the male taking some and going his own way independently of the female, which takes charge of the rest, has been recorded for other species: for the Snow Bunting by Tinbergen (1939:40) and for the Ovenbird by Hann (1937:212). With Cardinals, too, the last brood of the season may be divided between the parents for attention (Laskey, 1944:33). At a nest of the Bridges Ant-shrike, the male disappeared when the first nestling left, the female alone feeding the other until its departure nearly 24 hours later.

But in the Variable Seedeater, the division of the brood between the parents, even when it occurs, is apparently of only temporary duration. After the second nestling follows the first from the nest, the family is re-united. On July 1, 1944, while I sat in a blind watching a nest of a Gray's Thrush, a family of Variable Seedeaters foraged close about me. The adults were accompanied by two full-grown young, which addressed their parents with rapidly repeated shrill cries and were fed frequently. Their food consisted chiefly of seeds of the tuvarrá grass and the fruits of the mistletoe that grew on the mandarin tree where the thrush's nest was situated. Sometimes the parents would take a mistletoe fruit and put it directly into the mouth of a fledgling, first, I believe, removing the skin. But at other times they regurgitated the food in many installments, as when feeding nestlings.

One year a family of Variable Seedeaters, consisting of parents with a single fledgling, frequented my yard in September and October, often visiting a lemon tree heavily

infested with mistletoe, upon whose small green berries they feasted. The youngster, when it had been out of the nest at least seven weeks, continued to beg for food with high-pitched, rapidly repeated, long-continued cries. The parents fed it often, although it was perfectly able to take care of itself. One afternoon, while the young bird waited close beside him, the father plucked mistletoe berries until he had a throat-full, then fed them to the youngster in a number of installments, just as though he had been feeding at the nest. Under these circumstances, it would have seemed simpler and more direct if the parent had passed each fruit to his offspring as it was plucked; but the method of feeding by regurgitation persisted. The meal over, the parent flew away followed by the youngster, which flew equally well.

By late August, when young and old flock together in rice fields and other grassy places, the young males hatched in the last few months reveal all stages of the transition from the olive juvenal plumage to the contrasting black and white of the adults.

Gross (1952), who made a careful study of this species on Barro Colorado Island, discovered two males assisting a single female in the care of young.

#### LATER BROODS

In nest 24, built in a calabash tree in early May, 1942, nestlings were hatched on May 23 and 24. My notes fail to record the fate of these young seedeaters. At the beginning of August a female, presumably the same one, reconstructed this nest, laid two eggs in it on August 7 and 8, and successfully reared two fledglings, which took wing on September 2. From nest 45, the two fledglings departed on July 16 and 17, respectively. About August 10 the female reconditioned her nest, and on August 14 and 15 she laid two eggs. Her attempt to rear a second brood was unsuccessful, for two days later the eggs had vanished. These two are my only certain records of second broods.

The principal breeding season, which as we have seen may begin at the end of April in a wet year or not until late June in a severely dry year, comes to an end in late August or early September. My latest nests with eggs were found in the last week of August; my latest record for the departure of nestlings is September 20, 1948. So far as available evidence goes, the breeding season terminates at about the same time, whether it begins early or late. Hence, although the seedeater's principal period of reproduction is always in the rainy season, it is possible that they may produce more broods in years when the preceding dry season has been short and mild than in years when it has been long and severe. In September song ceases and the birds flock. But in December, when the *tuvarrá* grass (*Paspalum*), so abundant in El General, produces another crop of seeds, the seedeaters sing and nest again, continuing into January. Yet song is at this season never so profuse, nor nests so abundant, as during June, July and August. Of my 82 recorded nests, only 3 were found near the end of the year. But at this season, when nests of all kinds are far fewer than in the months of spring and summer in the Northern Hemisphere, one does not go nest-hunting with the same zeal as during the period when the harvest is richer; hence the disparity in the number of recorded nests of the seedeater may not be an accurate index of the relative abundance of nests in the two breeding seasons. I have seen full-grown young birds from this year-end nesting plead for and receive food as late as the beginning of March. Probably they had hatched in January.

One of the January nests of the seedeater was situated in a guava tree about a hundred feet from my dwelling, whence I could hear the shrill chorus which the nestlings raised each time that food was brought to them. One day at noon my attention was drawn by the excitement of the parent birds. They uttered their mournful call notes, and the male from time to time delivered brief snatches of song. Hurrying up to the

guava tree, I found a slender green snake stretched out in a sinuous line along the branch that supported the nest. Its head was at the nest, and an abrupt swelling in the forepart of its body revealed the fate of one of the nestlings. Seizing a stick, I knocked down the snake. I could not find the second nestling, but its weak cries issued from a tangle of vines beneath the nest. The parents hovered around, and long after I had driven the serpent away continued their calling.

Did the loud, chiming chorus which the nestlings raised each time they were fed lead the snake to them, or do snakes locate birds' nests by sight or smell alone? If the voices of nestlings do in fact guide snakes to their nests, one would suppose that natural selection would long ago have put an end to their volubility, especially in regions where snakes are abundant.

#### SUPPLEMENTARY NOTES ON

#### *Sporophila aurita corvina*

At most points along the Caribbean coast of Central America this race is common and conspicuous in suitable habitats; in Guatemala and Honduras it is far less abundant than the swarming White-collared Seedeater with which it associates, but in Costa Rica it is possibly the more numerous species. Males of the Lesser Rice Grosbeak are readily confused with the black males of this form of the Variable Seedeater, but they may be distinguished by their even thicker bills and, in the proper season, by their fuller and more varied song. The females of the two species are more easily separated; the female grosbeak has a richer brown plumage than the female seedeater.

In its dietary habits the Black Variable Seedeater appears to differ little from other members of the genus. In the Lancetilla Valley of northern Honduras, many seedeaters roosted nightly in the depths of a tall stand of elephant grass (*Pennisetum purpureum*), in company with more numerous White-collared Seedeaters and other species (see account of *Sporophila torqueola*). The seedeaters, flying singly or in little flocks, would begin to congregate in their roost an hour before nightfall; and while waiting for the day to end the males of the several species would from time to time lift a many-voiced chorus of song. The song, compared with that of *S. a. aurita*, is somewhat more hurried in delivery. Richmond (1893) considered this seedeater, as he heard it in Nicaragua, to be something of a mimic; but I have not noticed this trait among those members of the species that I have heard in Honduras and Costa Rica.

The breeding season is long. Huber (1932) found a nest with eggs at Eden, Nicaragua, at the end of March; but nests are rare before April or May. On August 2, 1937, I found well feathered nestlings near Vara Blanca, Costa Rica, at an altitude of 5000 feet; and at lower altitudes the birds continue to breed even later. In a nest in the Lancetilla Valley in Honduras, the eggs hatched on August 24; and at Chipoc, Guatemala, Anthony (Griscom, 1932:350) found newly laid eggs on September 1.

The nest is placed in a small tree or bush, in a clump of grass, or in a low, spiny palm. The six nests which I have seen ranged from 18 inches to 8 feet above the ground. The lowest was in a little bush growing near the top of a roadside bank 10 feet high; the highest was in a lemon tree in a dooryard. Carriker (1910:890) states that the nest may at times be as high as 15 feet above the ground, in a small tree.

The nest structure is not significantly different from that of *S. a. aurita*. However, a nest on a palm leaf differed somewhat from others that I have seen, apparently as a result of its unusual position in the acute angle between the rachis of the frond and one of the lateral pinnae. Here it was suspended by the rim, vireo-style, by means of a number of strands of material wrapped over the rachis and a single long fiber over the pinna.

The deep, loosely woven cup was composed of fine grasses, rootlets, tendrils and fibers. The internal dimensions of three nests varied from  $1\frac{5}{8}$  to 2 inches in diameter and from  $1\frac{1}{2}$  to 2 inches deep.

Of the six nests that I have seen, five contained two eggs or nestlings, one held three eggs. Sets of three appear to be as rare in this form as in the nominate race: Carriker (*loc. cit.*) states that two eggs are "invariably" laid, and Huber (*loc. cit.*) and Richmond (*loc. cit.*) report only sets of two. In the set of three, the eggs were laid on consecutive days.

A nest with three eggs was observed in a small lemon tree on a coffee plantation in eastern Costa Rica. On a rainy afternoon the female covered them continuously for 73 minutes and then 61 minutes; but during a bright morning her sessions were much shorter. Her recesses ranged from 8 to 26 minutes. Sometimes the male sang in a madre de cacao tree near the nest; but either he performed very seldom, or he did most of his singing at more distant points, beyond range of hearing. Rarely he brought food to the nest; I saw this only twice. On one of these occasions he fed his mate while she incubated; on the other, he came to the nest during her absence and went through the motions of feeding nestlings when there were only eggs. The third of these eggs had been laid on May 6 and all three hatched on May 18, giving an incubation period of 12 days.

On the afternoon of the day of hatching the male was already attending the young. Both parents fed the nestlings by regurgitation, coming to the nest with nothing visible in their bills, then producing a number of little masses of food and distributing them between the three gaping mouths in no fixed order. On the morning when they were twelve days old, all three nestlings, already well feathered, spontaneously left their frail little nest. At a nest on the other side of the house, the nestlings were badly infested with *tórsalos* (screw-worms), which produced great swellings beneath the skin; yet they recovered from these parasites and flew away.

#### SUMMARY

Variable Seedeaters flock in grassy areas from the lowlands up to at least 5000 feet above sea level. Small grass seeds are their principal food, but when these are scarce they eat the achenes of various Compositae, small seeds of other plants, berries of mistletoe, and small insects.

These seedeaters roost gregariously in tall grass or in stands of sugar cane.

The male's song is rapid and varied but not of high musical quality. In El General the period of greatest song is from May to July, and there is also a good deal of singing in December and January.

Variable Seedeaters breed at times when there is an abundance of grass seeds. Since after the return of the rains some weeks elapse before the newly springing grasses set their seeds, there is a corresponding delay in the beginning of nesting, which starts earlier in wet years than in dry but is always considerably later than that of the majority of the small passerines of the same region. In El General the principal breeding season extends from late April, May, or even June to September, and there is also a scattering of nests in December and January.

The slight, open nest is placed in bushes or trees, usually from 4 to 20 feet up.

The two or very rarely three eggs of the set are laid early on consecutive mornings. They are incubated solely by the female, whose diurnal sessions are most variable in length; the sessions range from 2 to 148 minutes in the cases observed. Four females, each watched for six hours or more, incubated from 61 to 81 per cent of the time. One



female remained covering her eggs while army ants swarmed around her on the nest. The period of incubation is 12 or 13 days.

At long intervals the male of some pairs comes to the nest with food for his incubating mate. If she is absent when he arrives, he may present this food to the eggs.

The nestlings, hatched with sparse down, are brooded by the female; they are fed by both parents. One male began to feed them less than an hour after they hatched, but another delayed more than a day. The food, apparently consisting chiefly of minute grass seeds, is regurgitated by the parents, who usually give both nestlings a number of portions on each visit. Rates of feeding varied from three to eight times per nestling per hour, or rarely more.

The nestling period is usually 13 days; often it is 12 days and sometimes it is only 11 days. If undisturbed, the young leave with no urging by their parents, usually in the morning. As a rule they fly well as soon as they leave the nest.

Sometimes when one young bird has left the nest while the other lingers within, each parent takes charge of a different youngster. But after both young begin to move about, the family is reunited.

At least two broods may be raised in the principal nesting season which extends from May to September.

The Black Variable Seedeater of the Caribbean side of Central America has habits quite similar to those of the nominate form.

## WHITE-COLLARED SEEDEATER

### *Sporophila torqueola*

The White-collared Seedeater is the most northern species of the genus *Sporophila* and the only member of this genus which reaches the southern boundary of the United States. The species occurs from southern Texas through México and Central America to Costa Rica and is represented by several distinct geographic races. The Morellet White-collared Seedeater (*Sporophila torqueola morelleti*) is the form found from Veracruz southward. In both Guatemala and Costa Rica it ranges from sea level on both coasts up to about 6000 feet, and rarely even higher. Birds from the lower Pacific slope of Guatemala have been described as a distinct race, *mutanda*.

Like all seedeaters, the Morellet White-collared Seedeater is small, with a very short, thick bill. The male is black over most of the upper surface, including wings and tail, and has a black band across the chest. A white collar extends around the sides of the neck, the rump is white, there are white patches on the wings, and most of the under plumage is white. The female is brownish-olive above and buffy below.

Like other members of the genus, White-collared Seedeaters live in open, grassy places, including pastures, roadsides, weedy fields, and even marshlands covered with tall, coarse grasses. In suitable localities in the Caribbean lowlands of Guatemala and Honduras, they swarm in countless numbers. In 1930 I found this the most abundant species in the cleared lands of the Lancetilla Valley in northern Honduras. In Nicaragua it apparently is rather rare, but it is fairly common in both eastern and northwestern Costa Rica. In western Costa Rica south of the Gulf of Nicoya, it is largely replaced by the Variable Seedeater.

White-collared Seedeaters avoid the forest and even second-growth vegetation in which the woody plants have grown up to form a closed canopy that shades out the grasses. They subsist chiefly on the seeds of grasses, and in their dietary habits appear to differ little from the Variable Seedeater. Late in the evening, after a heavy rain, I watched several White-collared Seedeaters jumping into the air and pursuing insects on the wing in the manner of a flycatcher, but lacking the ease of motion and expertness of the latter.

#### ROOSTING

White-collared Seedeaters roost gregariously in the taller and denser kinds of grass, or in other similar vegetation. In the Lancetilla Valley in 1928, Peters (1929:466) found about two hundred of these birds roosting each night in a planting of bamboo. In the same locality in 1930, most of the innumerable seedeaters in the vicinity of the experiment station appeared to roost in a patch of elephant grass (*Pennisetum purpureum*) that formed a dense stand higher than a man's head and almost impenetrable to him. The birds gathered early at their sleeping place, in October beginning to congregate there at half past four in the afternoon, a good hour before nightfall. They would come from all sides, singly or in pairs or in little flocks of four or five, flying rapidly and low over the more open fields that surrounded the tall elephant grass and swerving upward as they reached their destination. During the breeding season, the black-and-white males were far more numerous in the roost than the brown females, many of which passed the night covering eggs or nestlings.

The White-collared Seedeaters did not occupy this roost alone, but shared it with a great number of birds of other species, including Black Variable Seedeaters, Blue-black Grassquits, Lesser Rice Grosbeaks, and a family of Lesson Orioles that nested nearby.



Fig. 7. White-collared Seedeater. Male and female of the race *Sporophila torqueola moreletii*.

When Orchard Orioles arrived in August, they also roosted in the elephant grass, as did the Baltimore Orioles which came down from the north much later. And in September and early October, large numbers of transient Kingbirds choose the same roosting place, which was now crowded with hundreds of birds of eight species, all of which met in seeming harmony. But the most numerous occupants of the elephant grass were the small finches, and of these the White-collared Seedeaters easily outnumbered the related species. Collectively these little seed-eating finches were far noisier than the orioles, while the Kingbirds were practically silent. From the time of their arrival until well after sunset they kept up an endless chatter; and now and again a burst of canarylike song, beginning at one point in the grass clump, would be caught up by a hundred voices and sweep like a gust of wind over the entire assemblage from end to end, then die as rapidly away.

At the Finca Mocá on the Pacific slope of Guatemala, the White-collared Seedeaters roosted in a narrow fringe of cattails which grew in the shallow water near the shore of a small artificial lake.

#### VOICE

At Alsacia plantation in the Motagua Valley of Guatemala, the White-collared Seedeaters began to sing about March 1, but at that time delivered only the opening notes of the song. In the following days they gradually worked up to the full performance. When I reached Lancetilla on April 22, 1930, I found the swarming seedeaters of the vicinity already in full song. They sang with an intensity scarcely equalled by any other bird of the region. Beginning rather deliberately with low notes that sometimes reminded me of the Field Sparrow's song, they gradually increased their pitch and their tempo, until with utter abandon they were pouring forth rapid gusts of canary-like song,

which often tapered off into dry chaffy trills too thin to be melodious. They sang all through the day, even at high noon, when all Nature seemed to drowse beneath the fierce vertical rays of the sun. Their season of song lasted until late September, when they entered a period of almost complete silence which continued for about three weeks, when the seedeaters were apparently molting. In the latter part of October the males resumed their singing, but now it had a character quite distinct from that which prevailed during the nesting season. The song had now a more tranquil, and even melancholy air; it consisted chiefly of the bird's lower and deeper notes, and usually lacked the ambitious trills so prominent in the breeding season.

At an altitude of 2000 feet on the Caribbean slope of Costa Rica, the White-collared Seedeaters came into song much later than they did near sea level in northern Central America. At Pejivalle in 1941, they began to sing during the last ten days of April. At this time most of the males wore a plumage intermediate between the brown-and-buff of the female and the black-and-white of their breeding attire; and some of those in this transitional plumage were singing, although their song was far less varied and impassioned than that of males in full nuptial dress.

Male seedeaters often sing when defending the nest from some more powerful bird. One day at Lancetilla I found a male and female fluttering and darting around a Kiskadee that was perching near their nest. They seemed almost frantic. Going up to the nest, I found it to contain a single naked nestling which lay on its side as though injured. Suspecting what had taken place, I withdrew into a neighboring thicket of bamboos to watch. Soon the Kiskadee returned to the tree that held the seedeaters' nest; whereupon the parents renewed their attacks, the male in particular falling upon the big flycatcher with such fury that he drove it away. And while attacking, the male seedeater sang, working up to his highest dry trills. But although chased away by the parents, the Kiskadee apparently soon returned to devour the nestling, for when I passed that way again ten minutes later, the nest-cup was empty. I have known the White-collared Seedeater to sing while trying to drive a Groove-billed Ani from the nest tree and to deliver his most animated song while I examined a nest.

#### NESTING

In northern Central America, the breeding season appears to begin in April. At Lancetilla I found my first nest with a single newly laid egg on April 28, 1930, a week after my arrival. At Alsacia in the Motagua Valley of Guatemala I saw no evidence of breeding until April 27, 1932, when I found a female building two months after I had begun field work in this region. At Alsacia nests were not easily located; but at Lancetilla, from May through September, they were so numerous in plantations and weedy fields that I made no effort to record all that I found. The latest contained a recently hatched nestling when discovered on October 1. At Colomba on the Pacific slope of Guatemala, 3000 feet above sea level, seedeaters were nesting in June and July. I found four nests between June 27 and July 24, 1935. A single nest with eggs was seen at Santa María de Jesús, 5600 feet above sea level on the same slope, on August 1, 1934, when it contained eggs. At Pejivalle, 2000 feet above sea level on the Caribbean slope of Costa Rica, a newly started nest was found on May 21, 1941, when the breeding season appeared to be just beginning. Near sea level on the Pacific side of the same country, between the Golfo Dulce and the mouth of the Río Térraba, I found a nest with a nearly feathered nestling and another with two eggs on October 22, 1947. On December 14 I discovered a nest in which the first egg was laid the next day. Here during the last months of the year, when scarcely any birds of other kinds were nesting, the seedeaters were singing and breeding in plumage which showed various stages of transition from that of

the females and young to that of the fully mature male. The foregoing records of nests from the Pacific side of Central America possibly do not refer to the race *morelleti*.

This seedeater's slight, open nest is situated in a bushy pasture, weedy field, garden or orchard, in a low tree, bush or clump of grass, sometimes in a small palm. At Lancetilla two nests were built in potted plants in a large propagating shed covered with open lattice-work to give "half shade." Most nests are three to five feet above the ground; sometimes they are lower and rarely they may be placed as high as 10 feet.

The nest is built by the female alone. Her first operation is to cover the supporting twigs with cobweb. Standing in what is to be the nest cavity, she wraps strands of cobweb about the surrounding branchlets and soon has the entire nest outlined, or better, sketched in, with cobweb, while there are still only a few wisps of firmer material. It is



Fig. 8. Female White-collared Seedeater on nest in a palm tree. Lancetilla, Honduras, August 31, 1930.

remarkable that a bird with so short and thick a bill, apparently little suited for work with material so light and delicate as cobweb, should handle it so well. Next the seedeater gathers fine rootlets, fibers, or delicate branches from the inflorescences of grasses, for the body of the nest. These are sparingly used and form a thin, open fabric through which much light passes. The lining may be of horsehairs when these are available. Five or six days of leisurely work suffice to complete the slight structure. The finished nest is an open cup measuring about  $1\frac{5}{8}$  inches in internal diameter by  $1\frac{1}{4}$  to  $1\frac{3}{4}$  inches in depth.

All of the numerous nests that I have seen on the Caribbean side of Guatemala, Honduras and Costa Rica have contained at most two eggs or nestlings. But of the five nests I found on the Pacific slope of Guatemala, two contained sets of three. The eggs vary from pale blue to bluish-white or pearl-gray in ground-color and are finely mottled with light brown or chocolate, the markings usually heaviest in a wreath about the thick end but by no means absent from the remaining surface. Some eggs bear a few heavy

blotches of black or deep brown in addition to the finer and lighter flecking. The measurements of 13 eggs average 16.3 by 12.7 millimeters. Those showing the four extremes measured 17.5 by 12.3, 15.9 by 13.5 and 15.5 by 12.3 millimeters.

Incubation is performed by the female alone. In one instance the eggs hatched in 13 days. The nestlings are attended by both parents and remain in the nest 10 or 11 days. I am not certain how many broods a single pair may raise in a year, but the breeding season is long enough for three at least. Throughout the nesting season the seedeaters flock to a certain extent and continue to roost in large companies. After the close of the season they join in larger flocks amid the grassy fields and along the weedy roadsides.

#### SUMMARY

White-collared Seedeaters flock in grassy fields and even marshes from sea level up to about 6000 feet in both Guatemala and Costa Rica. They subsist largely on the seeds of grasses.

They roost gregariously in stands of tall grass or bamboo or among cattails in shallow water, often in company with a variety of other small birds.

Song is apparently confined to the males, which in northern Central America sing freely from March until September, with another period of more subdued song after the molt in October. The song is rapid and complex, and it is often delivered in the face of danger.

In the Caribbean lowlands of Honduras and Guatemala, nesting begins in April and continues until October. On the Caribbean slope of Costa Rica it began in May whereas in the region about the Golfo Dulce on the Pacific side of the same country some were nesting in the wet months of October and December. In this last region males were breeding in transitional plumage.

The slight, open nest is situated in weeds, bushes or low trees, usually from three to five feet up and rarely as high as ten feet. The female builds it alone, using much cobweb, and she completes her task in five or six days.

All the nests contained at most two eggs, except some of those on the Pacific slope of Guatemala, where two sets of three were found. Only the female incubates. At one nest the incubation period was 13 days.

The nestlings are fed by both parents and remain in the nest 10 or 11 days. After the breeding season, young and old forage in large flocks in open fields.

## YELLOW-FACED GRASSQUIT

### *Tiaris olivacea*

The Yellow-faced Grassquit is one of the relatively few species of small land birds common to the West Indies and the Central American mainland. On some of the Greater Antilles it is an abundant bird; I found it numerous on the island of Jamaica. On the mainland its distribution is peculiarly irregular. Said to be common in parts of eastern México, in Caribbean Guatemala it has been recorded only rarely, and apparently it is equally uncommon in Honduras and Nicaragua. But in Costa Rica, Panamá and Colombia it is again abundant. In the cultivated districts of Costa Rica it is present in great numbers, ranging from the Caribbean lowlands up into the highlands to about 6200 feet and, over the higher portions of the Pacific slope, down to about 2000 feet above sea level. It inhabits only open country with an abundance of pasture grasses and is never found in woodland. It breeds in some of the wettest districts of the Costa Rican highlands and seems to prefer humid to arid regions; but I have found it living in the rather dry Cauca Valley in the vicinity of Cali, Colombia.

The Yellow-faced Grassquit is a small bird, measuring about four inches in total length. The prevailing color of both sexes is grayish-olive; but the male is distinctively marked with a bright yellow stripe above each eye, a narrow yellow streak on the lower eyelid, and a patch of the same color on the throat. These yellow areas are surrounded by black on the forehead, crown, sides of the head and neck, and breast. The yellow and black markings so prominent on the male are at most faintly suggested in the more uniformly olive plumage of the female. These little finches flock in the pastures and along the grassy roadsides, often in company with Variable Seedeaters and Blue-black Grassquits, both of which are almost equally small. Females, and young males in a plumage resembling that of the females, are always more numerous than the yellow-mustached males in adult attire.

#### FOOD

Resting upon a nodding grass stalk, the birds gather in their short, thick bills the minute seeds which are their chief sustenance. I have also watched them pluck the tiny white protein bodies, favored by ants, from the hairy brown cushions at the bases of the petioles of the cecropia tree. Often the grassquits hunt in flocks over bare ground, industriously picking up minute objects that I have never been able to distinguish. When grass seeds are scarce, they sometimes forage among the foliage in the crowns of low trees, almost in the manner of wood warblers.

#### SONG

The grassquit's song is a long-drawn, rapid trill, weak but sweet in tone. It is heard through much of the year, but most frequently in May, June and July, when the nesting season is at its height. In August the song wanes, in September it is heard rarely, but in October it may increase in amount, rising to a second climax in December, which corresponds to a second and less important period of breeding. During the arid month of February, when the grasses dry up, the grassquit is rarely heard, but flocks in silence in the moister fields, searching for lingering grass seeds. In March and April, when song in many other species swells to a grand chorus, the grassquit guards its silence. Like the seedeaters, it does not attain full song until later, when the grasses which spring up during the early months of the wet season are seeding freely and it begins to nest. This, at

least, is the annual course of the grassquit's song in the basin of El General in southern Costa Rica, where the first two or three months of the year are often nearly rainless.

Among grassquits, true song appears to be confined to the male, although on rare occasions the female may deliver a tuneless imitation of his music. Usually he chants from a perch at no great height, a grass stalk or a low bush growing in a grassy field. He does not, like so many song birds, insist upon occupying the stage all alone while he performs, but willingly shares it with others of his kind. While I dwelt in Rivas, I frequently saw two or three grassquits singing close together amid the weeds of the field



Fig. 9. Male Yellow-faced Grassquit.

surrounding my cabin. Sometimes two songsters would occupy the same perch, only a foot apart. One afternoon, at the height of the nesting season, I watched five singing vigorously in the same small bush. The early afternoon was the period of the day when they were most songful.

The social singing of Yellow-faced Grassquits suggests that they lack that pugnacious jealousy so prominent and characteristic in many members of the finch family. Indeed, they are most pacific birds; I have never noticed any fighting or discord among them. Yet the breeding male does defend a small area, extending to perhaps twenty or thirty feet from his nest, from which he expels other males of his kind. But all that the territorial male does is to fly mildly in the direction of the intruder, who retreats without necessity of conflict.



## COURTSHIP

In courtship the male stands close beside the female, turns his body toward her, his head only an inch or two from hers, and sings while vibrating his expanded wings into twin halos. A low perch, a rock, or even the ground is the stage for this display. So vigorous are the movements of his wings that one would suppose that he would be lifted into the air if he did not tightly grasp his perch; but since he sometimes performs on a smooth rock, he evidently requires slight anchorage. None of the numerous female grassquits which I have watched as they were thus passionately addressed has appeared to be impressed. A female sometimes responds to the male with a negligent peck, or else she flew away and left him singing to an empty perch.

## THE INFLUENCE OF RAINFALL ON THE BEGINNING OF NESTING

Yellow-faced Grassquits begin to nest considerably later than most other of the passerine birds with which they dwell, for they await the ripening of the grass seeds which are their chief food. Like a number of other birds on the Pacific side of Central America, they breed earlier when the dry season has been short and relieved by occasional showers than when it has been long and severe, and they wait until rain has fallen regularly for two months or more before they start building. In 1936, when a severe dry season did not end until the last week of March, I found the first grassquit's nest on June 8, the first egg on June 11. In the following year, when in the same locality there was scarcely a dry season, I found the first nest on April 27 and the first egg on May 1. In 1940, in another part of the basin of El General, the dry season, which had been practically rainless, terminated in the second half of March; I found males building as early as May 20, but no egg before June 14. In 1942, another very wet year, with heavy showers falling early in March, a nest with two eggs was discovered on May 17, and another with three eggs on May 25. In 1943, although the year had been drier, I found a nest with two newly laid eggs on May 13; in 1944, a nest was discovered on May 9 and held the first egg on May 11.

The records for 1942, 1943 and 1944 were made on my farm at Quizarrá on the northern side of the valley, where the dry season is usually less severe than in the portions of El General lying in the rain-shadow of the coastal range and where the pastures usually remain green throughout the year. But in 1945 the early months of the year were even here fearfully dry, the rains hardly beginning until mid-April. I found no nest until mid-July, and this never contained eggs. The grassquits all but disappeared from my yard, where in former years they had sung and nested in small numbers in May, June and July. That year their breeding season seemed to have been a failure locally.

On the Caribbean slope of Costa Rica, where the early months of the year are not so dry as on the Pacific side, the grassquits nest considerably earlier. At Pejivalle, altitude 2000 feet, I found a nest with newly laid eggs on April 12, 1941, and numerous others in the remainder of the month. Near Vara Blanca, at an altitude of 5400 feet, a completed nest discovered on May 4 held its first egg on May 9. At this altitude, grassquits, although far from rare, are by no means so abundant as they are two or three thousand feet lower on the Caribbean slope.

## NEST SITE

The roofed nest of the Yellow-faced Grassquit is most often built in a tussock of grass, cluster of weed stems or low bush, in a pasture, weedy field or grassy roadside. About half of the forty-odd nests which I have seen on fairly level ground were between 6 and 12 inches above the surface. One unusually low nest was only four inches up. Many nests, however, are placed at heights above one foot, and in exceptional cases they

may be as high as six feet above the ground. One nest was situated at a height of 32 inches, between five stalks of maize growing in a cornfield. Several nests were about two feet up in tussocks of tall grass. In the dense, trimmed cypress hedges about the house that I occupied at Vara Blanca, nests were placed at heights of 45 inches, 54 inches, and 5 feet, but the last was not completed and never contained eggs. In a small coffee plantation on my farm, nests were built at heights of 3 feet, 4 feet, and 5 feet, and again the highest was abandoned unfinished. Only the male grassquit was seen working at the two five-foot nests which were never completed. Apparently he sometimes begins to build in sites of his own selection which are so high that his mate will not accept them; but the nests 4 and 4½ feet up contained eggs and later nestlings. Usually the nests are little if any above the tops of the surrounding herbaceous vegetation; but those in the coffee bushes were in exposed positions, as was a nest built at a height of one foot in a *Codiaeum* bush with variegated red, yellow and green foliage, amid the short grass of a lawn.

The foregoing paragraph refers only to nests built above fairly level ground. Many, however, are placed on banks, either in the vegetation growing upright on a steeply sloping bank, or suspended amid that which drapes over the edge of a vertical cut-bank. In a close-cropped pasture, a nest may be situated beside a bank or unevenness in the ground hardly exceeding its own height. Rarely the structure is set in a recess in the bank. One such nest was screened in front by a small fern frond and was difficult to detect. Another was embedded in moss which covered it above and on the sides, and was well concealed. A nest found near Alajuela, Costa Rica, was placed amid the herbage near the top of a nearly vertical bank 8 feet high, beside a much-traveled road. A nest at Pejivalle was supported in the herbage at the edge of a shallow drainage ditch in a pasture, just at the level of the surrounding ground.

#### NEST BUILDING

The nest is built by both male and female, but I have seen them working separately more often than together. At nests recently begun, I have found the male at work far more often than the female. Apparently he selects the site and begins the construction. Then, if the nest meets the approval of his mate, she joins him and takes an active part in building. As the nest nears completion, she does the greater share or even builds alone, her mate leaving the lining of the structure more or less to her. But at some nests, at least, he helps until the work is finished. By no means every nest begun by a male is accepted by the female.

On June 4, 1937, I watched a nest which when found the preceding day appeared to be newly begun. In the two hours between 8:40 and 10:40 a.m., the male brought material 42 times, and between 1:15 and 2:00 p.m., 24 times more. Usually he came to the nest with a whole sheaf of straws in his bill. Although a female, to all appearances his mate, frequented the vicinity of the nest, she showed no interest in it. The male often interrupted his work to display before her, as described earlier.

On June 7, when this nest was nearing completion, I watched from 7:55 to 9:25 a.m. At first male and female were working together; but after bringing six billfuls of material in the first half hour, the male stopped. The female continued alone for the next hour; she brought 16 billfuls of material during 1½ hours of watching. At the end of this period the nest appeared to be finished.

A neighboring nest was watched for 2½ hours when it was nearing completion. The female alone worked at it, bringing 27 billfuls of material, each consisting of fine pieces of grass inflorescences destined for the lining. Arriving with laden bill, she usually alighted upon a long, slender blackberry cane that drooped over the bank where the nest was situated. Here she would rest and look around before she entered to deposit and arrange the

material. Sometimes a long piece of it would catch on the blackberry thorns and pull her back when she started to fly toward the nest. It often caused her much strenuous effort to disengage these entangled strands; but she would never relinquish a piece of them and tugged with determination until she tore them free. Meanwhile the male sang tirelessly near the nest. Sometimes he would perch beside the female, facing her, and trill while vibrating his half-expanded wings. Once, during the female's absence, he entered the nest, but so far as I could see took nothing into it. Once he went to the doorway while



Fig. 10. Nest of Yellow-faced Grassquit at El General, Costa Rica, June, 1937.

the female was arranging the material inside. Upon departing, he picked up a fine straw from the bank below the nest, but instead of returning it to the structure, he carried it a short distance away and let it fall. He seemed definitely to have ceased building.

At another nest found in October, 1942, I saw only the male working when the nest was newly begun; but later both sexes built together. I have records of several additional nests which the male was building when they were found, but which were abandoned before completion, apparently because the female did not accept them.

Although a great amount of labor and material enter into the construction of the thick-walled, roofed nest of the Yellow-faced Grassquit, those found in very early stages of construction appeared to be finished three to six days later. The completed nest is

usually an ovoid structure with its long axis upright; more rarely it is nearly globular. In the side, near the top, is a round doorway giving access to a very snug, well-padded chamber. The structure is composed chiefly of fine straws, grass blades and weed stems and is lined in the bottom with fine pieces of grass inflorescence or shredded bast fibers. A representative nest was  $5\frac{1}{2}$  inches high by 3 inches in transverse diameter. The round, sideward-facing entrance was  $1\frac{1}{2}$  inches in diameter. The interior cavity extended  $1\frac{1}{2}$  inches below the lowest part of the doorway.

The nests of the great majority of finches are open cups, and roofed structures are exceptional in the family. The Yellow-browed Sparrow of South America builds on the ground, at the top of a grassy bank, and constructs a globular nest of grasses and fibrous materials with a round entrance in the side. The Black-striped Sparrow constructs a far bulkier, oven-shaped nest which often is only partially roofed. The Orange-billed Sparrow, so widespread in the forests of tropical America, likewise builds an oven-shaped nest, which is usually well covered over with dead and living leaves.

#### THE EGGS

The first egg may be laid on the day following the completion of the nest, but more often two or three days elapse before it appears, and sometimes as many as four or five days. The eggs are laid in the early morning from before sunrise until about half an hour after sunrise. They are laid at intervals of approximately 24 hours until the set is complete.

I have records of 38 Costa Rican nests that contained 2 eggs or nestlings, 19 nests with 3, and one with 4. Of these 58 nests, 7 were found in the highlands at about 5500 feet above sea level; and of these high-altitude nests, 5 contained sets of 3, and 2 held sets of 2 eggs. A single nest at about 4300 feet contained 4 eggs. The remaining 50 nests were at altitudes between 2000 and 3000 feet, on both the Caribbean and Pacific slopes; and among these the smaller sets predominated, there being 36 of 2 eggs and 14 of 3 eggs. Hence it appears that at higher altitudes Yellow-faced Grassquits lay on the average larger sets than at lower altitudes. On May 5, A. W. Anthony (Griscom, 1932: 352) found a nest with 4 fresh eggs at Finca Sepacuite in the Department of Alta Verapaz, Guatemala. Bond (1943:123) states that in the island of Hispaniola he has never seen a clutch of more than 3 of either this or the Black-faced Grassquit, but mentions a set of 5 eggs of the former species recorded by Danforth (1929:374). In Trinidad, the related Sooty Grassquit usually lays 2 or 3 eggs in a set, but occasionally 4 are found (Belcher and Smooker, 1937:545).

The Yellow-faced Grassquit's eggs are dull white, speckled with shades of brown and chocolate, thickly on the large end and usually sparingly over the remaining surface. The measurements of ten eggs average 16.8 by 12.8 millimeters. The eggs showing the four extremes measure 17.5 by 12.7, 16.7 by 13.5 and 15.9 by 11.9 millimeters. Because of the difficulty of removing the eggs through the narrow doorway of the nest without breaking them, a larger number was not measured.

The distribution by month of laying of 91 nests in the valley of El General, 2000 to 3200 feet above sea level, is as follows: April, 1; May, 26; June, 19; July, 15; August, 14; October, 9; November, 2; December, 4; January, 1.

#### INCUBATION

The female Yellow-faced Grassquit incubates without the assistance of the male. My first nest of this species was situated ten inches above the ground in a patch of densely crowded grasses and weeds in an opening in the midst of a thicket. The three eggs were laid on June 11, 12 and 13, 1936. At two o'clock on the afternoon of June 24,

I began to watch this nest from a blind, remaining until 6 p.m., then returning at dawn the following day—the last of incubation—and continuing my vigil until 11:26 a.m. On June 24 the female returned from her last recess of the day at 4:47 p.m., well over an hour before nightfall, and sat until 6:26 the following morning, more than an hour after daybreak. During her eight hours of activity falling within my periods of observation, she took five completed sessions ranging from 18 to 89 minutes and averaging 50.2 minutes. Her six recesses varied from 22 to 39 minutes and averaged 28.2 minutes. She spent 64 per cent of the time in the nest. She sat for much longer periods during the early half of the morning than later in the day; but her recesses were no longer in the early morning than during the afternoon, with the result that during the early forenoon she kept her eggs covered a considerably greater proportion of the time. For so diminutive a bird, she sat on the eggs for surprisingly long periods.

The female grassquit invariably approached her nest in a most indirect fashion, and with great caution. Returning from her recess, during which she foraged out of my sight, she would alight six or eight feet above the ground in some bushes behind the nest. Here she repeated, usually many times, a low *tick*, which was sometimes compounded into a dry trill—a lower pitched, less rapid and less melodious version of the trilled song of the male. As she rested here in the bushes, surveying her surroundings before advancing nearer the nest, she usually preened her feathers. After her delay here, she flew down to some low weeds a few yards from the nest, and here might *tick* and even trill some more. Then, usually with one or two additional pauses, she advanced to the nest and alighted on the roof, from which she rapidly hopped down into the sideward-facing entrance. Once inside the nest, she quickly turned around to face outward. She invariably sat on the eggs with her head showing in the doorway and her tail uptilted against the rear wall. Small as her little hooded nest appeared to be, it was amply spacious for the tiny bird who occupied it. Most of the time she incubated in silence, but if her mate came within hearing of the nest she might voice a few lock *ticks*.

Upon leaving her eggs, the grassquit would regularly turn after passing through the doorway and hop upon the roof of the nest, from which she would take flight. While sitting, she was at all times exceedingly shy. Approach as cautiously as I could, I was never able to surprise her in the nest. Her wariness was such that it was difficult enough for me to reach the edge of the opening amid the bushes in time to see her dart away from the nest. Such shyness is typical of nesting grassquits.

Sometimes the male grassquit poured forth his rapid little trill from the top of one of the bushes or low trees that surrounded the grassy opening where the nest was hidden. More often he stayed out of sight. Sometimes when the female returned to her eggs, he accompanied her to within a few feet of the nest; but I did not once see him actually go to the entrance.

Seven years later, I gave considerable attention to a grassquit's nest built in the midst of the slender shoots springing from a cutting of *Codiaeum variegatum* in my front yard. The two eggs were laid on June 25 and 26, 1943. On July 7, I devoted the morning to watching the female incubate in this nest so attractively situated among the yellow, red and green foliage. This grassquit also spent long periods on the eggs. In six hours, she took six turns in the nest, ranging from 15 to 61 minutes in length, totalling 253 minutes, and averaging 42.2 minutes. Her five recesses varied from 9 to 25 minutes, totalled 89 minutes and averaged 17.8 minutes. She kept her eggs covered 70.3 per cent of the morning. Like the first grassquit, she always sat with her head in the doorway. Often she arose to look at the eggs beneath her. Frequently while sitting she uttered sharp monosyllables, resembling the sound made by striking two pebbles sharply together. If she heard her mate singing nearby, she called many times in this fashion; and as she flew from the nest, she would rapidly repeat these sharp notes.

The male of this pair was more attentive to his incubating mate than the male at the earlier nest. On half of her returns to the nest he escorted her. After she had settled on the eggs, he might hover beside the nest, then hop about on the bare ground beneath it. Once, after hovering beside the nest, he rested in the doorway. Often he sang close by. Thrice the female flew from the nest when she heard him singing nearby; then they went off together.

While incubating, the female grassquit often sleeps late in the morning. At one nest I found her slumbering, with her head turned back and buried in her plumage, in broad daylight, half an hour after other birds were up and about.

The first sign of the approaching hatching of the egg is a slight roughness of the shell at a point where the egg is thickest. This may be detected with a finger-tip at least 18 hours before it hatches. The incubation period, as determined at seven nests, is 13 days. At the nest in the *Codiaeum* bush an effort was made to time the incubation period in terms of hours. The second egg, laid before 6:00 a.m. on June 26, hatched between 5:32 and 6:18 a.m. on July 9, giving an incubation period of 13 days within a margin of less than one hour. In one nest all of a set of three eggs hatched 16 days after the last was laid, but here the incubation was abnormally lengthened. At one nest the period was only 12 days.

#### THE NESTLINGS

I watched the nest in the *Codiaeum* bush throughout the morning on which the eggs hatched. In the dim light at 5:05 the female awoke in the nest and began to preen. At 5:24 the male was heard singing for the first time, close by the nest. The female now began to call to him. At 5:32 she called again, answering the male, then flew from the nest, alighted beside him on a strand of the wire fence close by, and then flew off with him. The eggs had not yet hatched. Returning to the nest alone after a ten-minute recess, the female spent much time with her head bent down beneath her, where I could not see it. Was she watching an egg hatch, or helping a nestling to emerge from the shell? At 6:03, just as the sun began to appear above the mountains in the east, she took the large part of an empty shell in her bill, held it by the edge, and somehow caused it to revolve between her mandibles. As it turned she broke off small fragments from the edge and ate them, until it was all consumed. Then, at 6:05, she flew from the nest.

Seven minutes later, at 6:12, she returned, the male accompanying her to near the nest. For about two minutes she stood in the doorway with her tail toward me. I could not see what she did; she may have been feeding a nestling. Part of the time while the female was standing so, the male rested on a garden stake four feet away from her; but he did not seem to give attention to what she did nor discover that an egg had hatched. At the end of two minutes, the female entered the nest to brood. At 6:18 she ate the cap of a shell, then the main part of a second shell, in the same rotary fashion as before. Hence I knew that the second egg had hatched. After this she spent much time with her head bent down into the bottom of the nest, appearing to be vigorously moving something.

During the next four hours, the female grassquit fed, or seemed to feed, the nestlings unseen in the nest, on seven of her eight returns to it. All this occurred while the male appeared to remain unaware of the nestlings. Yet five times he sang close by the nest while his mate fed them. At 8:17, when the male was singing on the garden stake four feet from the nest, the female called sharply within, then came half-way through the entrance and continued to call. Her mate did not respond, but on the contrary moved farther off and continued his trilling. A few minutes later the female again called sharply while the male sang close by. I could detect no difference between these calls and those she had uttered while incubating a few days earlier.

But at 10:55, while the female was taking a recess, the male grassquit came, singing

as usual, alighted on the ground below the nest, then in the doorway, looking in. He lingered about two minutes in this position, but apparently did not deliver food to the nestlings. This was his first direct visit to the nest that morning. It will be recalled that during the morning when I watched the female incubate, two days earlier, the male had gone to the doorway just once during six hours, but while the female was within. Half an hour after his first view of the nestlings, the male grassquit returned, singing as nearly always. He went to his favorite garden stake, then clung to the back of the nest. Apparently he was not thoroughly familiar with the position of the doorway. But soon he found it, fed the nestlings for about two minutes, then flew away. Thus he first fed the nestlings 5 hours and 22 minutes after the female ate the first empty shell. Nearly half an hour later he again brought food to them. As nearly as I could tell, the young grassquits received 12 meals during the first 6 hours, 10 from the female and 2 from the male.

After the hatching of the eggs, the character of the female's sitting changed greatly. During the  $5\frac{3}{4}$  hours after she ate the first shell, her 11 periods of brooding ranged from 4 to 30 minutes, averaging 15.3 minutes. Her 11 absences ranged from .7 to 24 minutes, with an average of 16.2 minutes. Comparing this with the corresponding figures for the penultimate day of incubation, it is seen that her periods of sitting fell from 42.2 to 15.3 minutes, although her absences decreased only slightly, from 17.8 to 16.2 minutes. Although during the course of the morning of July 7 she had incubated the eggs 70.3 per cent of the time, now on July 9 she brooded the newly hatched nestlings only 48.6 per cent of the time. Compared with other species of passerine birds for which I have similar data, this is an unusually great diminution in the time spent in the nest immediately after the hatching of the eggs.

As the Yellow-faced Grassquit approaches the nest with food, none is visible in its tightly closed bill, although a few grass seeds may be seen clinging to the outside. The food for the nestlings is carried in the parent's throat, or perhaps in still deeper regions of the alimentary tract. While the parent stands in the doorway of the nest, head inward, it produces this nourishment and with rapid movements places it in the mouths of the nestlings in front of it. After the young birds are older and can raise their gaping, yellow-rimmed, red mouths above the sill, it is possible to see something of the process of feeding, but not as much as one would wish. The food transferred to them is not in liquid form, like that supplied by female hummingbirds to their young, but comes in solid, rather cohesive masses. I have been able to obtain only fleeting glimpses of this substance; but from its pale green color and granular appearance, I judge that it consists of the compacted minute seeds of grasses. In rapid succession, the parent places billfuls of this regurgitated food into the mouths of the nestlings, giving alternately a portion to one and then to another, or sometimes favoring a single nestling with several successive portions. Each time a parent comes to the nest to feed, it brings sufficient food for a considerable number of portions, which are delivered so rapidly that I have found it impossible to count them. I have never seen a grassquit bring insects in its bill, and if any are supplied to the nestlings, they must be rather small ones and mixed in the masses of grass seeds. At each visit to the nest, the parent requires from about 30 seconds to 2 minutes, rarely longer, to deliver the food to the nestlings.

As with so many birds that feed their young by regurgitation, the grassquit's rate of food-bringing is low, as compared with that of small birds that carry the food in their bills. When the nestlings in the *Codiacum* were four days old, I devoted the first four hours of the morning to watching their parents attend them. Between 5:30 and 9:30, the female fed the nestlings six times, the male thrice. If the time required to transfer the food to the nestlings may be taken as a measure of its quantity, the female also brought more at each feeding than her mate. Since on the morning the nestlings hatched the female had fed them ten times in six hours, her rate of bringing food had remained almost

constant, about  $1\frac{1}{2}$  times per hour. Both parents together fed the two nestlings a little better than twice an hour. During the four hours, the female brooded the nestlings four times, for 24, 12, 14 and then 15 minutes, a total of 65 minutes, or a little more than one quarter of the time.

Seven years earlier, at my first nest, I had spent five hours watching the parent grassquits attend their nestlings when eight days old. Three of these hours were in the early morning, when there were two nestlings; but when I returned in the afternoon to watch for two hours more, one of the nestlings had disappeared. During the five hours the female brought food six times and the male four. If we consider only the three hours in the morning, while there were two nestlings, the mother brought food four times and the father thrice, which is a little better than twice an hour for both, and about the same rate as at the nest with two four-day-old nestlings. With other species that feed their young by regurgitation, as with pigeons and those woodpeckers which use this method, there is only slight increase, if any at all, in the rate of food-bringing as the nestlings grow older; and indeed there may even be a decrease in rate, although presumably a larger quantity is delivered at each meal.

The eight-day-old nestlings, although still nearly naked, were not brooded at all during the five hours that I watched them. The parents usually carried away the white pellets of excrement in their bills; but when it was necessary to remove two at a single visit to the nest, they swallowed the first, thereby leaving the bill free to take up the second pellet.

The newly hatched, blind nestlings of the Yellow-faced Grassquit have skins so dark that they are nearly black and they are utterly devoid of natal down. In this complete nakedness they differ from other finches and the great majority of passerine birds, which bear at least a few tufts of down on head and back. But a similar absence of natal down is found in certain jays, vireos, wrens, cotingas and American flycatchers, most ant-birds, and in whole families of non-passerine birds, as woodpeckers, kingfishers, motmots, toucans and trogons. In the Troglodytidae, Vireonidae, Corvidae, and Tyrannidae, as in the Fringillidae, the condition of the nestlings at hatching is not uniform throughout the family, those of some species bearing down and those of other species being devoid of it. The interior of the mouth of the nestling Yellow-faced Grassquit is red, as is true of all other finches I have seen.

The eyes of the naked nestlings begin to open when they are three days old. The next day the pin feathers begin to sprout. These become very long, and when the nestlings are seven or eight days old, the horny envelopes begin to break off and the plumage begins to expand. At the age of ten days the young grassquit is fairly well clothed with feathers, olive-green on the back and buffy-olive on the underparts; but the crown still bristles with black pin feathers, while the remiges and rectrices barely protrude from the ends of their sheaths. The young grassquits leave the nest at from 12 to 15 days of age, when they are completely feathered. One brood of two was covered by the female during every night except their last in the nest. On their final night I found them sleeping alone, heads buried in their plumage. The following day they departed, aged twelve days.

After the close of the principal nesting season in October, males, females, and young flock together through the grassy fields. Young males have already begun to acquire the bright yellow and black areas of the adult plumage, which they attain by means of the postjuvinal molt.

#### EXTENT OF THE BREEDING SEASON

In El General, Costa Rica, the principal breeding season of the Yellow-faced Grassquit extends from late April, May or June—depending upon the amount of rain during the early part of the year and the luxuriance of grasses—to August or September. I have



records of three nests in October, 1942. None of these was successful; and after the abandonment of one, I opened the eggs and found both infertile. In November, 1943, I found a male building; but the female was not seen to join in, and the nest was abandoned when scarcely begun.

In 1952, when I was absent from Costa Rica through April, May and June, there was an unusual amount of singing and nesting among the grassquits about my residence between the end of September and the beginning of November. In these five weeks, seven nests were built within a radius of 50 yards of the house. Eggs were laid in six of these between the first week of October and November 7. Three nests were abandoned when some undiscovered creatures, possibly mice, pulled up the fine lining in the bottom, partly or completely covering the eggs and sometimes blocking the doorway. In three nests the eggs hatched, but the nestlings died or vanished within a few days of birth. Not a single one lived to be a week old. Although I have a few scattered records of nesting in this district in October of other years, such concentrated activity at the height of the wet season is most unusual. Unfortunately I do not know whether this late nesting was caused by a general breeding failure earlier in the rainy season.

I have records of four nests in which eggs were laid in December, and one with eggs laid in January. Hence in this species we may recognize, on the Pacific slope of Costa Rica, a major nesting season between May and September, and a minor nesting season in December and January, with sometimes a considerable spurt of reproductive activity in the very wet months of October and November. This situation is closely paralleled by the breeding seasons of the Variable Seedeater (*Sporophila aurita*). Furthermore, in wet years when *Tiaris* breeds early, *Sporophila* usually does likewise; and in dry years when one begins to build late, the other does, also. The few available dates of local nests of the Lesser Goldfinch, another small seedeater, suggest a similar breeding periodicity. And I suspect that if its nests were not so exceedingly difficult to find, the breeding seasons of the abundant and widespread Blue-black Grassquit would present a similar picture; certainly the periods of song of the male suggest that this is true. But of those passerine birds of different food requirements for which I have a significant number of nest records, not one shows a corresponding distribution of nest dates through the year; and very few have eggs or young in December or January. Thus these small eaters of grass seeds illustrate convincingly the influence of the availability of food upon reproduction.

In the West Indies, nests of the Yellow-faced Grassquit "may be found virtually throughout the year" (Bond, 1943:123; Wetmore, 1927:555-557).

#### ENEMIES

Among the enemies of nesting grassquits are field mice, which often take possession of the roofed nests and close up the top of the chamber with finely shredded soft material from the lining. Nests newly completed, and even those containing eggs, are sometimes occupied by mice. Possibly they sometimes devour the eggs, but I have found unbroken eggs in nests inhabited by them.

Ants take their toll of nestlings. In one nest the young were killed and slowly devoured by fiercely stinging fire-ants. I have seen army ants (*Eciton*) crawl over unbroken eggs without harming them; but had there been nestlings, they would certainly have picked their bones bare.

Sometimes I have found nests with a small round hole in the back or side, and the contents gone. Similar holes are often made in the walls of the pensile, roofed nests of flycatchers which have been pillaged; but I have never been able to discover the agent of destruction. Undoubtedly snakes take a considerable toll of eggs and nestlings, but I

have not chanced to surprise one in the act. Finally, numerous nests are ruined when laborers cut down the weeds in plantations or along the roadsides. With so many causes of loss, it may be that the majority of grassquits' nests are unsuccessful.

#### SUMMARY

Yellow-faced Grassquits flock in grassy areas with scattered trees and bushes, from sea level up to about 6200 feet in Costa Rica.

Small grass seeds are their mainstay, but when these are scarce they forage in the foliage of low trees. They also hunt over bare ground.

The male's long-drawn, rapid trill is heard through much of the year, but in El General chiefly in May, June, and July. He courts the female by vibrating his spread wings and trilling while he perches close beside her.

The grassquits begin to nest later than most of the small passerines with which they dwell, for they await the ripening of the grass seeds. In years when the dry season is short and relieved by occasional showers, they breed earlier than when it is long and severe. In El General the principal breeding season may begin at any time from mid-April to June, and it continues until August or September. A few nests are found as the wet season comes to an end in December and January; and in exceptional years there is considerable nesting at the height of the rainy season in October and early November.

The roughly ovoid nest has a thick roof and a narrow doorway in the side. It is placed in a tussock of grass, a bush, or other low vegetation, rarely as high as five feet above the ground.

Both sexes build; but the male, who apparently often selects the site, sometimes does all or most of the work at first, whereas his mate is usually more active in finishing the structure. Not every nest begun by the male is accepted by the female. The unusual height of some nests built by the male is apparently the cause of the female's failure to use them.

The male defends a small area surrounding the nest, flying at intruders, who retreat and avoid all fighting.

In Costa Rica the nest usually contains two eggs. Sets of three are frequent, and there is one record of four. The eggs are laid at about sunrise on consecutive days.

Only the female incubates. Her sessions tend to be long, often exceeding an hour and sometimes lasting an hour and a half. The incubation period is normally 13 days but exceptionally is 12 or 16 days.

Both parents give the nestlings regurgitated food, apparently consisting largely of grass seeds. At one nest the male first brought food about 5½ hours after the first egg hatched. Visits with food are rather widely spaced, but many portions of regurgitated nourishment are usually delivered at each feeding.

Dark-skinned and quite devoid of down upon hatching, the nestlings are fairly well covered with feathers when about ten days old. When they are from 12 to 15 days old, they leave the nest, wearing a plumage like that of the adult female.

Mice often take possession of nests with eggs, ensconcing themselves within and closing up the doorway with shredded material. Ants sometimes devour nestlings, and numerous nests are destroyed in the course of agricultural operations.

## BLUE-BLACK GROSBEAK

### *Cyanocopsa cyanoides*

The Blue-black Grosbeak is one of the widespread birds of the tropical American rain-forests, ranging in its several forms from southern México to Brazil and Bolivia. Like other rain-forest species, in northern Central America it occurs only on the more constantly wet Caribbean side; but farther south where heavy forests cover both coasts, it is at home in the Pacific as well as the Caribbean lowlands. Although in the Santa Marta region of Colombia, Todd and Carriker (1922:508) did not meet the species above 2000 feet in the foothills of the semiarid section, while in the more humid districts it stayed even lower; in the valley of El General I found it nesting at 3200 feet above sea level. For Guatemala, Griscom (1932:349) records the bird from Finca Sepacuite in Alta Vera Paz, whose altitude he gives (p. 417) as 3200 feet. Far less strictly confined to the primary rain-forest than most of the small birds which are at home in its deep shade, the Blue-black Grosbeak may wander far into the neighboring clearings and lush second-growth thickets in search of food, and it may even build its nest hundreds of feet from the nearest heavy woodland. It is especially fond of maize fields, which provide it with such an abundance of rich food that it sometimes stays to rear its family in them.

A typical grosbeak, this species is easily recognized by its plump form, short, heavy, swollen bill, the plain dull blue-black of the male (at least in the Central American races which chiefly concern us here), and the deep brown of his mate. In both sexes the wings and tail are darker than the body plumage, being black in the male and dusky with brown margins in the female. The eyes are dark, the bill black, and the legs and feet blackish. Through most of Central America there is scarcely any bird, and none in the deep forest where it is most at home, with which one is likely to confuse this stout-billed finch. In eastern Guatemala and southern México, where the Blue Grosbeak occurs both as migrant and resident races, a careless novice might confound the two species, which are about equal in size and thickness of bill. But the plumage of the Blue Grosbeak is a far brighter blue; and it prefers the more open, drier districts to the rain-forests and adjacent clearings where the Blue-black Grosbeak dwells.

Like so many birds of the underwood of heavy tropical forests, the Blue-black Grosbeak seems never to flock. Probably, as Todd and Carriker suggest, the pairs remain together at all seasons; but I have no definite evidence that male and female keep company during the closing months of the year. Yet in January, long before the nesting season, some pairs are already formed. Although noisy, the grosbeak is shy and retiring, as a rule keeping itself so well concealed in the dense lower vegetation that it is difficult to learn whether one is alone or in company with a mate.

The grosbeak enters sheds and granaries in quest of grain; and it was perhaps in search of food that in February, 1935, a female flew into the kitchen behind the main edifice in the narrow clearing in the rain-forest on Barro Colorado Island in the Canal Zone. This kitchen, in a separate building, had a high ceiling, beneath which, at the top of the wall on all four sides, was an open space covered only with wire netting for the sake of ventilation. The doorway, which stopped well below the top of the wall, opened into a covered passageway leading to the dining room; hence it probably did not appear a promising avenue of escape to the bird who remained above its level. She flew from side to side of the room, endeavoring to escape through the wire netting below the ceiling. At first she bumped hard against the screen, but after repeated collisions learned to alight gently upon it. Her first fright over, she sat for a long time on the shelf-like beams

that encircled the room just below the wire netting. She lingered in the room nearly six hours, in which time the cook and other people passed in and out many times through the open door; yet it never occurred to the bird that she might regain her freedom by following the humans she saw leave the room. After a number of futile attempts to capture her or to drive her gently with stick or broom to the doorway, I managed to catch her in a butterfly net. When taken in hand she fastened her strong, sharp beak on my thumb with a grip that commanded respect, in this reminding me of the North American Cardinals that I used to trap for banding. Released in the open, she flew toward the neighboring forest in the direction she had been flying when she entered the room.

#### FOOD

With so sturdy a bill, the Blue-black Grosbeaks are well equipped for breaking and eating hard grains. What kinds of seeds they consume in their native forests I have not yet discovered; but where man has made clearings and sowed cereals, these provide the grosbeaks with a nourishing fare, to which doubtless many of their kind became accustomed in pre-Columbian times. Most of my observations on their dietary preferences have to do with their fondness for maize. In 1940 I rented, near the Río Pacuar in El



Fig. 11. Male Blue-black Grosbeak.

General, a little cabin of rough, unpainted boards, not far from which stood a rustic shed full of ears of maize still enclosed in their husks. In June a male grosbeak repeatedly brought his two full-grown young to eat the hard, dry grain. Once when they had lagged behind, he drew them to him by repeating a loud, sharp monosyllable, quite distinct from the usual half-harsh, half-liquid call note of his kind. Clinging sideways to one of the upright split logs that formed the walls of the thatched granary, he plucked at a single huskless ear of corn exposed in the adjacent chink until he succeeded in detaching

a yellow grain. Then he dropped with his prize to a log lying beside the construction and broke the hard grain into pieces with his powerful black bill. When it had been sufficiently crushed, he put the fragments into the expectant mouths of his offspring. This granary was separated from the forest's edge by at least a hundred yards of open field.

In later years, when I acquired a farm of my own in the same region and had a thatched granary close by the woodland, the grosbeaks would come, along with Cassin and White-fronted doves, to feast on the dry stored maize, probably taking advantage of those ears whose tough husks had been gnawed open by squirrels. One day, when husking out maize in this shed, I threw out on the grass in front an ear whose grains had been all but turned to dust by weevils. Presently a grosbeak flew up to enter the granary was separated from the forest's edge by at least a hundred yards of open field. noticing the naked ear of maize lying on the ground a few yards away, he flew out and began to eat a grain. To me, this spoiled corn seemed sorry food, and wishing to provide the bird with better fare, I threw down a sound ear that landed a few feet from the first. This frightened the grosbeak into the hedge; but after a few minutes he returned, not to the sound ear, but to the spoiled one I had first thrown out. Plucking off another grain, he began to break it in his bill.

Perhaps a single example of the selection of spoilt maize when sound grains were equally available is not sufficient to prove that grosbeaks habitually prefer the former. But I have additional evidence that they do not disdain corn that is nearly rotten. Among the maize that we throw out for the chickens, on the lawn just outside my study window, there are at certain seasons many decayed and weevil-eaten grains. The poultry prefer the sound grains and, if not very hungry, leave the damaged ones lying in the grass. One year a male grosbeak formed the habit of coming to eat the maize left by the hens. Each day he came repeatedly, announcing with sharp notes his approach through the trees in the yard. Advancing with circumspection, he would at last drop down to alight on the top of a garden stake a foot or two high, whence he looked nervously around to make sure that no danger was in sight before daring to risk a descent to the ground. Here under the open sky his plumage was deepest blue, rather than black as it appears in the woodland shade, and a patch at the bend of each wing was bluish-white. After several false starts, he braved the final step, dropped to the grass and hopped about until he spied a grain overlooked or disdained by the chickens, then promptly rose with it to the shelter of a neighboring avocado tree. Usually after seizing a grain the bird retreated so swiftly that I could glimpse little of it, but once I clearly saw that it was a discolored, spoilt one that he devoured in the avocado tree. Knowledge of the chickens' preference for wholesome maize strengthens my belief that the grosbeak was often satisfied with damaged grains.

The grosbeaks haunt the milpas from the time the maize begins to ripen until the last grains dropped or overlooked by the harvesters have been eaten by the numerous avian and mammalian gleaners or until they have sprouted in September's heavy rains. But they are equally in evidence about fields of rice in wooded districts. Here they relish tender grains in the milky stage as well as older and harder ones. This fondness for cereal crops seems to be effecting a change in the habits of the grosbeaks, bringing them from the forest into the cultivated lands. In regions where the encroachments of agriculture are causing a rapid dwindling of the woodlands, it seems likely that they will become more and more inhabitants of clearings and second-growth thickets.

#### VOICE

The Blue-black Grosbeak is a superb and generous songster, whose notes seem to the human ear to be tinged with a sweet sadness which doubtless he does not himself

feel. There is some variation between the songs of the several races inhabiting Central America, and single birds possess several distinct utterances; but the most surprising contrast is between the two parts of the song most typical of the grosbeaks of Costa Rica and Panamá. The first verse consists usually of six whistled notes, full, strong and mellow, followed with scarcely a break by a queer, rapid, breezy little flourish in a wholly different style, which comes as an anticlimax to the formal opening of the recital. One must be fairly close to the singer to hear this hurried finale; at a distance only the first part of the song is audible. Chapman (1929:272), who gives the musical notation of the opening verse, describes the performance in these words: "The first part of his song is a sweet, somewhat dreamy but clearly enunciated phrase of six notes with intervals that can be placed on our scale . . . Without pause these notes are followed by a little twittering warble in another key and tone. The effect is as unusual and musically as incongruous as though a White-throated Sparrow should end his own song with that of a Junco."

The foregoing remarks refer chiefly to the Blue-black Grosbeaks in the Panamá Canal Zone, but those in the valley of El General in Costa Rica have a very similar song. One bird who sang in the forest near his incubating mate repeated over and over a verse consisting of four, long, full, mellow, whistled notes, following by from four to six short, weak notes, higher in pitch and hurriedly thrown out, forming a startling contrast with the stately first verse. He also gave more sparingly a second song consisting of seven or eight notes all of the same character, well articulated and modulated — a homogeneous performance rather than one of two antithetic parts like the first. Both types were delivered with a number of variations, the whole constituting an almost unbroken flow of melody that lasted for nearly half an hour in the middle of the day. In other males I have noticed that when the song of two contrasting parts is repeated continuously many times, the breezy twitter tends to be slurred over and forms a very minor element in the whole performance.

One afternoon in April, a male grosbeak flew across the front of my house singing sweetly and continuing this for a distance of a hundred feet or more. Chapman states that on two occasions in early January he heard "what appears to be the 'ecstasy' song of this species; a rapid, rushing melody suggesting the flight-song of the Rose-breasted Grosbeak both in form and tone. It was apparently given from a perch, lasted for about three seconds, and was closed with the usual song."

The Blue-black Grosbeaks in the Lancetilla Valley of northern Honduras, of whose taxonomic status I am uncertain, have a song noticeably distinct from that of their species in Costa Rica and Panamá. When I worked in this region more than twenty years ago, I considered this grosbeak one of its foremost songsters, ranking with Gray's Thrush and the Spotted-breasted Wren. As I then wrote, its song "consists of seven or eight clear, flute-like notes, the first four or five slowly rising in pitch, the last three rapidly falling." These birds performed in the midst of such dense thickets that I could hardly ever glimpse them even when guided by their voices. After hearing this song often at the end of October, 1930, I became acquainted in the following December with that of the grosbeaks in the Canal Zone, and I was at once struck by the differences in the character of the performances of the two races — sufficiently alike to suggest at once their close relationship, sufficiently different to hint at minor taxonomic differences. In particular, the contrast between the opening and closing notes of the most typical song was far sharper in the Panamanian than in the Honduran grosbeaks.

The female grosbeak also gives a song which at its best is almost as full and rich as that of the male and which it resembles in form. When low it is sweet in tone, but when loudest it is marred by a harshness absent from the male's voice. I heard a female sing

while she and two or three other grosbeaks were chasing each other through the under-wood in great excitement. One female sang while building with her mate. All three whose nests I watched during incubation sang in response to their mates while sitting. Three females sang sweetly in an undertone as they flew from the nest as I approached to examine eggs or nestlings.



Fig. 12. Lowland rain-forest in the foothills at Lancetilla near Tela in northern Honduras. Habitat of the Blue-black Grosbeak, Blue-diademed Motmot, Massena Trogon, and Hermit Hummingbird.

The grosbeaks' period of song is long. In the Lancetilla Valley I arrived too late in the spring to note when they began; but they still sang freely at the end of October, a gloomy season when scarcely any bird nested. On Barro Colorado Island they sang liberally in January, and in the region about the Golfo Dulce on the Pacific side of southern Costa Rica they often sang in December. These observations suggest that in the lowland forests of southern Central America the grosbeaks sing throughout the year. But in El

General, more than 2000 feet above sea level, the period of song is somewhat shorter. Here singing begins in early or mid-February, although in some years I have not heard it before March, and it may continue through the hot, dry, smoky, enervating weather at the end of the dry season, which depresses the vocal activity of many song birds. It is at its height in the grosbeak's breeding season, which extends from April to September, but it is only seldom heard in the course of the heavy rains of October and November. For December and January I have no record of the grosbeak's song in this region.

In addition to their songs, the grosbeaks utter a variety of call notes. One is sharp and metallic, another low and nasal, a third between harsh and liquid. When a mated male and female were close together, they talked in low, nasal tones; but as the latter approached and left the nest she voiced the sharp monosyllables.

#### NEST BUILDING

On the wetter Caribbean side of Costa Rica, Carriker (1910:885) found a nest with two slightly incubated eggs on March 5, but in the valley of El General this grosbeak breeds considerably later. Although I have records from this region of one nest which contained eggs in early April, and of two others built toward the end of the same month, these are exceptionally early. Like the grassquits, seedeaters, and other finches which subsist largely on the seeds of grasses and cereals, the grosbeaks are predominantly late nesters, whose breeding season is at its height in July and August, when the maize ripens. Eisenmann (1952:57) cites a record of a nest containing eggs on Barro Colorado Island in July, and Harrower (1936) found at Gatún in the same region a nest which on July 27 held two eggs.

Of the dozen nests that I have found in El General, seven were in primary forest, sometimes beside a trail or even a wider roadway that made a gap in the leafy canopy. Two were in fields of ripening maize, two in a small coffee plantation, and one near a path through a small, clear grassy area surrounded by dense, low bushes. All these nests outside the primary forest were within an easy flight of its edge, the most distant not over 200 yards away. The lowest of these nests, that in the grassy opening, was 16 inches above the ground; the highest, one in the midst of the forest, was 8 feet up; the remaining 10 ranged from 3 to 6 feet in height. Six of the forest nests were built in low, slender palms bristling with a formidable array of needle-like black thorns, and the other in a tree fern armed with milder spines. The two nests in the coffee plantation were in coffee bushes, those in the milpa in the maize plants themselves; and the low nest in the grassy opening in the thicket was in a dense clump of sprouts from the stump of a bush. One nest in a cluster of spiny palms rested on the remains of a nest of a Brown Thrush-like Manakin, which apparently had itself been built over an earlier nest of the grosbeaks. The following year this much used nest was repaired once more by the grosbeaks, who laid there the earliest eggs of which I have a record.

After years of searching, on April 21, 1948, I at last found a pair of Blue-black Grosbeaks building their nest. It was situated in a spiny palm tree in the midst of the forest. On this and the following morning both sexes took important shares in the work, with the male bringing material somewhat more often than his mate. During the hour from 6:48 to 7:48 on April 22 he came with 5 billfuls and she with 6, and in the following hour he brought material 20 times and she 15. Thereafter work became desultory. There were a few additional visits to the nest not included in the foregoing totals, because beneath an overcast sky, in the deep underwood of the high forest, the light was so dim that I could not always distinguish blue-black from brown as the birds darted rapidly back and forth through the foliage. They brought long pieces of fibrous material grasped in their thick bills and trailing behind them as they flew, and dry branched inflorescences



of a forest tree, apparently a species of *Trichilia* which had flowered profusely a few weeks earlier. Each partner sat in the open cup for several minutes, giving it shape; and as a rule each delivered its load to its mate if it found that the other had come ahead of it and was shaping the nest. Once, however, the female arrived with a billful while her mate was sitting, drew back when he reached over the rim to take it from her, and would not relinquish it. Both male and female sang while at work. Her song was almost as loud and musical as his; and neither used the low and rapid second part that contrasts so oddly with the mellow opening verse of the male's full song.

The completed nest is an ample open cup, sometimes frail but more often with strong, well made walls of moderate thickness, yet open enough to allow some light to pass through the meshes of the bottom. It is accordingly far less massive and bulky than the nests of the saltators and the Striped Brush-finch. The foundation and outer layers of the wall are composed of dry weed stems, lengths of slender herbaceous vines, tendrils, coarse rootlets, branched inflorescences, coarse fibrous material, and the like. The lining is of brown and black fungal filaments, of the kind which grow over the outside of decaying branches in the humid undergrowth, and which greatly resemble horse hairs. One nest, rather bulkier than usual, measured  $6\frac{1}{2}$  by  $4\frac{1}{2}$  inches in outside diameter by  $3\frac{1}{4}$  in height. The cavity was  $3\frac{1}{4}$  by  $2\frac{3}{4}$  inches in diameter by 2 in depth. Another measured 3 inches in internal diameter by 2 in depth.

#### THE EGGS

With a single exception, each of my 12 nests in El General contained 2 eggs, and this was the number in the few additional nests of which I have found published records. The exception, the latest nest of all that I have seen, was kept under observation during the period of laying but apparently never contained more than one egg. At one nest the eggs were laid on consecutive days, both before 10:15 a.m. The eggs are white or more often tinged with blue (both varieties occurring in the same set), blotched and speckled with cinnamon, chestnut or reddish-brown, and pale lilac. The pigmentation is heaviest on the thick end, where sometimes the spots tend to be aggregated in a wreath, but on most eggs there is more or less speckling over the remaining surface. The shell has a moderate gloss and is of great beauty. Sixteen eggs measured at the nest in El General averaged 23.5 by 17.3 millimeters. Those showing the 4 extremes measured 25.4 by 17.1, 23.8 by 17.5 and 22.6 by 15.1 millimeters.

The distribution by month of laying of 12 nests in the valley of El General, 2400 to 3200 feet above sea level, is as follows: April, 2; May, 1; July, 4; August, 4; September, 1. The September egg was laid at the very beginning of the month.

#### INCUBATION

In nearly 38 hours of observation divided between 3 nests, I saw only the female cover the eggs. At a nest situated in a cluster of drying corn stalks in a small field of maize, about 50 feet from the forest's edge, I watched from daybreak to an hour past noon on August 12, 1945. In these  $7\frac{1}{2}$  hours the female grosbeak took 3 long sessions lasting 99, 64 and 160 minutes (in this order), with 3 recesses of 22, 29 and 57 minutes. She incubated 75 per cent of the time. To a nest in a coffee bush in a small plantation, I devoted two entire mornings and one whole afternoon. On the morning of July 26, 1948, this female took 3 sessions lasting 57, 87 and 115 minutes, and 3 recesses of 17, 40 and 17 minutes, covering the eggs 78 per cent of the 6 hours. The following morning was taken up with only 2 sessions of 88 and 203 minutes and 2 recesses of 19 and 45 minutes; she covered the eggs 82 per cent of the morning. On the afternoon of July 29, when only a brief, light shower fell, this female took 2 sessions lasting 137 and 48

minutes, and 3 recesses of 70, 63 and 31 minutes, thus staying on the nest only 63 per cent of the time. Considering the 3 watches together, she covered the eggs 73.5 per cent of 18 hours.

Both these female grosbeaks took sessions unusually long for a passerine bird unaided in incubation by her mate and rarely or never fed by him, but their recesses were also long and this reduced their total time on the eggs. But at the very late nest situated in a clump of small thorny palms in the forest, the female far surpassed these two in her constancy of sitting. On the morning of September 8, 1948, she took 2 sessions lasting 99 and 220 minutes, and 2 recesses of 18 and 19 minutes. On September 10 she was sitting when I resumed my watch 5 minutes before noon and continued without a break until dusk at 6 o'clock. There were light showers and drizzles from 4 o'clock onward, but none of the heavy, long-continued downpours to be expected at this season. This female had covered her eggs 95 per cent of 12 hours — a most unusual record. Although the grosbeak in the coffee bush sat considerably less constantly in the afternoon than in the morning, this female in the forest incubated even more steadily after midday. After fasting all afternoon, save for one feeding by her mate, this grosbeak took only a 19-minute recess to find food at sunrise next morning.

Although many nonpasserine birds both big and little take sessions on the eggs far longer than those of the most assiduous sitter among these grosbeaks, no other of the numerous passerines that I have watched incubate has remained continuously on her eggs for 6 hours in the daytime. The next longest uninterrupted diurnal session of any passerine bird that I have watched was one of 5 hours less 2 minutes (298 minutes) taken by a Spectacled Antpitta, a species in which the sexes alternate on the eggs. Then follows one of 4 hours less 2 minutes (238 minutes) by a male Great Antshrike, who also alternated with his mate; one of 225 minutes by a female White-tipped Brown Jay, liberally fed by attendants; one of 220 minutes by this same grosbeak in the palm tree; one of 217 minutes by a male Spotted Antbird, who took turns with his mate; one of 214 minutes by a tiny female Yellow-thighed Manakin, who had no mate; one of 210 minutes by a female Orange-billed Sparrow, also incubating without assistance; then one of 203 minutes by the Blue-black Grosbeak in the coffee bush. Next in my records of incubation by 23 individuals of 10 species of finches is a session of more than 180 minutes by an American Goldfinch, a bird generously nourished by her mate.

The female grosbeak in the maize field was not fed by her mate while I watched. He was not typical of his kind, and later I failed to see him help with the care of the nestlings. The grosbeak in the coffee bush was fed once on the first morning and twice on the second, but not in a period of equal length after noon. It was difficult to detect the nature of the food brought to her, for unless the piece was unusually large the male carried it wholly within his mouth and bill. But at nine o'clock on July 27 he came with a morsel visible between his partly separated mandibles. It was about the size of a grain of maize and dark in color. After singing responsively with the female a number of times, he flew to the nest and passed the morsel to her. Taking it into her own strong bill, she "chewed" on it for several minutes. At first the male, perching close beside the nest, leaned over her, forming a splendid picture as a ray of sunlight penetrating the plantation's shade trees fell upon his dark blue plumage, and once he seemed about to take the hard morsel back into his own bill. But after a minute or two he flew off. The female continued to work the refractory particle between her great mandibles: but it resisted their pressure; and at last, with an effort, she gulped it down whole, while her mate continued to sing among the neighboring bushes. Soon he flew out of hearing, to return an hour later with nothing visible in his bill. Perching beside his mate, he passed a whitish substance to her in a number of small installments, chewing it bit by bit as he

delivered it, the whole transaction taking about two minutes. Then he continued to sing near the nest.

At the nest in the spiny palms where the female incubated with such extraordinary constancy, she was fed twice in the morning and once in the afternoon. Only on this last occasion could I see anything of the food. He then passed, in several installments, a whitish substance of undetermined nature. Three feedings in 12 hours did not seem much to sustain the female grosbeak through her long periods of sitting, but apparently on her brief excursions she took advantage of some readily available source of food.

At all three of the nests, but especially at the two to which the male brought food, he sang much within hearing of his sitting mate, sometimes continuing his song for half an hour. Often she replied with a song less powerful but scarcely less beautiful than his. At the nest in the coffee bush this responsive singing was sometimes continued for minutes together. The male would often escort his mate to the vicinity of the nest and sing nearby while she settled on her eggs. Sometimes when singing near the nest, he used an undertone. This attention to nest and mate, constant in the early morning, decreased as the day wore on.

In addition to all this singing from the nest and its surroundings, there was much sharp calling, which contrasted strongly with the evident caution of the birds in approaching it and made it appear likely that the enemies that the grosbeaks chiefly feared discovered their prey by sight or scent rather than by sound. On some of her returns to the nest the female seemed extremely distrustful. She advanced gradually from bush to bush, in each of which she paused for a considerable time, in some for a minute or more, while she turned her head from side to side, rocked her body forward and backward, twitched her wings and flitted her tail up and down, at the same time spreading the feathers fanwise. Sometimes she flew from one side of the nest to the other to repeat the same elaborate gestures, then before settling on her eggs made a final survey of the surroundings from a point close beside it. Meanwhile her mate might behave in much the same fashion, but at a greater distance from the nest. The female grosbeak seemed the very incarnation of wariness; yet all the while she repeated those sharp, penetrating notes, that would cancel all her caution except in relation to some enemy dull of hearing, like a snake. This calling might continue for a while even after the female had settled down on her eggs. The male, when he came to feed his mate, presented the same contrast of distrustful scrutiny of the surroundings and seemingly reckless use of the voice. The female's flight from the nest at the end of a session was more often silent, but sometimes it was accompanied by the same sharp monosyllables that announced her arrival.

Whether because of so much vocal activity at the nest or from other causes, most of those which I attempted to study were prematurely destroyed. At two nests which I found after the set was complete, the eggs hatched 14 days later; in these the second egg had apparently been newly laid. At another nest the eggs hatched after 13 days of incubation.

#### THE NESTLINGS

The newly hatched grosbeaks have tightly closed eyes and dark skin shaded by dark gray down, and as with other finches the interior of the mouth is red. They develop rapidly and at the age of 10 days are well clothed with feathers. On August 4 the eggs in the coffee bush hatched, and next day I spent the first 5 hours of the morning watching the parents attend the two-day-old nestlings. In this period the female fed them 11 times and the male gave them food 6 times. Both brought the food inside the bill or mouth, so that little or nothing was visible as they approached through the glossy foliage of

the coffee bushes. Then, standing beside the nest, they would work their mandibles and produce small, solid particles which they held in the tip of the thick bill and passed to the nestlings below them, repeating this until they had exhausted the supply. Once the male brought a small insect whole or nearly so, but usually I noticed in the parent's bill a whitish substance. This might have been broken grains of maize, as the main crop was now ripening throughout the valley, but if so it came from a good distance. If the female was brooding when the male arrived with food, she would hop from the nest, sometimes advancing toward him, then while he was engaged in the rather lengthy procedure of feeding the nestlings she would return beside him. At times she would take some or even most of the food into her own bill and pass it to the nestlings, but at other times he had expended his supply before she returned. Then after his departure she would resume brooding. The male devoted five minutes to giving the nestlings their first meal of the morning; but after that the feedings of both parents became progressively shorter, until they required only a fraction of a minute.

The female alone brooded the nestlings. Her first period of diurnal brooding lasted 30 minutes; but afterward she sat for shorter periods, generally from 10 to 12 but once for 15 minutes; and after 10 o'clock she further reduced her sessions in the nest, staying only from 3 to 8 minutes at a stretch. All this was in striking contrast to her long sessions before the eggs hatched. Counting as continuous those periods of brooding which were interrupted when she hopped from the nest to allow the male to feed the nestlings, she brooded 12 times for a total of 132 minutes, or 46 per cent of the elapsed time. While sitting in the nest she often sang in a subdued voice, answering her mate who sang in the distance.

Both parents habitually came to the nest with the same incongruous mixture of caution and recklessness that I had noticed during incubation. Indeed, their circumspection in approaching the nest was now accentuated, yet with no diminution of their tell-tale loquacity. Advancing by stages, with much flitting of wings, fanning of tail, turning from side to side and peering about, they would finally reach the nest; but even while actually resting beside it they would not infrequently utter their sharp calls.

When a few days old the unfeathered nestlings vanished from the nest in the coffee bush, abruptly terminating my study. Several years earlier I had spent 4 morning hours studying the care of two 4-day-old nestlings in the cornfield. The male, who unlike the males of the other two pairs had not fed his mate while I watched her incubate, did not come near the nestlings. Once I heard from the distance a song which might have been his, although with equal likelihood it was the voice of some other grosbeak. Possibly he had died. In the 4 hours the mother fed the nestlings 7 times. Each time as she approached the nest nothing was visible in her bill, although at times her mouth was so full that it remained slightly open. Then, standing on the nest's rim, she would produce a whitish substance and place particles of it in the open red mouths of the nestlings, feeding them alternately, and giving to each a number of portions on each visit. It was not possible to recognize with certainty the nature of this broken food; but from the fact that twice she came to feed the nestlings a few minutes after I had seen her pluck grains from an ear of maize, it is highly probable that this was the young birds' principal fare. We earlier presented numerous observations which show that maize is a favorite food of the adults.

Unlike the grosbeak in the coffee bush who was aided by her mate, this lone female brooded her nestlings for long periods. Her 4 spells of brooding lasted for 12, 53, 25 and 48 minutes, together covering well over half of the 4 hours of my watch. The maize had dried and its drooping leaves failed to shade the nestlings, which on this brilliant morning were much exposed to the sun and would seem to have required shading rather

than warming. Their blackish skins must have absorbed much heat, yet they appeared to feel only slight distress in the bright sunshine. The nest had been attached to the maize stalks on one side only, and several days earlier it was so alarmingly tilted that I deemed it prudent to tie it up with cord. Despite my effort to keep it even, it still leaned outward; and as usual in a tilted nest, the grosbeak sat always facing upward, her tail projecting over the lowest part of the rim.

Six days later I again devoted four hours of the morning to watching this nest in the cornfield. One of the nestlings had tumbled from the tilted nest and died before I found it. The survivor continued to thrive, and now at the age of ten days it was fairly well clothed with plumage, which from time to time it preened. Again no male took an interest in the nest. The mother brought food 7 times. Coming with nothing visible in her bill, or at most with food barely showing in her slightly open mouth, upon reaching the nest she would produce many portions, sometimes 12 or even 15, from her mouth or throat. Again all that I could detect was a whitish material which seemed to consist of mashed grains of maize. I wondered what those grosbeaks who dwelt in great forests remote from men's farms would find as a substitute for this nourishing grain. I was also struck by the resemblance between the mode of feeding the nestlings of the Blue-black Grosbeak and seed-eating finches like *Sporophila* and *Tiaris*, which also come to the nest with nothing visible in their bills, then produce numerous portions which they deliver to their youngsters in rotation. But with these smaller seedeaters the food consists of many painstakingly collected tiny seeds of the more typical grasses rather than broken grains of that most aberrant and taxonomically puzzling of all the Gramineae—maize or corn. The female grosbeak now no longer brooded, but once she shaded the nestling from the hot sunshine for two minutes. She carried off all droppings in her bill, keeping the nest perfectly clean.

This lone nestling left the nest at the age of 12 days, and from another nest two young departed at the same age. From a third nest a single youngster left when about 11 days old. In their first plumage the grosbeaks are dull brown, with dusky wing and tail feathers, and resemble the adult female.

#### NUMBER OF BROODS

On April 19, 1953, I found a nest containing two nearly feathered nestlings in a small orange tree growing in a pasture near the woodland's edge. This nest, which had probably been built in late March, was an unusually slight and flimsy structure resting on the remains of a last year's nest of this or some other species. This exceptionally early breeding was apparently brought on by the abundance of food close at hand; within easy flight was an open granary full of dry maize that the grosbeaks often visited, and a late maize field where the grain ripened in February and March. The frequent showers during the first two months of the year were possibly another contributing factor. The flimsiness of the nest suggested that at this early date the impulse to build had not reached full intensity. The young left this nest on April 20, and in the following month at least one of them was often seen with a parent at the neighboring granary.

Seventy-five feet from this nest the grosbeaks built another in an exactly similar site in another small orange tree, and in it the female laid another set of two eggs, the second of which was deposited between seven and half-past eight o'clock on June 18. There can be little doubt that this was a second brood of the pair that had already reared at least one young. This second nest was noteworthy for its composition. The foundation was composed almost wholly of dry, many-branched inflorescences of *Begonia cuspidata* with the winged fruits still attached, and the bowl itself was made of dry inflorescences of another sort, apparently of a species of *Alchornea*.

## SUMMARY

Blue-black Grosbeaks forage and nest both in lowland rain-forests and in neighboring clearings and thickets. In Central America they range upward to somewhat over 3000 feet above sea level. They never flock but they are sometimes paired as early as January.

In regions where the forests are interrupted by cultivated lands, maize and rice, especially the former, are favorite foods. The grosbeaks often enter rustic granaries to eat dry maize, and sometimes they nest in maize fields.

These grosbeaks are superb songsters with a varied repertoire. A typical song is marked by the contrast of the rich, full opening notes with the weak, hurried finale. The female's song is only slightly inferior to the male's, and while sitting in the nest she sings back and forth with him. In lowland districts these birds appear to sing throughout the year; but in El General, at an elevation of 2500 feet, the period of song extends from February to September.

In El General nest building may begin in April or even late March; but the height of the breeding season falls later, in July or August, when the grains and grasses which are a principal source of nourishment are ripening their seeds.

The nest may be situated in the forest, usually in a low, spiny palm, or in neighboring cultivated areas, such as coffee plantations or maize fields. A dozen nests ranged in height from 16 inches to 8 feet. The open cup is built by both sexes, who sing while they work.

The set of two eggs (rarely one) is incubated by the female alone, who often sits for long periods, sometimes as much as six hours continuously by day. At some nests the male feeds his sitting mate once or twice in half a day, but at other nests he was not seen to bring food. The period of incubation is 13 or 14 days.

The nestlings, hatched with sparse, dark gray down, are brooded by the female and they are fed by both parents. At one nest, which was abnormal, the male was not seen to attend them. Their food is chiefly a whitish substance brought inside the parent's mouth or bill; apparently it consists largely of mashed maize or other grains. Rarely a recognizable insect is delivered to the nestlings.

The young remain in the nest 11 or 12 days.

Two or three broods may be raised in a season.

## BUFF-THROATED SALTATOR

### *Saltator maximus*

Big, slender, long-tailed, and thick-billed, with olive-green or grayish plumage quite lacking in brilliant colors, the saltators form a distinct group in the great finch family. Like other members of the genus, the Buff-throated Saltators are confined to tropical America, where they are found from southern México to Brazil. In Central America, I have been familiar with the race *S. m. magnoides*, which inhabits the Caribbean slope from Chiapas and Yucatán to northwestern Panamá and also the Pacific slope as far south as central Costa Rica, and with the race *S. m. intermedius*, which is found on the Pacific side of Costa Rica and in Panamá. Although I have found nests of both subspecies, my studies of nest life have been devoted chiefly to *intermedius* in the upper Térraba Valley of southern Costa Rica. Here the Buff-throated Saltator is found from sea level up to about 5000 feet. On the other side of the Continental Divide, I have met saltators nearly as high.

The Buff-throated Saltator of Panamá and southern Costa Rica is a large finch about eight inches in length. The top of its head and cheeks are dark gray, and there is a narrow white stripe above each eye. The back, wings, and long tail are bright olivaceous green. Covering the throat is a large patch of buff completely enclosed by a wide black border which extends along the sides of the throat and crosses the breast. The remaining under parts are grayish, becoming buff on the under tail coverts. The high-arched, laterally compressed bill is black and the eyes and feet are dark. The sexes are alike in appearance.

Buff-throated Saltators inhabit tangled second-growth thickets, neglected pastures, coffee plantations with abundant shade, riverside tangles of vegetation, and the bushy margins of the forest. They may penetrate the more open parts of the woodland near its edge and hunt in the tree tops at no great distance from the clearings, but they are absent from the depths of heavy forest. Although Carriker (1910:877) and others have found Buff-throated Saltators in small flocks in the Caribbean lowlands of Central America, those of the Panamanian race remain mated throughout the year and I have never seen them flocking. They are shy, silent, retiring birds, and except while delivering their beautiful song they are not easy to find amid the tangled vegetation where they dwell. But one year a pair roosted amid the dense foliage of a big orange tree in my yard, along with wintering Baltimore Orioles and many tanagers of several species.

#### FOOD

Buff-throated Saltators subsist largely on berries and other soft fruits. For several years a few of them have attended the feeding shelf beside my house, coming singly or in pairs to eat the bananas or plantains displayed there. They are always very shy and ready to dart away the moment anyone appears on the porch. They eat freely of the green fruiting catkins of the cecropia tree. Sometimes they devour the corollas of flowers; I have seen them eat leguminous blossoms; and once I watched one swallow whole an entire corolla of *Mandevilla hirsuta*, a vine of the dogbane family whose trumpet-flowers are as big as garden morningglories, and are pale yellow with a red throat. The Grayish Saltator also relishes the corollas of flowers.

#### ANTING

One afternoon at the end of October, a pair of Buff-throated Saltators came into my yard and flew to a lemon tree where there was an arboreal nest inhabited by fat brown



Fig. 13. Buff-throated Saltator.

ants of medium size. One of the birds perched beside the nest and took an ant in the tip of its thick bill. Holding its right wing extended in such a manner that the primary feathers shielded the side of its breast and belly, it rubbed its bill—and apparently also the ant grasped in it—rapidly against these feathers. Then it seemed to eat the ant, but of this I was not certain. It repeated this act over and over, always with a fresh ant. Once the saltator advanced very close to the nest to pick an ant from its surface. Here a leaf was interposed between its bill and wing, which was held forward as before; and now the bird rubbed the ant against the leaf instead of its feathers! At the time I witnessed this peculiar behavior, I had little notion of what the saltator was trying to accomplish. In subsequent years, a good many notes have been published describing this still imperfectly understood activity, widespread among birds, and now known as “anting.” Apparently the birds anoint the inner surfaces of their remiges with formic acid secreted



by the ant in their bill; and they seem to derive considerable satisfaction from this act, although exactly how it affects or benefits them remains obscure.

#### VOICE

The common call note of the Buff-throated Saltator is a slight, sibilant monosyllable, often delivered in flight, and absurdly weak for so large a bird. It is given less often than the beautiful musical phrases which the members of a mated pair use to keep in contact and assure each other of their continued presence. I first became familiar with this musical call in Honduras many years ago and have since heard it innumerable times in the Térraba Valley of Costa Rica, and in this respect races of the Buff-throated Saltator differ little or none at all. One member of pair delivers a musical phrase consisting of three or four syllables, in a soft, modulated tone; the mate replies with a similar phrase. The two may call back and forth to each other many times over. It is a delightful experience to stand between the male and female when they are calling so and to hear the liquid warbled notes come alternately from right and left. At times I have been unable to detect any difference between the voices of the male and female when they call; but at other times one has seemed to sing *cheery cheery*, a phrase of four syllables, answered by one of three syllables that sounded like *cheer to you*, delivered with falling cadence. I have heard a female saltator, when approaching her nest, sing both parts of this duet over and over, placing either phrase first.

In addition to this responsive singing, there is also another song, longer continued and usually more powerful, which is heard chiefly in the nesting season and which appears to be delivered by the male alone. Usually he mounts to a fairly high perch, often to a conspicuous post on a lofty dead limb, but at times he sings well screened by the foliage. There is considerable variation in this song, not only between different geographical races of the species, but even between individuals of the same race dwelling not many miles apart. In the Motagua Valley of Guatemala, the Central American Buff-throated Saltators sang in a voice which was pleasant but neither rich nor powerful, a simple phrase that I paraphrased *tralé le-e-le, tralé le-e-le*, and so on, many times over. At dawn this song might be continued for fifteen or twenty minutes with hardly an intermission; later in the day I heard it only for briefer periods. In character it was so much like the dawn songs of some of the flycatchers, that until I actually saw the saltator while he sang, I supposed that I was listening to a member of the flycatcher family. It was hardly more forceful than the responsive song; had the latter been longer continued, it would have made the finer music. Once I heard the male deliver the *tralé le-e-le* song in a undertone, while his mate sang back *cheery cheery*, then went to sit in the nest. I thought her song nowise inferior to his, although it was not so prolonged.

In the Térraba Valley of Costa Rica, the Panamá Buff-throated Saltator has a more powerful voice than its northern relatives. Although fuller-toned, more mellow and more positive, the song even here often possesses in large measure that yearning, wistful quality so frequent in the songs of saltators of this and other species. Some individuals have particularly strong, clear, far-carrying voices, and the tempo of their song is slow and deliberate. But again the song is a rich, full-voiced, long-continued, unbroken but measured sequence of soft, lilting notes, not divided into phrases, nor readily represented in the syllables of human speech.

Here in the Térraba Valley, the song of the male saltator is interspersed with loud, clear, single notes that appear unrelated to the musical theme, but are placed with fair regularity at the end of each liquid phrase, like an emphasized punctuation mark. Often this sharper note has a peculiar ventriloquial quality, appearing to proceed from a different direction than the body of the song. As he delivers the emphasized note, the

male opens his bill far wider than while singing the softly flowing phrases of his song. These peculiarities once led me to believe that it was the female who interjected these staccato notes while her mate sang, always with due respect for his versification. Some of my field records are so positive on this point that I hesitate to contradict them; yet I am quite sure from observations under especially favorable conditions that the male saltator himself intersperses his song with these staccato punctuation marks. Possibly both observations are correct; for we have seen that while the *cheery cheery* and *cheer to you* are usually delivered by male and female responsively, the latter may sing both phrases together.

After I had known the Buff-throated Saltator for many years and was beginning to believe that I had become familiar with all its varied utterances, it surprised me with yet another type of song, rather different from anything that I had hitherto heard from it. On March 19, 1948, in the dim light before sunrise, in an orange tree in the pasture in front of my house, a saltator which I took to be a female rested motionless amid the foliage; another bird, apparently her mate, stood close by, facing her, and with head depressed sang in a low voice hardly above a whisper, hurriedly and with great intensity, continuing for several seconds. When the silent partner flew to another bough, he followed and again stood close beside her to perform as before. Soon she flew away, and the pair answered each other with the usual responsive refrains. I have heard such intense whisper singing addressed to a female only on this single occasion.

The song of a Lesser Buff-throated Saltator, which in October I heard near San Ramón Chanchamayo in the eastern foothills of the Peruvian Andes, reminded me greatly of that of the Panamá Buff-throated Saltator, but seemed even softer in tone.

In the upper Tétraba Valley, between 2000 and 3000 feet above sea level, some Buff-throated Saltators begin to sing in January or February; but it is March before their singing becomes general, and by the end of the month they perform profusely. April and May are their months of fullest song. During June, which is likely to be a wet and gloomy month, their singing rapidly wanes; yet through July and August they may carol generously at dawn, and sometimes later in the day in fine weather. From September to the end of the year their songs are rare and mostly brief. These remarks refer to the "territorial" song of the male; the responsive singing of male and female is heard throughout the year, but this also most often in the nesting season.

#### DOMINANCE

In the pair of saltators which came to my feeding shelf in 1946 and 1947, one member had the black band across the chest distinctly broader than the other. The bird with the wider pectoral band, which was probably the male, usually went first to eat bananas, then flew away. The male, who had waited respectfully on a neighboring branch until her partner was satisfied, now dropped down to the board, ate as much as she wanted, then went off in the direction that the first had taken. One morning the supposed female came first to the table; but when the male flew up beside her, she retired without having tasted the banana and waited on a nearby branch until her mate had finished and flown away. Unlike most birds of this and other species that visited the table, these two saltators never ate side by side except at the height of the breeding season. While they had eggs or young in the nest, the male was more amiable and permitted his mate to share the board with him. But soon after the last brood was out of the nest his old crustiness reasserted itself, and she had again to stand respectfully aside until he had finished his meal. After the youngsters had emerged from the seclusion they seek upon quitting the nest, they were brought by their parents to receive banana at the feeding shelf. In the excitement attending one of the earlier visits of a young saltator to the board, its mother

so far forgot herself as to alight on the table to obtain food for the youngster while her touchy mate was there; but he would not stand for this, and drove her away as usual. The relaxation of male dominance during the nesting season, and even the winning of ascendancy by the female, has been observed in a number of other species.

Occasionally a saltator tried to keep Song Tanagers or other birds off the board while it ate, but such behavior was exceptional and never led to actual fighting.

#### NEST BUILDING

In the upper Térraba Valley, nest building begins about the middle of March, but it does not become general before the end of the month. The bulky, open nest is placed in tangles of bushes and vines amid thickets, weedy fields, long-neglected pastures, at the bushy edge of the forest, in a dense hedge-row, or in stands of bracken where the tall, straggling fronds are almost impenetrable to man. More rarely it is built in an orange or a lemon tree in a shady dooryard, in a coffee bush in a clean but well shaded plantation, or in a compact tussock of tall grass in a pasture. The site is usually low, between 10 inches and 7 feet above the ground. Only 7 of the 53 nests that I have recorded were higher than 7 feet, and only 4 above 10 feet. The highest were: 11 feet up in an avocado tree; 17 feet up among clustering foliage, but in an exposed position, in a guava tree in a pasture; and 15 and 30 feet, respectively, amid the denser foliage of orange trees.

The study of nest building presents difficulties. The saltators are so shy and secretive that usually their nests are completed before the bird watcher finds them. If discovered while building, these birds are likely to abandon their nest. But on April 28, 1939, I had the good fortune to find the earliest beginning of a nest, 27 inches above the ground in the midst of a tussock of tall guinea-grass in a pasture near a river. There were merely a few lengths of dry herbaceous vines, supported between the grass-haulms, and arranged in roughly circular form. Much as I desired to watch the bird at work, I allowed a day to pass without attempting to do so. During this day, April 29, the saltator built actively, and not only completed the slight foundation of coarse vines, but placed a considerable thickness of the middle layer composed of broad, dry grass blades. In the evening I set up my blind, not in the position which commanded the most satisfactory view of the nest, but at a more distant point where it seemed less likely to cause the shy bird to abandon her work. Here I had only an imperfect view of the nest through a narrow gap among the grass-haulms, yet I dared not separate them more widely.

The following morning at 6:30 I entered the blind; but the female saltator was so suspicious that it was seven o'clock before she overcame her fears and went to work. In the next three hours she brought material to the nest only twenty times, and always broad, dry grass blades held crosswise in her bill. So far as I could learn, she worked with only the moral support of her mate, but with that he was very liberal. She labored in a most leisurely fashion, for after making from two to five visits to the nest in fairly rapid succession, she and her mate would go off for a long recess, sometimes staying away for as much as forty minutes, during which no work was done.

Although the male saltator did not work himself, he took considerable interest in the progress of the undertaking, and after each absence of the pair from the vicinity he would precede the female to the nest and inform himself as to its condition. Since he habitually entered the tussock from the right side, while the female always entered from the side away from me, I could see clearly that he brought no material in his bill. But once he passed food to his mate across the nest; and I believe that he repeated this later although I could not see plainly because of interfering grass blades. After each visit of inspection, he would withdraw to a little distance while his mate worked. Often he rested

at the top of a neighboring tall bush, where he sang with rich, full, deliberately measured notes. When not singing his "territorial" song, he and his mate called back and forth to each other. The female uttered these notes even while holding material in her bill.

By the following morning, May 1, the thick middle layer of the nest, of broad grass blades, had been completed; and the female was bringing pieces of fine, dry vines for the inner lining. I watched from seven until eight o'clock, in which period she came with material only seven times. Since now both male and female approached the nest from the far side, conditions for observation were so unsatisfactory that I did not continue my vigil. By evening the nest appeared to be completed. The lining of fine dry vines, although so slight that it did not cover the bottom, was as ample as in a neighboring nest that already held eggs. Thus, without working hard, the female saltator had completed her bulky nest in four days or less.

Seven years passed before I again watched a Buff-throated Saltator build her nest. On June 3, 1946, I had set my blind in the pasture behind my house to witness the completion of an unfinished nest of the Bellicose Elaenia, discovered the preceding day. But the little flycatcher would not work so close in front of the brown tent; and while waiting for her to become reconciled to its presence, I noticed a saltator carrying material for a nest. She was building in the midst of the crowded stump-sprouts of a guava tree in the shady pasture, placing her nest only ten inches above the ground—the lowest nest of the species that I have seen. The outer shell of the bulky structure was composed largely of the dry inflorescence branches of a neighboring tree of *Alchornea latifolia*, and it was so recently begun that it had scarcely any bottom.

In 3½ hours of attentive watching, I saw only the female bring material to the nest. From 6:30 to 7:00 she brought 13 billfuls. From 7:00 to 7:08 building and watching were interrupted while I moved the blind closer to the nest. From 7:08 to 8:08 the female made 20 trips to the nest. In the following hour she came 20 times more; but from 9:08 to 10:08 she made only 10 trips. A light rain began to fall at about 9:20, and possibly this, as well as the lateness of the morning, slowed down her work. In the whole 3½ hours she brought material to the nest 63 times.

Her material was chiefly strips of monocotyledonous leaves for the middle layer of the nest, but there were also lengths of dead vines and other things. Upon approaching with something in her bill, the saltator always came to rest in a small guava tree standing a few yards from the nest, and after a pause here and a survey of the surroundings, she dropped down and vanished amid the stump-sprouts. While in the guava tree, she often sang the sweet responsive song. The male, unseen in the distance, delivered the longer solo song, especially during the earlier part of the morning, and sometimes he gave the responsive song also. Twice he brought food and gave it to the female in the guava tree near the nest. Once she quivered her wings after receiving the morsel. At other times the male came into the trees about the nest with something in his bill, but I did not see him feed his mate. Although rain fell steadily during the following morning, June 4, the saltator completed her nest by lining it with slender dead vines and other material. Despite unfavorable weather, this nest was apparently built in only three working days.

After they began to come to my feeding-shelf for bananas, the saltators, like their neighbors the Black-striped Sparrows and other birds, became less distrustful of me and my blind, so that at last I could watch them under more favorable conditions as they nested in the orange trees or hedges near the house, or in the neighboring coffee grove. Watching these birds build is so delightful an occupation that in subsequent years I have devoted some time to observing the construction of five additional nests, without finding any evidence that the male took an active share in the work. Each of these five males, like the two at the earlier nests, fed or seemed to feed his mate at least once,

although the foliage which usually clusters closely about a saltator's nest often made it difficult actually to see the transfer of food. At all the nests the male took considerable interest in his mate's task, followed her on her trips for material, and sang responsively with her; and two of them went from time to time to sit in the unfinished nest, although so far as I could see without bringing a contribution to it or attempting to shape it. At a nest in a coffee bush, four times I saw the female actually sit upon her mate, who had gone to try out the nest and did not make way promptly enough when she came to resume work. After he pushed out from beneath her, she settled to the bottom and made vigorous movements to give the structure shape.



Fig. 14. Nest and eggs of Buff-throated Saltator at El General, Costa Rica, April 21, 1937.

In all, I have devoted 25½ hours to watching the building of 7 nests, during which the females made 272 visits to them. The most rapid building I saw was 22 visits in an hour between 7 and 8 o'clock in the morning; but this female came only 17 times the next hour, and 10 times the third hour. Some building females did not visit the nest more than 8 times an hour even in the early morning, and the rate of working of all of them fell off sharply after 9 or 10 o'clock. Two nests were built in 3 days, 2 in 3 or 4, 2 in 5, and one in 6 days. The nests which it took more than 4 days to finish were built early in the season, before the middle of April. Those more quickly completed were made later.

One day in early April, while watching a nest of the Royal Flycatcher that hung above a sluggish stream, I saw a Buff-throated Saltator, a female, I think, fly into a tangle of vines that covered over a neighboring low tree. Here she sang a whisper song, full of intensity despite the weakness of the tone. She continued this for a considerable

period during which, by quivering her half-spread wings and plucking with her bill at loose shreds of bark and dry leaves, she clearly revealed that she was thinking of a nest.

The finished nest of the Buff-throated Saltator is a well-made, bulky, open cup. The foundation is composed of long pieces of coarse dry vines and weed stalks, some of which hang untidily far below the bottom. The thick middle layer is generally of flat materials: grass blades; strips from the broad leaves of banana, *Heliconia*, or similar great-leaved monocotyledonous plants; pieces of epidermis from decaying stems of the same plants, or fibers from their interior; papery bark of trees, and the like. The lining is composed of fine dry vines, fine tendrils, rootlets or fibers. The cavity of the nest measures from  $2\frac{3}{4}$  to  $3\frac{1}{4}$  inches in diameter by from  $2\frac{1}{2}$  to 3 inches in depth. Nests of the Streaked Saltator are often found in the same thickets with those of the Buff-throated Saltator. Although the two species build rather similar structures, those of the latter may usually be distinguished by their greater bulk.

#### THE EGGS

The earliest set of eggs of which I have a record was laid in El General on March 20 and 21, 1947. It is rare, however, to find eggs before April. At one nest the female was building actively one morning and laid her first egg early the next morning. At one nest a day elapsed between the completion of the nest and the laying of the first egg; at 3 nests this interval was 2 days; at one nest 3 days; and at one nest 4 days. In 17 nests, the eggs were laid on consecutive days. The first egg of the set is generally laid in the hour following sunrise, the second between 7 and 8 o'clock, but sometimes later, making the interval between layings somewhat more than 24 hours, sometimes as much as 26 hours (for details see Skutch, 1952:50). My experience in timing the laying of several of these eggs (each the second in the set) was similar, and that at nest 22 may be given as an example. At 7:00 a.m. this nest contained a single egg which had been laid the preceding morning. When I returned at 7:55 I found the saltator sitting in the nest. She sat with steadfastness unusual for a shy saltator, allowing me to look on from a distance, until 8:20, when she flew away, revealing two eggs in the nest.

In Central America, the number of eggs in the Buff-throated Saltator's nest is regularly two. I have four records of nests from the Caribbean lowlands of Guatemala and Honduras, and 45 from the Térraba Valley of Costa Rica, each containing 2 eggs or nestlings. The Penards (1910:461) state that in the Guianas the number of eggs of the nominate race may be either 2 or 3. The eggs of the Buff-throated Saltator are bright light blue, marked around the larger end with a wreath of dots, irregular blotches and scrawls of black. On some eggs the fine scrawls are long and intricately tangled, on others they are greatly reduced or lacking, the marks consisting of blotches alone. Usually the remaining surface of the egg is immaculate, but sometimes it bears scattered black spots or scratches. One exceptional egg was finely flecked with brown over the entire surface and bore also a few coarser blotches of this color. The measurements of 47 eggs average 27.5 by 19.2 millimeters. Those showing the four extremes measured 31.8 by 17.5, 26.2 by 20.6 and 25.4 by 19.1 millimeters. The longest egg measured was also the narrowest.

The distribution according to the month of laying of 51 nests in the valley of El General, 2000 to 3200 feet above sea level, is as follows: March, 3; April, 17; May, 19; June, 9; July, 1; August, 2.

#### INCUBATION

The eggs are incubated by the female only. On April 1, 1944, I found a nest situated in a low, dense clump of *Baccharis trinervis* in an abandoned pasture. The shrubby composite was covered with small white flower-heads, and its crowded foliage provided excellent concealment. The nest contained one egg when found, and the second was laid

the following day, April 2. I devoted the morning of April 10 and the afternoon of April 12 to watching this nest from a blind. The morning was brilliantly sunny, becoming overcast at noon. During the afternoon there were alternately showers and sunshine. In 12 hours the female took 18 sessions on the eggs, ranging from 6 to 52 minutes in length and averaging 25.7 minutes, and 17 recesses, from 6 to 34 minutes in length, and averaging 13.2 minutes. Her shortest sessions were taken between 7:30 and 9:00 a.m., her longest at the end of the forenoon. Her longest absence came just after sunrise; her shortest in the afternoon, as a shower began. During my 12 hours of watching, she spent 66 per cent of the time on the eggs.

On approaching her nest at the end of a recess, the female saltator nearly always paused to sing among the bushes behind it. Here she repeated over and over the sweet, soft notes of the responsive song, the one she used to answer her mate and which he uttered in response to her, never the louder and longer song that the male alone appeared to possess. In the early morning she would continue to sing for a minute or more, while her mate carrolled more loudly in a *targuá* tree above her, not directly answering her, but following his own separate theme. Toward noon, she sang less and less as she approached her nest, until at 10:29 she sang only once, and at 11:25 she returned without singing. This silent return to the eggs preceded the longest session that I witnessed. In the afternoon, however, she sang freely again. These songs always ceased before she flew to the bush where the nest was hidden; and while sitting she always preserved complete, discrete silence. She sat deeply in her bulky nest, only her bill and the top of her head with the white superciliary stripe, and sometimes her eye, being visible to me above the rim. Her long tail projected obliquely upward at the other side. Her session over, she usually voiced her thin, high call-note once or twice as she flew away.

During the early morning the male saltator was attentive to his mate, usually flew with her as she returned to her eggs, and then sang close by. Once he brought food that seemed to be intended for the female. He carried it up to the *targuá* tree where he sang, moved it about in his bill, then began to sing in an undertone and dropped it, apparently inadvertently, all before she had finished her own singing and returned to the eggs. Later in the morning he visited the nest while the female incubated, stood on the rim above her for about a minute, uttering low, soft notes, and possibly fed her; but I could not see this clearly. During the afternoon he did not come near the nest; but sometimes, when the female sang before settling on her eggs, he answered once or twice with the responsive refrain, from a distance.

On April 14, a dark morning with falling mist, I devoted three hours more to watching the female saltator incubate at this nest. Although during my earlier vigils she sat in silence, now she was somewhat vocal while incubating. Once while the male was giving the solo song in the tree above, she answered with the responsive song, repeating it ten times. During other sessions she sang more briefly in the same fashion. She also called sharply from the nest, and once repeatedly uttered a loud note like a sneeze. Why she should have been so much noisier while sitting on this cloudy morning I cannot surmise. Sometimes, when she heard the responsive song of her mate, instead of answering him she silently left the nest. She covered her eggs only 62 per cent of the three hours.

Two years later I discovered a Buff-throated Saltator's nest about fifty yards from the site of the one in the *Baccharis* bush. In 5 hours on a sunny morning, 4 days after incubation began, I timed 7 sessions on the eggs, ranging from 18 to 56 minutes in length and averaging 26.4 minutes. The female saltator's 7 recesses varied from 12 to 23 minutes and averaged 17.6 minutes. She spent 60.1 per cent of the 5 hours on her eggs. In the early morning she would repeat the *cheery cheery* song as she approached through the surrounding thicket, but after the middle of the forenoon she came without

singing, merely uttering her slight nasal note. She always incubated in perfect silence and was much less tuneful than the saltator at the earlier nest. The male also sang far less than the male at the nest in the *Baccharis*. I heard him sing the solo song only once and the responsive song only once; he did not approach the nest nor feed the female while I watched.

It is rare to find two saltators' nests close together; but because of the nature of the vegetation amid which these birds live, it is difficult to learn anything about their territorial relationships. Toward the middle of April, 1944, however, I was surprised to discover two nests situated only eight feet apart in neighboring coffee bushes in a small plantation. The first, which I designated nest A, was five feet above the ground and eggs were laid in it on April 12 and 13. Nest B was  $3\frac{1}{2}$  feet up and the eggs were laid on April 14 and 15. As I grew more familiar with the owners of these nests, I called the female of nest A, who had quite lost her tail, "Anne." Her neighbor I named "Betty." For a number of days I was uncertain whether they had separate mates, or whether both females were wedded to a single bigamist, as has been occasionally recorded for other finches. But after the nestlings hatched, each nest was attended by a male bird. Anne's mate became "Arthur," and Betty's mate, "Ben."

Setting the blind beneath a coffee bush in a spot which commanded a good view of both nests, I devoted the morning of April 22 to watching them. I had not spied upon them for long before it became clear to me that these two saltators which nested so close together were enemies rather than friends. It was also easy to see that Betty, who laid her eggs last, was dominant over Anne, who now had a very stubby new tail. Betty strongly disapproved of Anne's presence and made every effort to keep her away from her eggs. Each time she left her own nest, Betty flew over that of her tailless neighbor, and if she found the latter sitting, drove her rapidly away. Anne was afraid of Betty and never resisted her aggression, but timidly flew at her approach and was chased through the coffee plantation into the neighboring thicket. Sometimes one or both of the males would join in a general chase; but all flew so rapidly through the bushes that I found it impossible to determine the part taken by each.

Upon returnig at the end of a recess, Betty again drove Anne from her nest, if the latter had meanwhile returned to resume incubation. Sometimes the aggressive one went to look into Anne's empty nest, to make certain that it was unoccupied, before she returned to her own eggs. It apparently never occurred to her that she might rid herself of her rival once and for all merely by breaking the eggs.

Thus Anne carried on incubation under difficulties. She might return to her eggs during her neighbor's absence, but then could remain covering them only until the other's return; or she might steal softly up to her nest while Betty sat in her own and continue to incubate until Betty left, whereupon Betty's first act would be to drive her unhappy rival away from her maternal duties.

As a result of this state of affairs, the two saltators developed very different manners of returning to their nests. Betty would perch in a coffee bush and sing or call before going to settle on her eggs, much in the fashion of the saltator nesting in the *Baccharis* bush, which I had watched earlier in the month. Her singing post, strangely enough, was only half as far from her enemy's nest as from her own; Anne's nest was midway between the bush where Betty sang and Betty's nest. While sitting, too, Betty often sang responsively with her mate, or else called in a low voice. Sometimes three saltators would sing back and forth through the plantation.

Anne, although she might sing responsively with her mate while still a good way from the nest, habitually approached it in silence. She never sang near it and rarely even gave the low, nasal call note. She usually arrived so silently and unobtrusively, flying



low between the coffee bushes until she reached that in which her nest was built, that I was not aware of her return until she was actually at the nest. Often she even eluded the vigilance of Betty, sitting eight feet away. But sometimes, especially late in the morning, Betty saw her arrive and promptly left the nest to drive her away. Once settled deep in her spacious cup, Anne always incubated in perfect silence, while Betty answered Ben with lilting song, and sometimes with low call notes as well. Sometimes, while taking a recess, Betty would return to the vicinity of the nests apparently for no other purpose than to see whether Anne was sitting and to drive her away if present; for having accomplished this she would go away, not at once returning to her own eggs.

As each saltator sat on her eggs, only her tail, her bill and the top of her head, with the conspicuous white superciliary stripe, were visible to me above the rim. Both clung to their nests with a steadfastness unusual in saltators, allowing me to approach almost within arm's length before they flew off. They even remained in their nests while I set up the blind! Possibly each was so engrossed in her rival that she became careless of other sources of danger.

Betty's comings and goings were without external compulsion; but she did not incubate in quite normal fashion, because she sometimes left her nest to drive away her enemy. During 6 hours of the morning, her 12 sessions ranged from 2 to 39 minutes, with an average of 19.1 minutes. An equal number of recesses varied in length from 2 to 16 minutes, with an average of 9.7 minutes. She spent 66.4 per cent of the six hours on her eggs—very nearly the same as the saltator in the *Baccharis trinervis*.

Anne's 12 sessions ranged from 1 to 36 minutes, with an average of 13.5 minutes. Only two of these sessions, however, were spontaneously terminated; ten times Anne fled abruptly as Betty approached. Twice she was chased from the nest after having sat for only a minute. Her 12 absences ranged from 6 to 31 minutes, with an average of 15.1 minutes. During the 6 hours, she sat in the nest only 47.2 per cent of the time—considerably less than normal.

At seven nests the last egg hatched 13 or 14 days after the last was laid. At three of these nests, where an effort was made to determine the incubation period in hours, this proved to be: nest 31, between 13 days 20½ hours and 14 days 1 hour; nest 38, between 13 days 10 hours and 14 days 0 hour; nest 47, between 13 days 6½ hours and 13 days 10 hours.

The incubation period of Anne's eggs was abnormally lengthened by the interruptions she suffered. It will be recalled that her second egg was laid on April 13, between 7:00 and 8:20 a.m. Her first egg was pipped on the evening of April 25 and promised to hatch in the normal time; but the following morning I found it stuck so hard to the bottom of the nest that a piece of the shell broke away as I lifted it; later in the day this broken egg was removed from the nest, probably by Anne herself. The second egg was pipped by April 26, but did not hatch until late in the morning of April 29, after 16 days of incubation—three days longer than normal. The young bird within had begun to hammer at the shell after little more than the normal period of incubation, but it had required three days to effect its escape instead of less than one day as at the other nests. Such a long interval between the pipping of the egg and the emergence of the nestling is not rare among nonpasserine birds but is quite abnormal among song birds.

#### THE NESTLINGS

I have twice watched the final act of emergence of the young saltator from its shell. One morning at 8 o'clock I found both eggs pipped in a nest in the Lancetilla Valley of Honduras. By 2 p.m. one egg had hatched, but the shell of the second was not yet pierced. At sunset this second egg had a hole about 5 millimeters long in its large end,

where the transverse diameter was greatest. Through this narrow gap the short, blunt bill of the young bird protruded. The head was bent forward and turned to the right of the body; rhythmically it moved up and down, alternately pushing the bill outward through the perforation and withdrawing it again. With each outward thrust the culmen of the upper mandible was brought to bear against an end of the slit, chipping off a bit more of the shell. At the same time, the chick slowly rotated within the shell, so that the head moved backward, ever bringing the ridge of the upper mandible against an unbroken part of the shell, and with each fresh thrust lengthening the fissure. The bill opened and closed with each movement of the head. When the gap extended half way around the circumference of the egg, the struggles of the bird succeeded in breaking it the rest of the way, so that the large end fell off like a cap; and the chick squirmed free into the palm of my hand. Its down was plastered to its pink skin in dark, curly strands. From the time I picked it up with the five-millimeter-long gap in the shell until it completely escaped, only ten minutes had elapsed. Since the sun had already set, I hastened to return it to the nest, in order that its mother might cover it through the night. At another time, when I began to watch a chick that had made a perforation only 3 millimeters long in its shell, it was completely free of the egg 13 minutes later.

The newly hatched saltator has a pink or salmon-colored skin. There are a few tufts of long, olive-green down on the crown, shoulders, wings, middle of the back and flanks. The eyes are tightly closed, and the interior of the mouth is red.

I had hoped to make a continuous watch of the nest in the *Baccharis* on the morning when the eggs were due to hatch; but in the previous night a yearling colt destroyed my blind. From another blind I saw the male saltator feed the nestling about two hours after the first egg hatched. What led him to begin feeding so promptly I do not know; but he had been in the habit of making occasional visits to the nest, sometimes bringing food, while his mate incubated the eggs. The first morsels brought to this nestling were mashed well in the parent's bill, at times being alternately offered to the chick and squeezed in the parental bill for a minute or two before they were swallowed. After feeding, both parents would linger on the rim, looking attentively down into the nest; sometimes they continued in this attitude for as long as five minutes.

At the nest in the coffee bush, Betty's egg hatched during the night of April 27-28. Dawn on April 28 found me in the blind, eager to watch the parent saltators attend their newly hatched nestling. At 5:23 there was barely enough light to see Betty eat both parts of the empty shell. At 5:30 she left the nest, flying at once to Anne's to chase her rival away. Meanwhile Ben, her mate, sang overhead. In 7 minutes she returned to her nest after singing many times in the neighboring coffee bush. While brooding, she sang responsively with Ben, over and over. At times three saltators were singing back and forth. Betty brooded for 8 minutes, took a recess, returned to brood again, went off, and only upon her fifth return to the nest brought the nestling its first meal, at 6:24, an hour after she had eaten the empty shell.

Although he had been exchanging songs with his mate during nearly three hours, Ben did not bring food to the nest until 8:13. The morsel that Ben brought then seemed to have been intended for Betty rather than for the nestling. After delivering it to her, he flew away before she rose to pass it to the nestling, which even on this visit he failed to see. In the next 2½ hours Ben and Betty frequently sang to each other as they had done before the egg hatched; but Ben did not again bring food to the nest until 10:50, when Betty chanced to be absent; he alighted on the rim and saw the nestling for the first time. Mashing the morsel well in his bill, he patiently offered it to the young until it was swallowed, then lingered at the nest for 5 minutes, most of the time intently looking at its newly-hatched occupant. Twenty-eight minutes later he again brought food

to the nest. The long interval between his first and second visits, as compared with that between his second and third visits, strengthened my conclusion that when he delivered food to Betty at 8:13 he did not learn that a nestling had hatched. He began to bring food with frequency only after seeing the nestling and delivering food directly to it, on his second visit of the morning, at 10:50.

In the course of 6½ hours of the morning, Betty brooded her newly hatched nestling for 22 periods, ranging from 3 to 25 minutes and averaging 10.3 minutes. Her 22 recesses ranged from 3 to 16 minutes and averaged 7.5 minutes. She spent 57.6 per cent of the morning on the nest, as compared with 66.4 per cent while she incubated on April 22. She might have sat longer, had she not jumped from her nest so often to chase Anne away. Between 6:24 and noon she fed the nestling, as nearly as I could determine, 12 times, mashing the food well between her thick mandibles before delivering it.

Meanwhile Anne continued to incubate her single remaining egg under great difficulties. Her neighbor Betty seemed even more determined to keep her away from the nest than before her egg hatched. Sixteen times in the course of the morning Betty chased Anne away, 14 times from the nest itself after the latter had been incubating for at least a few minutes and twice before she had time to settle herself on the eggs. Although Anne returned 16 times to the coffee bush that held her nest, she was allowed to incubate only 13 times, for periods ranging from 3 to 21 minutes. Only one of these sessions, that of 9 minutes' duration taken before sunrise, was terminated by Anne's spontaneous departure; all the others were abruptly cut short by Betty's interference. As a result of so much active hostility, Anne succeeded in keeping her eggs covered for only about 95 minutes out of the 390 minutes that I watched—only 24.4 per cent of the morning, slightly over half as much as on April 22. Her absences varied from 6 minutes to nearly an hour at the end of the morning. No wonder that her nestling required three days to break out of the shell!

As before, Anne came and sat in silence, thereby differing greatly from her melodious neighbor. To drive off Anne, Betty never needed to resort to force. She had merely to fly over her rival's nest, or to alight in the coffee bush a few inches above it; Anne would immediately dart away toward the denser vegetation at the edge of the plantation, flying low between the coffee bushes with Anne in close pursuit, the chase accompanied by shrill notes of excitement. Once one of the males joined in the pursuit and the three shot back and forth through the plantation. As a rule, the pursuit was of shorter duration and appeared to end when the two females reached the tall cecropia and other trees at the top of the bank at the edge of the coffee grove. I could not convince myself that the two females ever came into actual contact; if they did, it was momentary.

On April 30, a cloudy morning, I devoted four hours more to watching these two nests. Anne's chick had at last escaped from the egg and was now less than one day old; Anne's new tail, after 17 days or more of growth, was approaching normal length. Betty's nestling was two days old. The relations between the two females had not changed with the hatching of Anne's egg; but Anne's nestling had an unpredictable effect upon Betty. Each time she approached or left her own nest, Betty would go to have a look at Anne's nest to make sure her rival was absent. On two of these hostile visits of inspection, Betty gave Anne's baby the morsel she had brought for her own! The sight of Anne's nestling lifting its bright red mouth appealed so irresistibly to her maternal instinct that she was impelled to place in it the morsel intended for her own offspring. After one of these feedings, Betty brooded Anne's nestling for five minutes, at the end of which she seemed suddenly to wake up to what she was doing, jumped from Anne's nest, and flew across to sit in her own. After the second feeding, Betty stood for about two minutes looking down into Anne's nest, but did not brood, and in the end went to sit in her own nest. Her

whole manner of approaching Anne's nest contrasted sharply with that followed by Anne herself; she sang as she came, flew up from a different side, and clung higher above it than was Anne's custom when she fed her own nestling.

Both males were neglectful of the nestlings to the extent that by the end of the morning I was still not quite sure whether the two females had separate mates. Ben fed Betty's nestling only 3 or 4 times in the 4 hours. Once one of the males, probably Arthur, seemed to be on the point of feeding Anne's chick, when Betty darted from her nest and put both him and Anne to flight.

In the 4 hours of my watch, Betty brooded her two-day-old nestling 11 times, for periods ranging from 3 to 21 minutes, a total of 130 minutes. Of the number of feedings, I was not quite sure, but credited her with 5, while the male brought food 4 times to her nestling, making 9 meals in all. Betty's absences from the nest ranged from 4 to 18 minutes, and added up to 110 minutes.

Anne brooded her less than one-day-old nestling 13 times, for periods ranging from 1 to 11 minutes, a total of 79 minutes. With the 5 minute brooding that Betty gave it, this nestling was actually covered for 84 minutes. Anne would have brooded her nestling much longer, but every time she sat in the nest she was sooner or later driven from it by her neighbor; not once was she permitted to sit out her spell of brooding and leave spontaneously. In the 4 hours, Betty drove Anne from the nest 14 times, once before she was able to settle down on it. Anne fed her nestling 9 times and Betty fed it twice; thus it received 11 meals, more than came to Betty's chick. Again the impossibility of actually seeing the nestling leaves some doubt as to the accuracy of this count.

By May 4, when Anne's nestling was 5 days old, her mate was bringing food more often than she. I could distinguish the two parents not only by the fact that Anne regularly remained to brood after feeding the nestling while Arthur never did so, but by the different positions from which they delivered the food. Anne would stand on the rim at the far side of the nest, then after the nestling took the morsel she brought, she hopped down to brood it. Arthur always came to the near side, clung to the upright branch beside and above the nest and reached far down to place the food into the nestling's upraised mouth, then flew away. He fed the nestling 16 times, Anne 12 times, making 28 feedings in the course of 4 hours. Anne brooded 10 times, for periods ranging from 1 to 23 minutes, a total of 70 minutes. She invariably flew from the nest when her mate approached with food; 4 times her brooding was cut short by his arrival, and 5 times more she was chased away by Betty. Only once did she terminate her brooding spontaneously.

Betty's nestling continued to receive fewer meals than her neighbor's younger nestling—only 16 during the 4 hours. Because she and Ben delivered food in exactly the same manner, I could not always distinguish them. But thrice Ben brought food while Betty brooded, and 5 times after feeding, Betty remained to guard or brood, thereby revealing her identity. Usually after feeding she delayed on the rim for a while, looking down at the nestling, then entered the nest to warm it. In 4 hours she brooded her six-day-old nestling for 5 periods ranging from 1 to 29 minutes, a total of 63 minutes. In addition, she spent 28 minutes standing on the nest's rim.

On subsequent days, Anne's nestling continued to receive more food than Betty's (see table 3). Arthur was a faithful attendant and fed more often than his mate. As the nestling grew older and required less brooding, Anne and Arthur attended it with less interference from Betty, although the latter continued to drive her rival from the nest whenever she found her sitting there. Even on the day Betty's youngster left the nest, I twice saw one saltator chase another through the coffee plantation and had little doubt

that the pursuer was Betty and the pursued Anne, whose tail, now full-grown, no longer served to identify her.

Table 3  
Care of Nestlings by the Buff-throated Saltator

Date 1944	Hour, a.m.	Nestling A		Nestling B			
		Age, days	Fed, times	Age, days	Fed, times		
April 30	6:15-10:15	1	11	84	2	9	130
May 4	7:00-11:00	5	28	70	6	16	63
May 6	6:40- 9:10	7	12	19	8	10	16
May 7	6:30- 9:00	8	19	20	9	14	17
May 11	6:15- 8:15	12	16	0	13	10	0
Totals	15 hours		86	193		59	226

At the age of 12 days the nestlings were clothed in dark greenish-olive plumage. They had poorly defined buff superciliary stripes in place of the conspicuous white ones of their parents; the throat was slightly lighter than the breast, but quite lacked the bold black border of the adults. Their bills were horn-color instead of black. While I watched the nests on May 11, Betty's nestling preened much but gave no indication of its approaching departure. It was still in the nest at 8:15, but when I returned at noon I found the nest empty. It had left at the age of 13 days. Anne's nestling departed between 7:55 and 8:50 a.m. on May 14, aged 15 days.

Including the foregoing, I determined the nestling period of 16 young saltators at 11 nests. One left when approximately  $12\frac{1}{2}$  days old, 5 at 13 days, 6 at 14 days, 4 at 15 days. All these youngsters left the nest spontaneously, so far as I know. At one of these nests the two nestlings left when between 13 days and 14 hours and 14 days 3 hours of age. Ten of these nestlings are known to have departed from the nest in the forenoon, but only two from one nest in the afternoon. In two instances I found the mother brooding her well feathered nestlings on the night before their departure, and another female brooded on a rainy afternoon the day before they left. From most of the nests which I have tried to follow through the eggs or nestlings have prematurely vanished, but I never chanced to discover what carries them off. Like many other finches, after quitting the nest the young saltators vanish into the midst of dense thickets where it is practically impossible to follow them.

#### SUBSEQUENT BROODS

In the course of the long breeding season extending from mid-March through August, the Buff-throated Saltators have ample time to rear several broods; but the losses of eggs and nestlings are so great that few pairs, I believe, produce more than one or two sets of living young. A nest in the Lancetilla Valley of Honduras, from which a newly laid egg disappeared on June 10, 1930, was replaced by another, in a similar situation about 200 feet distant, which before the end of the month held two eggs. These vanished on July 1, and 16 days later a new set was begun, without much doubt by the same bird, in a new nest in a very similar site about 200 feet from the second. This third nest was also prematurely destroyed, by agricultural laborers in the course of their work. Apparently such re-nestings are continued until a brood is fledged or the breeding season draws to a close. I have four records, all from El General, of true second broods, of which the first egg was laid from 16 to 26 days after at least one living nestling left the preceding nest. In one instance the new nest was a few yards distant from the first, in a similar low site, and contained its first egg about 16 days after two fledglings left the earlier nest. In another instance the new nest was built in a coffee bush about 50 feet distant from the coffee bush where a single nesting was fledged, 18 days before the second set of eggs was begun.

Still more detailed evidence of true second broods was gathered from the saltators nesting in the privet hedge in front of our house in 1947 and 1948. On May 16 of the former year two nestlings left a nest in this hedge, which was apparently the second built by this female in this season, for in March two eggs had vanished from a nest in a neighboring part of the hedge. In a third nest, eight feet from the second, a new set of eggs was begun about June 11, about 26 days after the first brood left their nest. Both of these older young survived until they became independent, and I saw one of them near the nest in which their parents were feeding their second successful brood. The following year, in the same hedge, two nestlings were fledged on May 2. One was found dead in the pasture the next day, but the other lived until it could take care of itself. On May 17 a new nest was begun 60 feet from the first, and on May 23 the first egg was laid in it, 21 days after the departure of the first brood. In both years this pair of saltators was successful in rearing two broods, but I found no indication that they attempted to produce a third.

#### THE YOUNG AFTER LEAVING THE NEST

Upon leaving their nest at the age of 13 to 15 days, the stubby-tailed young saltators are led by their parents into the neighboring thickets and are promptly lost from sight. Usually the watcher sees little or nothing of them until they are well grown and independent of parental care. But in 1947 and 1948, when the feeding shelf beside the house was a continuing attraction to the pair of saltators that in each of these years reared two broods in the neighboring privet hedge, I enjoyed unusual opportunities for filling in this chapter in the saltators' history. For three or four weeks after they left the nest, I saw nothing of any member of the four broods, which doubtless lurked not far off. In each instance my first subsequent glimpse of the youngsters was in or near the feeding shelf, whence their parents had been carrying food to them. The four broods made their first public appearance, so to speak, at ages of 41, 31, 38, and 35 days, respectively. But since I may have overlooked their first sallies into the open, the lower of these figures seems the more significant; and we may conclude that the period of hiding continues for two or three weeks after the young leave the nest, and they begin to fly about more openly when a little over a month old. At this time they are still fed by their parents but are doubtless making their first efforts to provide for themselves.

The saltator which I saw in the open at the early age of 31 days was near the feeding shelf; three days later I first saw it on the shelf. On this day it came repeatedly to the board, both with its parents, who fed it liberally, and alone, when it helped itself, taking little mincing bites and delaying long over its meal. Obviously it was still unpracticed in feeding itself. I noticed that when passing food to a young bird, the parents held their compressed bills sideways. As the youngsters became more skillful in providing for themselves, parental feeding decreased.

I last saw a parent give food to a youngster of the first brood of 1947 when it was 51 days old; parents fed one of the second brood when it was 54 days old. The young of the first brood were last fed, so far as I know, two days before the next brood hatched. A week later I noticed traces of antagonism by the parents toward their older offspring. The bond between the old birds and the young became increasingly weak, and when the latter were 66 days old I saw the parents chase them from the feeding shelf. Yet their opposition was mild, for three weeks later I saw the parents on the board along with their offspring of both broods.

The relations between the members of the two broods was interesting, especially in 1947 when all four of the youngsters lived to fly about. I looked in vain for the saltators of the first brood to feed their younger brothers and sisters in the nest, as sometimes happens in Golden-masked Tanagers, and as has been recorded for several kinds of

bluebirds, swallows, and other groups of birds. When the young of the second brood were a few days old, I saw one of the older youngsters fly from the board, where it had eaten some banana, to the hedge above the nest, where it quivered its wings slightly, as though begging for food. But the parents were absent when this occurred, and it soon flew away. At the end of July the parents often came to the feeding shelf with a youngster of the second brood and two of the first brood, who persisted in keeping company with them in spite of occasional rebuffs. Once while a young saltator hatched in May was eating banana, one of those born in June stood on the board in front of it, begging with pleading cries and wings aquiver. But it received nothing from this source either then or later when I saw it entreat its older brother in the same fashion. By the first of September the family seemed to have dispersed. Rarely one of the youngsters still came to the feeding shelf; but the adults were finding their food elsewhere, and for a while I failed to see them there.

In 1948, when two pairs of saltators were bringing their young to the table, the situation became more confusing; and soon I could not tell which were the young hatched in the hedge and of known age. One day at the end of May a young saltator came to the board in company with an adult, whom it entreated for food. Receiving nothing, it proceeded to help itself in an inexpert fashion, taking very small bites. When some Song Tanagers arrived it pursued them with open bill, whether threatening or begging for food I could not decide. Two months later the feeding shelf was attended by a young saltator of a quarrelsome disposition, in that intermediate stage when it could feed itself but begged with fluttering wings whenever a parent was close by. It tried to keep other kinds from the board, and once it pounced upon the back of a female Song Tanager and drove her off. I never saw an adult saltator treat the other guests so rudely.

I was able to follow the acquisition of the adult plumage by these young saltators that came for my bananas. When, at the age of five or six weeks, I first saw them after their emergence from hiding, they had well grown tails and were scarcely to be distinguished from their parents by size. In plumage, although they bore a general resemblance to the adults, they differed conspicuously in several particulars. The head was more olive-green, not so gray as in the old saltators; but they had the same prominent white stripes above the eyes. The amount of black on throat and breast varied with the individual youngster, as it does with adults, but tended to be greater than on adults, encroaching upon the light area on the throat and leaving it much smaller than on mature birds. On some young birds of approximately the same age, the pectoral band formed a wide, poorly defined zone of dark gray rather than of black. This heavy dark band on the chest ran back in indistinct streaks into the gray of the more posterior under plumage, instead of having a definite margin, as in adults. Not only was the throat patch reduced in size, it was nearly white instead of distinctly buffy. The young saltator's thick bill was light horn-color instead of black. By gradual transition the youngsters became increasingly like their parents, until when they were three months old I found it difficult to detect differences in their plumage. Their bills, however, although darkening from the base outward, were still at this age distinctly lighter than in the adults and formed the best distinguishing feature.

#### SUMMARY

Buff-throated Saltators inhabit cultivated country with an abundance of trees and bushes and penetrate the edges and more open parts of woodlands, but they are absent from the depths of the forest. Confined to more humid areas, they range from sea level up to about 5000 feet in Costa Rica. They are mated throughout the year.

They subsist largely on fruits and come to a feeding shelf for bananas. Their diet includes the corollas of flowers.

They engage in "anting," in a tree rather than on the ground.

The common call note is weak; but mated birds keep in contact by a beautiful, melodious call uttered by both sexes. In the breeding season the male mounts into a tree to deliver a rich, full, long-continued song. He also addresses his mate with a hurried whisper song.

Except while there were eggs or young in the nest, the supposed male of one pair would not permit his mate to eat on the feeding shelf until he had finished.

In El General this saltator breeds from March to August. The bulky, open nest is placed in a bush or tree usually from one to seven feet up, rarely as high as 30 feet in very dense foliage. In 25 hours of watching at seven nests, the male was not seen to help with the building. But he follows his mate when she goes for material, sings responsively with her, feeds her from time to time, and may even sit in the nest, getting in her way. Three to six days suffice for building.

Central American sets consist of two eggs, of which the first is generally laid in the hour following sunrise, the second 25 or 26 hours later. Only the female incubates, taking sessions short for so large a bird and in fair weather seldom sitting for as long as an hour continuously. One female covered her eggs for 66 per cent of 12 hours, another 60.1 per cent of five hours, and a third 66.4 per cent of six hours. While sitting the female sometimes sings responsively with her mate, and at long intervals she is fed by him. The period of incubation is from 13 to 14 days, or, abnormally it may extend to 16 days.

The nestlings are brooded by the female and are fed by both parents, the male beginning to bring food within a few hours after they hatch. When the young are from 13 to 15 days old they leave the nest, usually in the forenoon.

Although nests are usually well separated, two containing eggs were once found only eight feet apart in coffee bushes. The two females, who had separate mates, were antagonistic to each other; and the dominant one repeatedly chased the other from her eggs and nestling. The silence of the less aggressive female contrasted with the dominant neighbor's free use of her voice. Their manner of incubating and brooding was also different. The dominant female from time to time fed and even brooded her rival's nestling. Both pairs succeeded in rearing a single fledgling, but both the incubation and nestling periods were longer at the nest of the harassed female.

At least two broods may be reared in a season, the female laying again from 16 to 26 days after the young of the first brood leave the nest.

For two or three weeks after leaving the nest the young remain well hidden, but when they are a month or more of age, they begin to move about more freely with their parents. At this age they attempt to feed themselves but still receive much from their parents, who continue to give them at least occasional feedings until they are 50 to 55 days of age. The parents become mildly antagonistic toward their offspring when the latter are about two months old.

The young acquire adult coloration by means of the postjuvinal molt, and when they are three months old, they are difficult to distinguish from their parents except by their lighter bills.



## STREAKED SALTATOR

### *Saltator albicollis*

Christmas Day, 1935, dawned clear and cloudless, with a brisk, chilling breeze driving down the valley of the Río Buena Vista from the high summits of the Cordillera de Talamanca at its head. I celebrated the day with a solitary walk through the cleared lands of the valley, where I had recently settled to study the birds and plants. The thickets on both sides of the rough, unpaved roadway and the abandoned bushy clearings that reached far up into the forest on the steep slopes were aglow with a profusion of white, yellow and red blossoms. On this bright morning early in the dry season the birds lurked silent and unseen amid the sheltering vegetation. I saw scarcely any until I came upon a gathering of Cuvier Hummingbirds that perched conspicuously in some wayside trees and repeated their simple verses with unwearied persistence. Late in the morning, from an abandoned field overgrown with acacia-like bushes and tall, coarse weeds, I heard for the first time the beautiful song of the Streaked Saltator.

The Streaked Saltator is one of the most plainly attired members of a genus of finches devoid of bright colors. Its upper plumage is olive-green, of a duller and more grayish shade than the upper parts of the Buff-throated Saltator. An indistinct whitish line extends from the base of his thick black bill to the dull white eyebrow. The under parts are grayish-white, conspicuously streaked with olive. The sexes are indistinguishable.

The Streaked Saltator was very abundant in the lower part of the valley of the Río Bueno Vista, at 3000 feet above sea level; and during the year and a half of my residence there, I learned most of what I have to record about its habits. In neighboring and lower parts of the basin of El General the population of the species was perhaps less dense, although in many districts the bird was certainly by no means rare. The abundance of this saltator in the valley of the Buena Vista, at the time of my study, appeared to result from the large area of cleared land in that particular successional stage most favorable to the bird. The dense, low, bushy growth which in the humid tropics occupies a maize field, or other abandoned patch of cultivation, between the first and third years after the last crop has been harvested, provides optimum conditions for this secretive bird of the thickets. Or a pasture which has been left uncleaned for a like period, and has grown up with a tangle of trees, bushes and interwoven vines, intersected in every direction by a network of crooked cowpaths, is perhaps an even more favorable habitat. Certainly it is easier to find the saltator's nests in such a pasture than in thickets where no grazing animals have opened pathways. Less tolerant of varied ecological conditions than the Buff-throated Saltator, the Streaked Saltator abandons the thickets if they remain undisturbed by agricultural operations until the swiftly growing trees form a closed canopy and exclude the sun's beams from the bushy undergrowth. Nor is this smaller saltator so commonly seen in plantations of coffee or bananas, in shady but clean pastures, or among dooryard shrubbery. The Buff-throated Saltator is a regular visitor to the feeding shelf in my yard; the Streaked Saltator, although sometimes heard at the house from not far distant thickets, rarely passes through the yard, and has never been seen eating the bananas put out for the birds on the shelf.

In Costa Rica the Streaked Saltator is known only from the southern half of the Pacific watershed. In this region I have found its nest as high as 3200 feet above sea level. From this northwestern outpost the species ranges through Panamá to northern



Fig. 15. Streaked Saltator.

South America, where it spreads over a vast area stretching from Perú to Trinidad. In the neighborhood of Cali, Colombia, I found Streaked Saltators singing and nesting in pastures where the bushy growth was sparser and more open than in the Costa Rican pastures where they breed. In the Santa Marta region of Colombia, Todd and Carriker (1922:501) found this saltator as high as 4500 feet above sea level.

Like Buff-throated Saltators, Streaked Saltators live in pairs throughout the year, although it is difficult to prove this because of the way they remain hidden in the low, entangled vegetation. They rarely expose themselves except to fly across a road or other clear ground which separates two thickets or to pass from bush to bush. Then they fly rapidly and low, in a direct course, and as they go they constantly utter notes of a peculiar character, later to be described.

## VOICE

The song that I heard from the Streaked Saltator on December 25 was unseasonable. In the basin of El General these finches usually sing with increasing frequency toward the end of March; but in a wet year like 1937 they may sing a fair amount during the second half of February. Their period of abundant song continues until early June, after which, with prolonged wet weather, they rapidly fall silent. About Cali, Colombia, the Streaked Saltators were singing freely and nesting at the beginning of January, far earlier than I have found them breeding in Costa Rica.

Most of the saltators are excellent musicians, and although the streaked species is not, to my ear, the most gifted, it nevertheless occupies a high place among its kin. The character of the Streaked Saltator's song varies greatly with the time of day. The bird's masterpiece is a refrain of four of five whistled syllables, forming an exquisitely modulated crescendo, and with the last syllable the longest. This verse bears a striking resemblance to the song of the Grayish Saltator as I heard it on the Caribbean coast of Honduras.

The crescendo phrase is often followed by two or more notes which are delivered with falling inflection and are rather harsh: *chu chu chu chu ch'ree rerr chup*. Sometimes the unmusical *rerr*'s and *chup*'s are repeated over and over until the crescendo is again uttered, thus forming a long-continued song of most uneven quality. The saltator's music is most pleasing to my ear when, as is often true, he omits the anticlimax and sings merely *chu chu chu chu ch'ree*, with intervals of silence between the verses.

At early dawn, the Streaked Saltators frequently deliver a song made up chiefly or wholly of their less musical notes *chip rerr chup chup chip rerr . . .*, often repeated and not ordered into any well modulated phrase. Sometimes they do indeed punctuate this rambling monologue with the crescendo phrase, even at dawn; but two which on April mornings sang within hearing of the cabin that I occupied in 1939 never once in the early morning graced their performances with the crescendo. Only after they had chanted monotonously, and with scarcely a pause, for about half an hour, did they begin to introduce their more musical song and give the performance a much needed variety. As the sun rose, they delivered the appealing musical phrase with greater and greater frequency, with correspondingly less of the inferior rambling song.

Neither at dawn nor later in the day do the Streaked Saltators ordinarily choose a high perch for singing but are usually content with a branch only eight or ten feet above the ground, rising barely above the thicket or dense rank grass amid which they pass their lives. As though to compensate for the lowness of the post from which he habitually sings, the saltator at times rises sharply into the air, and when well above the thicket, takes a short circling flight, singing loudly as he goes, and then dives headlong into the depths of the sheltering shrubbery. On this song flight the bird may rise from about thirty to a hundred feet above the low vegetation. On the highest flight which I witnessed the saltator sang as he ascended, then without circling darted down into the bushes.

These high ascents accompanied by song are almost never undertaken in the forenoon, rarely in the afternoon, and most often in the dusk at the day's end, well after the saltator and most other birds have ceased their ordinary or sedentary singing for the day. Then the gray bird rises up into the twilight, circles, sings once, becomes abruptly silent, and does not lift his voice again until the following dawn. The Streaked Saltator makes his crepuscular flight-song at about the same time that the Bellicose Elaenia rises on its much higher and more erratic course. The Buff-throated Saltator, which habitually sings from a perch far higher than that chosen by his streaked relation, never in my experience rises to sing in flight; nor do the Grayish Saltator or the Black-headed Saltator.

While flying in the ordinary manner, Streaked Saltators constantly utter notes of a

most peculiar tone quality, which sound, as nearly as they can be reproduced by the human tongue, like *qua qua qua* . . . Among the boys who in 1936 and 1937 found nests for me, we came to call this saltator the "qua-qua." This flight call has something of the same quality as the calls of the Black-headed Saltator, but is less loud. The call note of the Streaked Saltator is a low, weak monosyllable; and I believe that the louder flight calls must materially aid the members of a pair in keeping together amid dense thickets. The Streaked Saltators that were abundant in the bushy pastures near Cali, in the Cauca Valley of Colombia, uttered a flight call very much like that of their Costa Rican relatives; but all that I heard singing delivered only the rambling type of song, never the crescendo phrase so often used by the Costa Rican birds.

#### THE NEST

All the 22 nests of the Streaked Saltator that I have seen were completed when found. The bird is so shy that I have never succeeded in discovering one in the act of building. On January 3, 1941, I found a nest with two eggs near Cali, Colombia, at an altitude of 3300 feet. At slightly lower elevations in the basin of El General in Costa Rica, nesting begins somewhat later in the year. A full grown fledgling which I saw with its parents on April 16, 1937, must have hatched from eggs laid before the middle of March. The earliest nest actually seen in this region was found on March 24, 1937, when it already contained the full set of two eggs. April and May are the months when nests of this saltator are most abundant; and my latest nest held two unfeathered nestlings on June 12, 1942. In the Canal Zone, Harrower (1936) found eggs at Gatún as late as August 10.

The nest is usually placed at no great height in a shrub or small tree in a bushy pasture, or low, tangled thicket. If the thicket is very dense, the nest is likely to be situated near the edge or beside a path or small opening. My 22 nests ranged in height from 2 to 20 feet above the ground; but 16 of these nests were between 4 and 8 feet, and 9 at 6 or 7 feet. The highest was 20 feet up in a mango tree in a small, neglected coffee plantation. The next highest was 14 feet above the ground on a vine-draped branch of an acacia-like tree (*Calliandra*) in a thicket. The third highest was 13 feet up in a small tree thickly draped over with a slender parasitic vine (*Struthanthus*) in a clean pasture near a river. All these high nests, and especially the last, were in exceptional situations. The lowest nest was 2 feet above the ground, between the stumps of a cluster of small trees, overgrown by weeds, in a fairly open pasture.

The Streaked Saltator's nest is an open cup, somewhat resembling that of the Buff-throated Saltator but as a rule much less bulky. The foundation and outer wall are composed of slender dead vines, dry weed stems, or pieces of the fronds of the bracken (*Pteridium aquilinum*); the middle layer is of dry grass blades; the lining is of fine tendrils, vines, grass stems, or fungal filaments. The nest measures about 5 inches in over-all diameter by  $2\frac{1}{2}$  inches in height. The internal dimensions are  $2\frac{1}{2}$  to  $2\frac{3}{4}$  inches in diameter by  $1\frac{1}{4}$  to  $1\frac{3}{4}$  inches in depth.

#### THE EGGS

In Central America, the full set of the Streaked Saltator consists regularly of 2 eggs; I have records of 18 sets containing this number. Hallinan (1924:321-322) records 2 sets of 2. But on the Island of Chacachacare, near Trinidad, Belcher and Smooker (1937: 549) discovered a nest with 3 eggs. (In Trinidad and Tobago, these authors found occasional sets of 3 in the nests of a number of species which in Costa Rica seem never to lay more than 2 eggs.) In 3 of my nests, the eggs were laid on consecutive days; and one of these eggs was deposited between 5:30 and 7:00 a.m. The Streaked Saltator's

eggs are a beautiful clear blue. In a wreath around the large end are a few or many black or blackish spots or fine scrawls of the same color which at times are long and intricate; spots and scrawls may be intermingled. The measurements of 11 eggs from Costa Rica average 25.7 by 17.9 millimeters. Those showing the four extremes measured 27.0 by 18.3 and 23.8 by 16.7 millimeters.

The distribution according to the month of laying of 23 nests in the valley of El General, 2000 to 3200 feet above sea level, is as follows: March, 3; April, 9; May, 9; June, 2.

#### INCUBATION

The eggs are incubated by the female alone. On May 12 and 13, 1937, I devoted a total of nine hours to watching from a blind a nest containing two eggs which hatched on May 16. During the morning of May 12, when I kept vigil from dawn to noon, the sky was continuously overcast with light clouds; during the afternoon of the following day intermittent light showers fell while I watched from two to five o'clock. Although in appearance the female was not to be distinguished from her mate, his constant singing and her lack of song served for the recognition of each. The female saltator incubated far more assiduously on the rainy afternoon than during the cloudy morning, as appears clearly in table 4.

Table 4  
Incubation by a Female Streaked Saltator

	Periods in minutes			Total
	Shortest	Longest	Average	
A. M. Sessions	6	23	13.8	235
Recesses	5	11	8.2	131
P. M. Sessions	26	65	37.3	149
Recesses	8	12	9.7	29
Entire day Sessions	6	65	18.3	384
Recesses	5	12	8.4	160

Considering the morning and afternoon together, I timed 21 sessions which averaged 18.3 minutes, and 19 recesses that averaged 8.4 minutes. As computed by these averages, the saltator covered her eggs 68.5 per cent of the 9 hours during which watch was kept. Whenever she left or returned to the nest, she uttered as she flew the peculiar nasal *qua qua qua*.

For a good part of the day, the male saltator sang near the nest during his mate's absences, but he did so far more seldom while she incubated. There was a well marked tendency for the presence of the male near the nest to alternate with the female's sessions on the eggs. His arrival and singing near the nest was usually the signal for his mate's departure; and on her return he would fly off. But the alternation of guarding by the male and incubation by the female was not so consistent as with many pairs of Boat-billed Flycatchers, Brown Jays, and other birds that I have watched. During two hours of the morning, the male saltator failed to sing near the nest; and it is noteworthy that in this period the female's spells of incubation were considerably longer than during the hours immediately preceding and following, when the male came to call her from the eggs. It seemed that she awaited his arrival to begin her recess. In the early part of the afternoon, too, the male failed to alternate with his mate in a regular manner; but possibly this was because the frequent showers upset the rhythm of activity of the pair. Sometimes the male would arrive, sing near the nest once or several times or even for a few

minutes, then fly away when the female remained sitting and shielding her eggs from the rain.

While singing during the female's absences, the male saltator did not perch close to the nest. I could not actually see him because he was behind a dense clump of bushes, and I knew that he was near only by his song. Possibly he stayed near the nest at times for which I did not give him credit because he was silent. I could frequently tell by his flight-notes when he came or went. Once, late in the afternoon, he rose high into the air and circled, singing.

Twice, early in the morning, the male brought a morsel of food and fed his mate on the nest. This is a habit also of the male Buff-throated Saltator. The female flew away within a minute or two after receiving the offering, while the male lingered by the nest to sing and guard during her absence. Twice more, while the female was away, the male, who had been singing some yards from the nest, advanced to its rim, and standing there, lowered his head into the hollow, as though closely scrutinizing the eggs. Once he sang while examining the contents of the nest. His visit of inspection over, he each time withdrew a short distance and continued to sing amidst the thicket until the female returned to resume incubation. Twice, varying his usual procedure, the male saltator apparently accompanied his mate when she went away to forage and upon her return escorted her up to the nest, sang beside it a few times, then flew away, leaving her to settle down on the eggs.

Two years later, at a point seven or eight miles distant from the location of the nest we have been considering, I watched another nest of the Streaked Saltator, the highest of all that I have seen, situated twenty feet above the ground in a mango tree in a small, neglected coffee plantation. This nest contained two eggs, which had been incubated for an unknown number of days. The female's sessions in the nest were most irregular, being successively 27, 108, 7 and 31 minutes. Her recesses also varied greatly in length, and were for 7, 8, 10, 16 and 30 minutes. Her average session was 43.3 minutes, her average recess 14.2 minutes, whence it was computed that she incubated for 75.2 per cent of the 4 hours during which I watched.

During two of the female's recesses, the male stood guard over the nest, but during two other recesses he quite neglected it; and on the fifth, which was the longest of all and lasted half an hour, he stayed away until a minute before his mate's return. During his first period of guarding, he began by perching in the mango tree close by the nest, but soon went to rest upon the rim, looked intently down at the eggs, then continued to sit upon the rim until the female returned. But throughout his second period of guarding he stood on the opposite side of the mango tree, singing in an undertone. Apparently the male saltator's erratic behavior was responsible, in part at least, for the striking irregularity in the length of the female's sessions on the eggs. Entering the nest at 6:20, she sat continuously for 108 minutes, leaving when she heard her mate sing in a neighboring tree at 8:08. She took a ten-minute recess, and at 8:18 was escorted back to the nest by the male, who then flew off. But in sharp contrast to his previous long period of neglect, after only 7 minutes he returned and sang near the nest, whereupon the female ended her unusually short turn on the eggs.

Because so many of my nests of the Streaked Saltator were destroyed by predators, I was unsuccessful in my attempts to learn the incubation period. Probably it is 13 or 14 days, like that of the Buff-throated Saltator.

#### THE NESTLINGS

On the afternoon of May 15, 1937, both eggs were pipped in the nest where I had watched the saltator incubate on May 12 and 13. The following morning I witnessed the

events attending the hatching of the nestlings. Arriving in the dim light at 5:40 a.m., I found that one of the eggs had already hatched and that half of the empty shell had been removed. The newly hatched nestling already raised its gaping mouth for food, exposing a red interior. I went at once to the blind; but before I was well inside the mother bird had settled on the nest. Formerly she had been more wary, but now maternal devotion overpowered fear.

I did not notice whether the female brought food on her first return to the nest. After brooding for seven minutes, she flew off as her mate arrived to sing nearby. Four minutes later she returned and fed the nestling, then settled down to brood again. While she sat, the male brought food to the nest and she ate it. Probably the nestling did not require more just then. At 6:10 the male again delivered food to his mate on the nest; and this time she rose up to pass it to the nestling beneath her.

I continued to watch for four hours, in which the male, who had begun so promptly to attend his offspring, brought food to the nest fifteen times. If he found the female brooding, he always gave her his billful; but sometimes she flew away as he approached, leaving him to feed the nestling directly. The female brought food to the nest only six times of which I was certain; but it is not impossible that she came with food a few more times for which I failed to give her credit. Both parents carried the food chiefly in the mouth or throat, which made it difficult to see whether they brought anything; and because the nest was above the level of my eyes, I could not watch the actual feeding of the nestlings. But I am certain that the male brought food far more often than his mate, who devoted the greater part of her time to brooding.

Both parents exhibited great patience in coaxing the nestling to take food. If it would not at once swallow the morsel which she had brought for it, or which the male delivered to her as she sat in the nest, the female would settle down to brood, still holding the food in her bill; and after an interval she would rise up again, trying anew to make the nestling eat. Once she held food in this fashion for eleven minutes, during which she repeatedly presented it to the young one. The father was equally solicitous. Once, coming with food in his mate's absence, he tried in vain to make the nestling swallow it. So he flew to a nearby bush, where he waited and sang several times in an undertone, then after the lapse of a few minutes returned and again pressed the morsel upon the nestling. But the two parents together brought to the nest more food than the tiny nestling could possibly eat; and the female devoured a good share of that which her mate delivered to her.

Despite the circumstance that there was now a nestling to feed, the female saltator spent more time in the nest than four mornings earlier, when she incubated the eggs. On the morning of May 12, between 5:46 and 9:54 a.m., her sessions ranged from 6 to 23 minutes and averaged 12.9 minutes. In the same period, her recesses varied from 5 to 11 minutes and averaged 7.8 minutes. She spent 62.5 per cent of the four hours on the nest. Now on May 16, from 5:40 to 9:55 a.m., her periods of brooding ranged from 5 to 36 minutes and averaged 14.0 minutes; her recesses were from 2 to 10 minutes and averaged 5.5 minutes. She devoted 71.8 per cent of the time to brooding, an increase of 9.3 per cent over her time on the nest during the corresponding period of the morning before the eggs hatched. This increase in total time on the nest was effected by lengthening her average session by 1.1 minutes and shortening her average absence by 2.3 minutes. It seems likely that the food which the male brought to the nest, in excess of what the nestling could eat, was at least in part responsible for the female's greater constancy in sitting.

Now that he was busy hunting food and bringing it to the nest, the male saltator sang very little, and that largely in a subdued voice. I saw the female eat half of a shell

while sitting on the nest, but I did not notice her carry any away, so doubtless both parts of both shells were disposed of in this fashion. When I emerged from the blind and went to look into the nest at ten o'clock, I found that the second egg had hatched in the course of the morning, and the empty shell had already vanished.

Two days later these nestlings had disappeared, probably down the gullet of a snake. In only a single instance was I successful in following through the development of a nestling from hatching to departure from the nest. This young saltator, reared alone in the nest, was feathered when eleven days old. On the afternoon of the following day I found it perching on the rim of the nest. The next day it was gone. I could not find the fledgling in the tangled vegetation; but a parent was close by with food in its bill, leaving little doubt that the youngster had made a successful exit from the nest at the age of 13 days.

The young saltators remain with their parents and are fed by both of them until full grown. In the juvenal plumage the young closely resemble the adults; they can be distinguished most readily by the yellow tip of the black bill and the yellow corners of the mouth. They plead much for food, vibrating their wings and uttering soft, chirping notes, which sound much like the *peeps* of the domestic chick, although I have known two young saltators to make as much volume of sound as a whole flock of chicks. The parents gave these noisy youngsters many seeds of the *targuá* tree (*Croton draco*).

#### SUMMARY

On the southern Pacific slope of Costa Rica, Streaked Saltators inhabit the bushy growth that densely covers recently abandoned croplands and pastures overgrown with shrubs and vines. They range upward to about 3500 feet above sea level. Pairs remain mated through the year.

In El General they sing freely from late February or March to June and also sparingly in other months. The male's song is a beautiful whistled crescendo, usually accompanied by somewhat harsh, contrasting notes. His song is usually delivered from a low perch, but from time to time, especially in the afternoon and evening, he rises high above the thicket, circles and sings in flight, and then drops sharply earthward. A distinctive call is uttered by both sexes while flying.

In El General breeding extends from March until at least June. The open nest, usually less bulky than that of the Buff-throated Saltator, is placed from 2 to 20 feet up, but rarely above 8 feet. The birds are so secretive that building was not observed.

In Central America the set regularly consists of two eggs. The female alone incubates, sitting for periods rarely as long as an hour but exceptionally lasting almost two hours. One female incubated for 68.5 per cent of nine hours, another for 75.2 per cent of four hours.

The male guards the nest during the female's absences from the eggs, but he does not do this consistently. One male fed his incubating mate twice in a morning.

The nestlings are brooded by the female and are fed by both parents. At one nest the male began feeding early on the morning the eggs hatched, and soon he brought more than the nestlings required. Both parents spent much time coaxing them to take food, and the female ate what they could not swallow. She sat more constantly at this time than while she incubated.

One nestling left the nest when 13 days old.



## STRIPED BRUSH-FINCH

### *Atlapetes torquatus*

The Striped Brush-finch or Atlapetes is a species widespread in South America which in Central America is represented by an isolated race that appears to be confined to southwestern Costa Rica. Here it is known chiefly from the Térraba Valley, where it ranges upward to about 3500 feet above sea level. It is a rather big finch of dull coloration. Its head is striped with gray and black; a broad gray stripe extends from the forehead over the center of the crown and down the hindneck; on each side of this runs a black band, which in turn is bordered by a gray stripe that arches above the eye. The lores, cheeks and auricular region are black. All the upper plumage, including the wings, is olive-green; and the tail is dusky. The throat is snowy white, the center of the breast and belly white, and the flanks greenish-olive. The short, thick bill, the eyes and the feet are dark. The sexes are alike in plumage.

The Striped Brush-finch spends its life lurking on or near the ground in the deep shade of the heavier second-growth thickets and woodlands, where it is difficult to see. Sometimes it ventures a short distance into the primary forest, and rarely it enters shady plantations which border the thickets where it dwells. It seems to remain mated throughout the year. It forages largely on the ground, over which it progresses by hopping rather than walking, and it flicks aside the fallen leaves with its black bill, exactly in the manner of its highland relative, the Chestnut-capped Brush-finch. Its diet seems to be composed principally of the small invertebrate creatures which it finds lurking beneath the ground-litter of the thickets. At times it eats decaying leaves, a taste difficult to account for, unless it be that these leaves bear a fungous growth which serves as food. Among mammals, the agouti sometimes consumes such leaves.

#### VOICE

Like a number of related species, the Striped Brush-finch is a poor musician; indeed, his profuse vocal outpourings may be called "song" only technically, or through courtesy. He does not mount to some high perch as do towhees and many another denizen of low, dense vegetation, but is content to sing in obscurity from some low stand in the depth of the thicket, only a few feet above the ground. His song is so high-pitched as to be characterized as squeaky, and it is so rapidly delivered that it barely escapes being a trill. It is long-continued, especially at daybreak, and in quality resembles the song of the Chestnut-capped Brush-finch. One male Striped Brush-finch who in 1945 sang in the thicket at the end of my yard, had a voice even higher and weaker than usual for his kind, a thin falsetto that reminded me of nothing so much as the voice of the little Costa Rican Russet-collared Flycatcher as it sings at dawn. Resting in the dim early light upon a fallen log or some low branch of a bush, the brush-finch poured forth his thin notes for many minutes with hardly an interruption. Later in the day he used his weak voice more sparingly. The female also sings, a tuneless performance like the male's, but weaker than his voice normally is.

The season of song is very long, in the upper Térraba Valley extending from late February into October or even November. In September and October scarcely any other bird of the region sings so much as the brush-finch. The call note is a sharp, metallic monosyllable, resembling that of the Cardinal.

## NEST BUILDING

In a wet year the Striped Brush-finch may begin to breed in February. Although I have seen no nest so early, on March 22, 1937, I found a fledgling, with a very stubby tail and scarcely able to fly, which must have been reared in a nest begun not later than mid-February. April, however, is the month when the earliest nests are found in numbers. The bulky open cup is placed in a bush or tangle of vines in a thicket, often at its edge, or beside an opening amid the dense vegetation. One nest was situated in a tangle of climbing bamboos and vines at the edge of the forest; another was among the bushes and bamboos which fringed the bank of a wide stream, beside a clean pasture; and one very exceptional nest was built in a coffee bush, about 30 feet from the edge of a bank covered with densely tangled growth in which the atlatpetes dwelt. Twenty-four nests ranged from  $4\frac{1}{2}$  to 20 feet above the ground, but all except 2 of these were from 6 to 12 feet up. The two nests higher than 12 feet were both about 20 feet up in vine-draped trees in tall second-growth woodland. The first of these exceptionally high nests was built by a male alone late in the season, and apparently never contained eggs. The second was made chiefly by a female at the height of the nesting season, but I do not know whether she laid in it.

The nest may be built by both sexes working together, by the female alone, and apparently at times by the male alone. In the middle of the morning of April 8, 1943, I found a pair building. The site they had chosen was 6 feet up in a tangle of vines, in the middle of a vine-smothered thicket occupying a small opening among the trees of a tall but light second-growth woodland. Both male and female were at work, but the density of the vegetation made it difficult to follow their movements. They were laying the foundation with long pieces of coarse dead vines, many of which they broke away from the tangle by vigorous pulling. The pair was at work when I came at two o'clock in the afternoon to set up my blind in a position which commanded a satisfactory view of the nest, and the two birds were not greatly disturbed by my activities.

Returning at seven next morning, I found the female building with great energy. She was now bringing fairly big dead leaves for the middle layer of the structure, picking

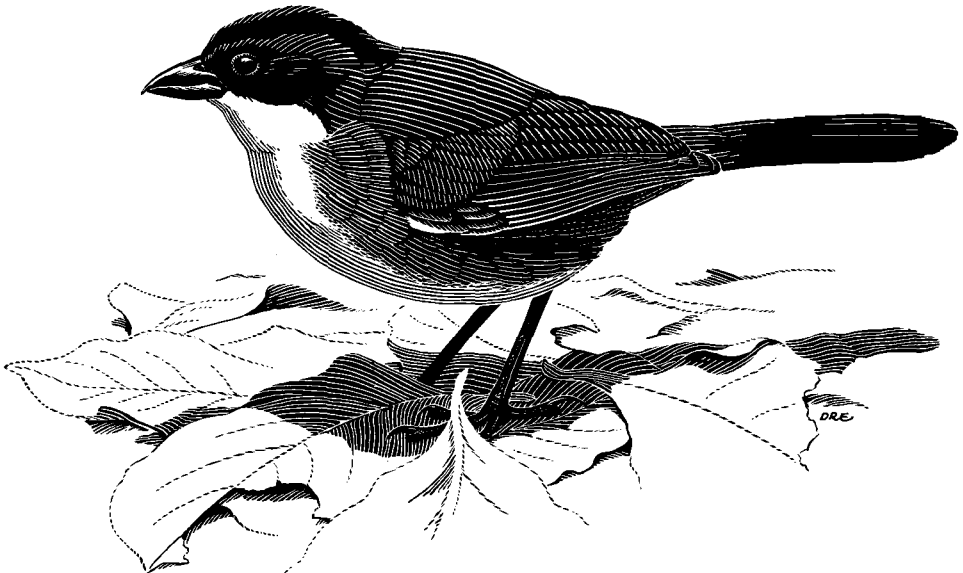


Fig. 16. Striped Brush-finch.

them from the ground beneath the nest and carrying up billful after billful in rapid sequence. Meanwhile the male was delivering his squeaky song off in the woods to my left. After a while, he came and carried up leaves, too. If the female happened to be on the nest when he arrived, he passed the material to her, but in her absence he sat in the nest to arrange the leaves with his own bill. Soon the pair went off and were absent for many minutes. When at length they returned, it was the female who first went to work. Soon the male came and brought leaves to the nest, but he stopped and went away while she continued to build. She worked by spells, taking a number of billfuls to the nest in succession, then going off and staying out of sight for considerable periods. By nine o'clock she was bringing fibrous materials for the lining instead of leaves, and now she worked more slowly, possibly because the nest was nearing completion. Her mate no longer helped. At 9:22 she took a long rest; and I waited until 10:00 without seeing any more work done. Between 7:00 and 9:22, 52 billfuls of material were taken to the nest, chiefly by the female. This nest appeared to be completed by April 11, three days after I found the pair laying the foundation.

On the morning of April 16, 1944, I surprised a Striped Brush-finch building a nest in a coffee bush. Actually, these birds are not often found in vegetation so open as that of a coffee plantation. I could not recall having seen them there before finding the nest. This pair was almost fearless of me. As I approached the nest, the female was sitting in it; and she was so steadfast, allowing me to look at her from hardly more than arm's length away, that I at first supposed that she had eggs. But later, when she went away, I saw that the structure was unfinished. The following morning I watched for three hours and saw only the female build. She worked more slowly than the atlatetes I had watched the preceding year, bringing material only 18 times between 7:00 and 10 a.m. Thirteen of these billfuls were brought during the hour between 7:09 and 8:10. The next morning her pace was even more leisurely; she took only 7 loads to the nest between 6:30 and 8:15 a.m., and 6 of these in the hour between 7:15 and 8:15. But on most of her visits to the nest her bill was heavily laden with many pieces of material, first with dead leaves, later with fibrous stuff for the lining. Most of her material was found amid dense vegetation on the bank at the edge of the plantation, about 30 feet distant from the nest, but a small amount was gathered from the ground beneath the coffee bushes. Sometimes while she worked she sang her tuneless song, like that of her mate, but weaker.

The male often followed his mate into the plantation and waited in a neighboring bush while she shaped the nest; but I never saw him bring anything in his bill. Like the female, he was almost fearless of me. The cacao bush where he would perch and sing was less than 6 yards from where I sat only partly screened by the foliage of a coffee bush. Once he dropped to the ground and began flicking fallen leaves aside with his bill, only 3 or 4 yards from me, and in full view.

At a third nest, which I watched for nearly 4 hours, I could again find no evidence that the male atlatetes helped to build. The female brought material 42 times, all in the first 2½ hours of my vigil. At a fourth nest, however, the male helped a little; I credited him with taking 2 billfuls to the nest, while his mate took 23, in the course of 2 hours. He sang much and from time to time would gather a few dead leaves, only to drop them carelessly from his bill.

Between September 12 and 16, 1944, a male brush-finch built a nest in the vine-covered top of a small tree amid tall second-growth, about 20 feet above the ground. His persistent singing drew my attention to him and his work. Although the sexes of this atlatetes cannot be distinguished by appearance, the loud, tireless singing of the building bird left little room for doubt as to his sex. The female sometimes came within sight and sang a little in weaker voice, but so far as I saw, she took no interest in the male's work.

A young atlatetes, full grown but with considerable yellow on its bill, was also present at times, suggesting that the pair had nested earlier, and with success. The building male seemed quite indifferent to my presence, although I stood without concealment beneath the vine-tangle where he built.

I found this male atlatetes at work only between 7 and 8 o'clock in the morning, but he by no means labored constantly during this period, sometimes for only 10 or 15 minutes. Many pieces of material he picked up only to drop again; but others, including both leaves and long pieces of dead vine, he carried up through the vine-tangle to the nest. One morning he was alone and sang profusely until the female arrived, worked in silence while she flitted about among the vines and branches below the nest without going to it, and then resumed singing after her departure. But soon he flew away in the direction his mate had taken, carrying with him a piece of dry vine that he had started to take to the nest. This was the last time I saw him at work. The nest was inaccessible; but so far as I could learn by watching from the ground, it was never used for eggs.

The completed nest is a bulky open cup. The foundation is composed of coarse dry weed stems or pieces of vine. The body of the nest is a very thick layer of dead leaves, many of them of considerable size and entire. The lining is composed of fine fibrous rootlets, black fungal filaments which have well been called "vegetable horse-hair," and the slender primary rachises of acacia leaves. The structure measures  $5\frac{1}{2}$  or 6 inches in diameter by  $3\frac{1}{2}$  in height. The interior is  $3\frac{1}{4}$  inches in diameter by  $1\frac{1}{4}$  to  $1\frac{3}{4}$  inches deep.

#### THE EGGS

We have already presented evidence that the Striped Brush-finch may at times lay in the second half of February. Yet I have not actually found eggs before early April, and they are certainly not common before that date. In two nests, the eggs were laid on consecutive days. They may be laid late in the day; in one nest the second egg was deposited between 9:15 a.m. and 2:20 p.m., in another between 10 a.m. and noon. Twenty-one nests contained each two eggs or nestlings. The eggs are slightly glossy, pure white or faintly tinged with blue. The measurements of 20 eggs average 25.5 by 18.5 millimeters. Those showing the four extremes measured 27.0 by 18.7, 25.4 by 19.4, and 24.6 by 17.5 millimeters.

The distribution according to the month of laying of 22 nests in the valley of El General, 2000 to 3000 feet above sea level, is as follows: April, 6; May, 5; June, 6; July, 3; August, 2.

#### INCUBATION

Incubation appears to be carried on by the female alone. At one nest she covered the single egg during the night before the second was laid. On May 27 and 28, 1936, I devoted 9 hours to watching a nest in which the set of 2 eggs had been completed on May 20. Although I could not distinguish the sexes of this pair except by the occasional singing of the male, my failure to witness a change-over on the nest, and the general character of the record, led me to conclude that the male took no part in incubation. In the 9 hours, I timed 6 sessions on the eggs which ranged in length from 41 to 70 minutes and averaged 52.8 minutes and an equal number of recesses varying from 21 to 68 minutes in length and averaging 34.0 minutes. The female devoted 60.8 per cent of the time to incubation. When I began to watch at daybreak on May 27, I saw that the nest had tilted considerably to one side because of the inadequate support provided by the vines upon which the bird had relied to hold it in place on the slender branch of the bush. She sat in a very slanting position and looked most uncomfortable. I thought that perhaps the long absence of 68 minutes with which she began the day was a result of the

discomfort she experienced while incubating in the leaning nest. Once when she was absent I straightened the nest. During the remainder of this and the first 3 hours of the following morning, she took no recess in excess of 33 minutes. The male sometimes accompanied her as she returned to her eggs, but he did not visit the nest itself.

A female atlapetes which I watched incubate on June 8, 1946, also began her day with a long absence lasting 71 minutes. Returning, she sat for 65 minutes, was absent 32 minutes, incubated 52 minutes, took a recess of 31 minutes, then sat continuously for 128 minutes (2 hours 8 minutes). When she terminated this long session it was nearly noon. She had covered her eggs 64.6 per cent of the morning, always in perfect silence. I did not once see her mate. A slow rhythm of incubation, with long absences from the eggs, appears to be typical of this atlapetes.

While incubating, the Striped Brush-finch sits with great steadfastness and allows a very close approach by a human visitor. Often she has remained on the nest until I touched the foliage close beside it, or the bottom of the nest, or almost touched her. Then as a rule she flitted through the bushes and tangled vines very close at hand, sometimes coming almost within arm's length, puffing out the snowy feathers of her throat until they were most conspicuous, and uttering sharp, wiry notes of complaint. Often these calls have drawn the male, who came almost equally close and added his scolds to hers. When visiting a nest situated well above my head in a tangle of climbing bamboos, I lifted a mirror attached to the end of a pole in order to see the contents by reflection. The atlapetes continued to sit until the mirror almost touched the nest, then flew from the eggs, spread her tail, and hopped upon the pole that I held in my hand.

At two nests, the incubation period was 15 days.

#### THE NESTLINGS

The nestlings are attended by both parents, who are most solicitous, coming very close and complaining with sharp notes when their nest is visited. The young are clothed with feathers at the age of 10 or 11 days. One nestling, which early lost its nest mate, took leave at the age of 13 days. When I visited another nest, containing nestlings 9 and 10 days old, respectively, the parents came in great excitement, flitting very close to both the nest and myself and voicing their wiry notes. They shook the nest by hopping repeatedly on the thin supporting branch. Of a sudden a nestling jumped out and fluttered to the ground. I caught and replaced it in the nest, but it would not stay. The attempt to make it remain only caused the other to jump out, too. They were scarcely feathered and very young to leave the nest. When I visited the nest the following day, to learn whether the youngsters had returned, I found it still empty. But one of the parents flitted around very close to me, just as it had done while the nestlings were present. I could not find the young birds in the dense thicket.

I do not think that the parents tried to make the nestlings flee from the nest at so early an age. Their close approach and repeated notes of alarm were a manifestation of anxiety for the safety of the nest and its contents; they behaved in much the same fashion when I visited the nest while it still contained eggs, and even after it was empty. But the combination of the mirror that I held above them, the alarm-notes of their parents, and above all the shaking of the nest when the adults hopped upon the supporting twigs, frightened the youngsters and caused their premature departure.

I had a rather similar experience at another nest, where I was careful not to cause the premature departure of the nestlings, as I wished to determine their full period in the nest. This nest was situated 12 feet up in a tangle of vegetation at the edge of woodland, beside an open pasture; and without using a mirror it was hardly possible to see what it contained. On my later visits I almost always found the parents close by, keep-

ing watchful eyes upon it. They would come hopping through the bushes at the edge of the woods and out along the projecting branch that supported the nest, with drooping wings, tail fanned out, and raised crest, repeating at short intervals a sharp monosyllable. On my visit to the nest late one afternoon, when the nestlings were between 11 and 12 days of age, this behavior of the parents caused them to hop out despite all my efforts not to frighten them. Their excitement, combined with the shaking of the nest and the presence of my mirror above it, was too much for youngsters already near the point of departure. They jumped out and fluttered to the ground at my feet. Immediately one of the parents emerged from the bushes, and placing itself in front of a nestling, hopped over the ground with drooping wings and depressed tail, trying to lead it back into the sheltering vegetation. This youngster soon followed; but the other went off in the opposite direction, hopping bravely over the close-cropped sward toward the river. When I followed to catch it, the parents came out into the pasture and alighted in a neighboring orange tree, where the excited male sang loudly. The youngster covered fifty feet before I overtook it. After examining its plumage, I returned it to shelter of the woodland's edge.

This young atlatetes had dark greenish-olive upper plumage, with the feathers basally gray. Its head, of the same color as its back, was marked with two sooty-black crown stripes and blackish cheeks, in the pattern of the adults; but the markings contrasted less strongly with the ground color and were not so prominent. Its throat was deep gray. The center of its breast and belly were still naked, their sides deep gray with buffy tips on the abdominal feathers. Its upper mandible was blackish, the lower mandible and corners of the mouth yellow, the interior red. The iris was deep brown, the legs and feet grayish-horn. Its tail was still very stubby.

Of 12 nests of known outcome, only 3 were successful; and in these 5 young were reared. The other nests were prematurely emptied by predatory animals.

The period of reproduction of the Striped Atlapetes in the upper Térraba Valley covers about 6 months. My latest occupied nest contained 2 very young nestlings on September 15, 1936. How many broods each pair may rear during the course of this long breeding season is unknown.

#### SUMMARY

Striped Brush-finches lurk on or near the ground in the deep shade of heavy second-growth woodlands and thickets. In Costa Rica they range upward from the lowlands to about 3500 feet. They are found in pairs at all seasons.

These finches hop rather than walk over the ground, and they use their stout bills to flick aside fallen leaves in search of food. At times they eat decaying leaves.

The males' song, delivered from near the ground, is weak, high-pitched, and scarcely melodious. The female sings in a weaker voice. They sing from mid-February to October or November.

In El General the breeding season extends from February to September. The bulky nest, containing many dead leaves, is placed in a bush or tangle of vines from 4½ to, exceptionally, 20 feet up. It may be built by both sexes working together, by the female alone, or, apparently occasionally by the male alone. It is sometimes completed in three or four days.

The two eggs are incubated only by the female, who takes rather long sessions that sometimes exceed two hours; she also takes fairly long recesses and keeps the eggs covered (in two instances) from 60 to 65 per cent of the morning. The incubation period is 15 days.

The nestlings are fed by both parents. If undisturbed the young remain in the nest until 12 or 13 days old; but with slight provocation they hop out several days earlier, when they can scarcely fly.

## ORANGE-BILLED SPARROW

### *Arremon aurantirostris*

The Orange-billed Sparrow is a finch of medium size with a bold color pattern that makes it easy to recognize. Its head is largely black, with a gray stripe along the middle of the crown and a narrow white one over each eye. The remaining upper plumage is plain olive-green. The throat is snowy white, contrasting sharply with the black cheeks and chin and the broad black band across the chest. The breast and abdomen are white, merging into gray or olive on the sides and flanks. The edge and bend of the wings are bright yellow. The stout bill is bright orange-red, the eyes brown, and the feet pale flesh-color. Usually the sexes cannot be distinguished by their plumage, but in some pairs the female may be recognized by her more narrow black breast band.

The species ranges through the humid Tropical Zone from southern México to eastern Perú, and like so many other birds of similar habitat is found on both sides of the Cordillera in southern Central America but is confined to the Caribbean drainage in the north. The nominate race which now concerns us occurs on the Pacific side of Costa Rica and in Panamá as far east as the Canal Zone. On the Pacific side of southern Costa Rica it nests up to at least 3500 feet above sea level.

The Orange-billed Sparrow passes its life on or near the ground in the deep shade of the high rain-forest. It may dwell at times in neighboring areas of tall second-growth which casts a heavy shade. On rare occasions it is met in shady pastures and similar situations not far from its forest haunts, but in places so open as this its presence is transitory. It hunts chiefly on the ground, over which it moves by hopping rather than walking, and it rarely ascends higher than ten feet, even to sing. Preferring those parts of the forest floor where the ground cover is densest and most tangled and the light dimmest, it is a shy, retiring bird. I have never seen it flicking leaves aside with its bill, in the manner of the species of *atlapetes* and so many other ground feeders. With its bright orange-red bill and sharply contrasting areas of black and white upon the head, it is conspicuous even in the dimmest depths of the forest, and forms an exception to the rule that animals which inhabit the deepest shade of the tropical woodland are clad in neutral colors which blend with their dark surroundings. It lives in pairs or family groups throughout the year.

#### VOICE

The song of the Orange-billed Sparrow is pleasant but far from brilliant. The male delivers a series of metallic tinkling notes that alternately rise and fall in tone; and these changes in pitch, coupled with modifications in the speed of delivery, are its only diversification. It resembles the song of the Striped Brush-finch, but it is more metallic and less squeaky in tone and less hurried in delivery. The song of the female consists of an emphasized first note followed by a more rapid sequence of lower but sharper metallic notes that are even less varied than those of the male. I have heard females singing while incubating eggs. The song of both sexes is delivered from the ground, a fallen log or low perch, never from a high station. The Orange-billed Sparrow sings through most of the year.

#### THE NEST

Like so many other ground feeders, the Orange-billed Sparrow does not begin to breed until the rains have soaked the ground litter and stimulated the increase of the small invertebrates that live there. In El General this sparrow's nesting begins in April or

possibly the end of March, is at its height in rainy May, and continues into September. The roofed nest is placed on the ground, often in the darkest parts of the forest. Usually it is situated on a slope, which may be either steep or gentle, on a shelving bank, or on a low mound such as is formed of the earth raised up by an uprooted tree; more rarely it is on almost level ground. As a rule, it is well screened by low vegetation, as terrestrial ferns, selaginella, aroids or crowded seedlings of trees; but sometimes it is in a fairly bare space. If in a level area, it is often at the base of a tree, or beside or even between the thick, spiny prop-roots of a stilt-palm. One unusual nest rested on fallen twigs leaning against a low bank beside a woodland path. While the back of the structure was in contact with the bank, its front was propped up ten inches above the ground.

The nest is a very bulky, oven-shaped structure, with a wide, round entrance in the side facing down the slope. My first nest of the Orange-billed Sparrow, found at an altitude of 3500 feet on a steep mountain side above the basin of El General, was fairly typical. The structure rested upon a high foundation composed largely of dead leaves. The walls and thickly thatched roof were made of many dead leaves, coarse rootlets, a few sticks, and many large pieces of green, living fronds of at least three species of ferns. The bottom was well lined with fine, light-colored rootlets, thickly felted. Although the nest's foundation rested on the ground, it was so high, and the slope so steep, that the sill of the entrance was about eight inches above the ground. In front of the doorway was a broad, semicircular platform made of large pieces of green fern frond brought by the bird and supported in part by the bulging foundation, in part by the living fern fronds among which the nest was situated. Other pieces of fern frond, also brought by the bird but dropped before she reached the nest, littered the ground below the platform. The great amount of green in the surface of the nest helped to conceal it in the fernery in which it was built.

In some nests frondose branches of selaginella, each with a myriad of tiny leaves, are

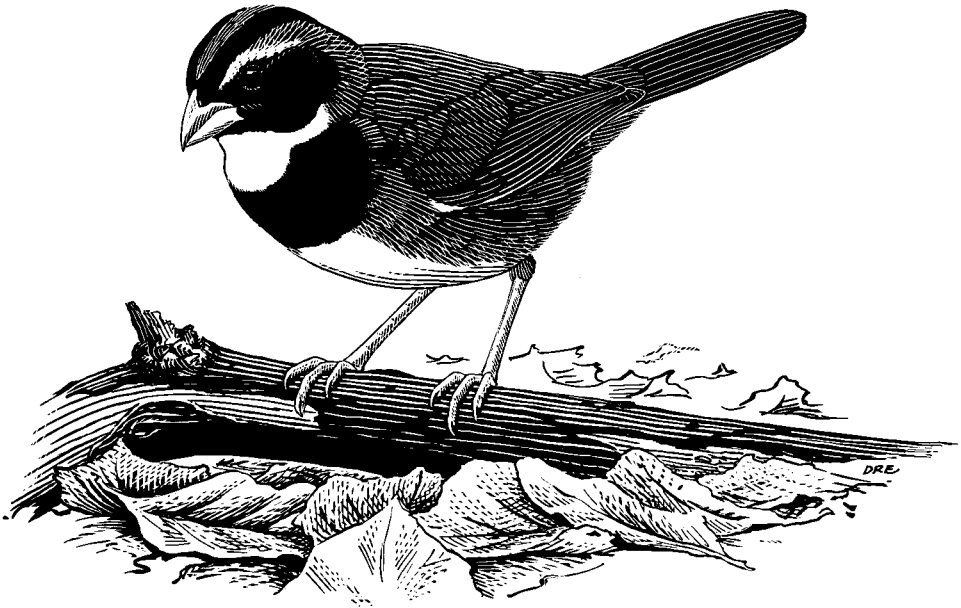


Fig. 17. Orange-billed Sparrow.



used instead of ferns; and one contained many pieces of green grass. The choice of such material depends on what is most readily available. Richmond (1893:490) records that in Nicaragua the nest is covered with living ferns and mosses. The amount of green included in the walls and roof varies from nest to nest, but all the 13 nests that I have seen contained some of it. Often it is a principal ingredient, used so generously as to make the outside of the nest almost wholly green, and it may be incorporated into the foundation, along with dead leaves and sticks. The foundation, walls and roof of other nests are composed of a great number of dead leaves, chiefly whole small dicotyledonous leaves and pieces of larger ones, and leaf skeletons, but with an admixture of fragments of decaying palm fronds and other monocotyledonous foliage and perhaps fibrous materials. A platform or runway is often but by no means invariably present in front of the nest, depending in part on whether the site invites such an extension. The ground in front of one nest was carpeted to a distance of nearly two feet with a number of green, lanceolate segments of fern fronds, each from 10 to 15 inches in length by one in breadth, and without much doubt brought by the sparrows themselves. Such pieces of fern are apparently broken or bitten off by the builders of the nests, and in the humid underwood of the forest during the rainy season they remain living and green for weeks. The rootlets and other fibrous materials of the lining may be light or dark in color. In some nests this lining is confined to the bottom, in others it extends almost to the ceiling of the chamber.

One nest measured 6 inches in horizontal diameter by 7 in height. The interior was 5 inches from front to back by  $3\frac{1}{2}$  from side to side by 4 inches high. An unusually bulky nest was 8 inches in diameter. Alvarez del Toro (1952:20-21) described and figured nests of this species from Chiapas, México, closely similar to the foregoing in construction, except that apparently they contained little green material in roof and walls. Each was provided, however, with a living fern bound into the fabric around the doorway and draping in front of the opening, which it effectively concealed — a feature I have not noticed in a Costa Rican nest. He compared these nests, on platforms placed directly on the ground, to a handful of trash left by the currents formed by a heavy rain. It is significant that of the nests I have seen, that which contained the smallest amount of green leaf, a single piece in the roof, was situated among the brown fallen fronds of a stilt-palm rather than amid the usual greenery. In this instance the incorporation of much green material into the nest would have made it more rather than less conspicuous. Its brown roof and walls blended well with the surrounding dry palm fronds.

Because of the great shyness of the Orange-billed Sparrows, I have not succeeded in finding a nest before it was completed.

#### THE EGGS

Each of my 13 nests found in El General contained 2 eggs or nestlings; and this is the number found by Richmond (1893:490), Carriker (1910:903), Harrower (1936) and Alvarez del Toro (*loc. cit.*) in other parts of Central America. The eggs are white and moderately glossy, marked with dark or light brown and often also with black. On some eggs the pigment occurs in a few fine dots scattered over the blunt end; on others there is a sprinkling of fine brown specks over the whole surface except at times the sharper end, with some heavy black spots in a wreath about the thicker end; and all intermediate conditions occur. Rarely there is a fine scrawl on the thick end. The measurements of 20 eggs from El General average 25.4 by 17.3 millimeters. Those showing the 4 extremes measured 26.2 by 18.3 and 24.2 by 16.7 millimeters.

The distribution according to the month of laying of 13 nests in the valley of El General, 2000 to 3500 feet above sea level, is as follows: April, 3; May, 6; June, 2; August, 2.

## INCUBATION

So far as I have been able to learn, the eggs are covered by the female only. If her nest is situated in the forest at a distance from a path, it is usually difficult for a man to approach through the dense undergrowth with sufficient stealth to surprise her as she sits; and it may be necessary, as was Richmond's experience, to make repeated visits before the nest's owner can be seen and identified. But if, as sometimes happens, the nest faces a woodland path, and especially if this route is repeatedly followed by people who do not harm the bird, she may before long permit one to approach closely and look in at her. Her bright bill is most conspicuous in the dimly lighted chamber where she sits facing outward.

On May 1, 1946, I found a completed nest situated on a low bank above a little used roadway, a short distance within the forest near my house. It was screened by low bushes, chiefly of the melastome family; and the wide doorway was prettily shaded by the tapering ends of several of the living sprays of selaginella that the builder had laid upon the roof. By May 3 the set of two eggs was complete, and I decided to learn something about the incubation habits of this retiring bird. The only practicable point for setting a blind was down the roadway, whence my view of the doorway was highly oblique and I could see little of the interior. But at an earlier nest I had failed to accustom the sparrows to a blind set directly in front. I watched from 5:00 a.m. to 12:46 p.m. on May 13, and from 12:45 to 6:03 p.m. the following day.

Although I had not yet learned to distinguish the sexes of these Orange-billed Sparrows by appearance, everything that I saw and heard in my 13 hours of watching pointed to incubation by a single bird, the female. Her rhythm of coming and going was slow, and her day was filled by 6 sessions, ranging in length from 14 to 102 minutes, with an average of 77.7 minutes, and 7 recesses varying from 29 to 52 and averaging 39.1 minutes. She spent 66.5 per cent of the day in the nest.

The sparrow sat low in her covered nest and much of the time was invisible to me as I looked obliquely through her wide doorway. But for considerable periods, too, I could see part of her bright orange bill. At times she preened in the nest, and then I caught glimpses of her black head boldly striped with white and gray. Through most of each long session on her eggs the bird sat almost motionless as far as I could see; but at length she would grow restless and move forward in the nest until I could view the whole of her head, which she turned constantly from side to side, seeming to be looking about her. After these movements had continued for some minutes, growing in amplitude, she would move slowly forward, pause on her doorsill to peer around, then hop outside. On her first departure of the morning at 5:31, she flew from her nest across the roadway in front; but seven other times she hopped away over the ground, turning around the side of the nest and going up the slope behind it, where she promptly vanished in the crowded low bushes. Then she and her mate remained out of sight and mostly out of hearing for the next half or three-quarters of an hour. At length she returned, hopping slowly and inconspicuously down the leaf-strewn slope behind the nest. Usually a few sharp, metallic monosyllables announced her approach. On reaching the nest, she hopped around to its front, then in through the doorway and quickly turned around to settle down facing outward. I never saw her sit with her tail in the entrance, an orientation which would have made it more difficult for her to escape if suddenly attacked. Only once, on her last return of the day, at 6:03 when the daylight was fading, did she vary her mode of approach by flying across the roadway toward the nest; but even then she covered the last few feet of the distance by hopping, voicing one sharp *chip* as she went. Her approaches and departures were as circumspect as those of the Black-striped Sparrow at its nest.

Through most of the day the female Orange-billed Sparrow sat in perfect silence. But early in the morning she called much from the nest, answering her mate who was calling and singing unseen in the dense undergrowth. Later, over a period of nearly half an hour, she sang much while her mate tinkled at no great distance. All this was before eight o'clock in the morning; after this she sat in silence.

The male did not visit the nest once in the course of the day. On the female's first return of the morning he accompanied her, as revealed to me by his song, but did not come within my range of vision. Twice again, once in the morning and once in the afternoon, I heard a song which I supposed to be his; and on the first occasion this song was answered by the female from the nest. Otherwise he remained out of my hearing as well as out of my sight; but doubtless his mate found and hunted with him during her long absences from the nest.

On June 7, 1949, I devoted the first  $8\frac{1}{2}$  hours of the day to watching another nest of the Orange-billed Sparrow, situated beside the spiny stilt roots of a chonta palm on level ground in the forest. Incubation had been going on for 12 days and the two eggs were within 3 days of hatching. This female took even longer sessions on her eggs, the 3 which I timed lasting 70, 106 and 210 minutes, with an average of 128.7 minutes. She, too, always sat facing outward. Her recesses were of 32, 35 and 52 minutes' duration, and she sat for 76 per cent of the time. Like the sparrow I had watched three years earlier, she came and went by hopping slowly over the ground, the fallen logs and brush, not flying until she was 10 feet or more from the nest. On her return she sometimes wove a most erratic course over the rough litter on the ground. On two of her three returns to the nest that I witnessed she brought in her bill an insect or other morsel, and after entering the chamber rose up to lower her head beneath her, at the same time rapidly voicing many low, chattering notes. She seemed to anticipate the hatching of her nestlings—behavior more common with male than female parents. She finally ate the food herself. Although I heard the male's song early in the morning, he did not once visit the nest; and after the middle of the forenoon I neither heard nor saw him.

At this nest both eggs hatched 15 days after the last was laid. At another they hatched in 14 or 15 days. At the nest studied in 1946 the incubation period was 16 or 17 days. Probably it was longer because the female was from time to time disturbed by people passing along the roadway which she faced as she sat.

#### THE NESTLINGS

The newly hatched Orange-billed Sparrows bear dark gray down, long and full, yet far from sufficient to conceal their pink skin. The interior of the mouth is red; the eyes are tightly closed. When those by the roadside were two days old, I devoted the morning to watching them from the blind. On this vigil I saw far more of the male than earlier in my study of the nest, and I learned to distinguish him from his mate by the broader black band on his chest, which also extended farther on the sides to a region which on the female was olive rather than black.

The female alone brooded the nestlings, and with much the same slow rhythm as she had earlier followed while incubating the eggs. Between 5:39 and 11:39 a.m. she brooded only 3 times, for 52, 67 and 81 minutes, giving an average of 66.7 minutes. Her 4 absences lasted 34, 25, 50 and 43 minutes, with an average of 38 minutes. She kept the nestlings covered for 64 per cent of the morning, as compared with the 66.5 per cent of the time she had spent in the nest while I watched her incubate. Thus she covered the two-day-old nestlings almost as constantly as she had covered the eggs.

While the mother kept the nestlings warm, it was the father who chiefly provided their nourishment. He brought food 9 times in 6 hours of the morning, she only thrice.

Both came with the food held visibly in their thick, bright orange bills and their mouths; they did not regurgitate it. Usually by the time the parent reached the nest the objects it brought were too well mashed for recognition; but at times I could distinguish insects or portions of them; and the food seemed to consist largely or wholly of invertebrate animals. When the male arrived with food and found his mate brooding, he would stand in the doorway and pass to her a portion of the contents of his bill. Then, when she rose to place this in the mouths of the nestlings beneath her, he would take advantage of their exposure to deliver the rest of his mouthful directly to them. In the absence of his mate, he fed the nestlings alone. After the young had been fed, their droppings were swallowed by the parents, mostly by the female, but sometimes also by the male.

Both parents were exceedingly cautious in approaching and leaving the nest. As on the day I watched her incubate, on her first departure in the dim light of early morning the female flew directly from her doorway across the road which it faced; but after this she always left more prudently, hopping slowly off through the undergrowth to the side of or behind the nest. The male after bringing food always left in the same discreet fashion. On her first return to the nest, the female hopped deliberately across the road in front of it, thereby exposing herself to view; but on all her subsequent returns she approached from the rear or side, where the dense, low herbage screened her as she advanced by slow hops. The male was invariably secretive in his manner of approach, always coming to the nest from behind. If he had been hunting on the opposite side of the roadway, he crossed this well above the nest, then worked down through the undergrowth to the doorway. Once he started to cross the road directly in front of the nest, but before reaching his destination he made a detour, hopping over a big, mossy rock by the roadside, then around through the undergrowth to arrive at the nest from behind. Now the sparrows were far more silent than on the days I watched the female incubate. Rarely they voiced a low *chip* while at the nest, and they sang very little within my hearing but at a distance from the nest.

At this nest the female while covering the nestlings would sit until I approached quite close, then jump out and hop rapidly away over the ground, but without any display. At only one nest did I see a parent "feign injury." So long as she had only eggs, this sparrow would slip from the nest and vanish while I made my way through the resisting undergrowth; and I never saw her sitting. But on the morning when her nestling was newly hatched, she sat firm while I came up and looked in at her from less than two yards away. When I drew closer, she jumped from the nest and dragged herself slowly over the ground with drooping wings—an excellent demonstration of "injury-feigning." She continued this until she had crept out of sight amid the low herbage, then voiced her sharp call.

The great majority of all the birds' nests that one discovers in tropical rain-forest fail to produce fledglings, and the Orange-billed Sparrows' nests are no exception to this rule. Of eight nests of which I know the outcome, only one was successful. It is not impossible that in visiting such low nests a man leaves a scent that attracts sharp-nosed, prowling mammals and so increases the losses by predation. Because of the destruction of all my nests found before the eggs hatched, I am not able to give the nestling period with exactness. Two nestlings which I first saw when a day or two old left the nest 12 days later, departing apparently spontaneously between 7:30 and 11:15 a.m.

On leaving the nest the young are uniform dark olive above, paler below, and quite lack the conspicuous head stripes and white throat of the adults. They acquire a plumage practically adult within a few months. In late July I saw a youngster, probably from one of the earliest nests of the year, with plumage nearly as in the adults; but its bill was still dark. Toward the end of November I found a young Orange-billed Sparrow

which still accompanied its parents, although it was as big as they, and as far as I could see in the dim light of the underbrush, it quite resembled them in coloration, except that its bill was pale yellow irregularly marked with blackish instead of bright orange-red. Because of the density of the vegetation, I could not see whether it still received food from the parents it so closely followed.

#### SUMMARY

Orange-billed Sparrows are at home in humid lowland forests, beyond which they rarely venture. In southern Costa Rica they nest up to 3500 feet above sea level. They live in pairs or family groups at all seasons and never flock. With their bright bills and contrasting areas of black and white, they are conspicuous in the most dimly lighted undergrowth. They forage on or near the ground, over which they hop, and they rarely ascend higher than ten feet, even to sing.

The song, a simple metallic tinkling, is uttered by both sexes, but the female's version is weaker and simpler. Sometimes she sings in the nest.

In El General this finch nests in the early part of the wet season, from April to August. The bulky roofed nest, with its wide doorway facing sideward, is built in the forest, on the ground, often on a slope or mound, but sometimes on a level area. It is noteworthy for the great amount of living, green vegetation, usually pieces of ferns or *Selaginella*, incorporated in its walls and roof; sometimes this material is strewn in front of the doorway.

The female lays two eggs and incubates them without help. Her sessions are long, averaging well over an hour and sometimes continuing for 2 or even 3½ hours without a break. She almost always comes to and goes from the nest by hopping over the ground rather than flying. One female twice offered food to her eggs three days before they were due to hatch. The period of incubation is usually 14 or 15 days, but in one nest it was extended to 16 or 17 days.

The nestlings, on hatching, have long, dark gray down. They are brooded by the female and they are fed by both parents, who bring food that is visible in their bills and which apparently consists of small invertebrates. Only exceptionally does a parent give a distraction display when the nest is visited by a human. The nestling period is at least 12 days.

In juvenal plumage the young differ strikingly from both parents, which are alike, but within a few months the young acquire a dress which differs little from that of the adults.

## BLACK-STRIPED SPARROW

### *Arremonops conirostris*

Although one of the least brilliant of the Central American finches, the Black-striped Sparrow is a beautiful bird in its clean shades of olive-green and gray. The sexes cannot be distinguished by appearance, and both have the head clear gray, marked with a broad black stripe along each side of the pileum and a narrow black stripe that extends from the base of the bill to the sides of the neck, passing around the eye. The rest of the upper plumage is bright olive-green, and the edge of the wing is canary yellow. The throat is dull white, the chest and sides light gray, and the abdomen white. The short and rather thick bill is black, the eyes brown, and the feet grayish flesh-color.

The species ranges from southern México through the length of Central America to Venezuela, Colombia, and the Pacific slope of Ecuador. Primarily a bird of the humid lowlands, in favorable regions it ranges far above sea level. In the valley of El General it is still a very common resident at 3000 feet. Near Vara Blanca, on the northern slope of the Cordillera Central of Costa Rica, I met Black-striped Sparrows as high as 5600 feet, but very rarely and only during the period between early March and the first of August. I did not succeed in finding a nest in this locality; but on March 3 I heard a sparrow singing; and it is likely that a few pairs may migrate a short distance up the mountain slopes to breed, then move down to spend the stormier months of the northern autumn and winter in milder regions. In Guatemala, farther from the Equator, this sparrow apparently does not range nearly so far above sea level as in Costa Rica.

The habitat most favorable for the Black-striped Sparrow appears to be one in which low, dense vegetation that affords concealment and sites for nests alternates with areas of bare ground or close-cropped sward, over which the birds can hop in search of food. Such conditions are most often found in neglected pastures where patches of low bushes, weeds and vines are scattered more or less thickly in the grass kept low by the cattle, or in pastures of coarse, tussock-forming grass, like the Guinea-grass. Weedy fields from which annual crops have been recently harvested are agreeable to the Black-striped Sparrows; but when allowed to lie fallow for more than a year, such areas, if fertile, become covered by vegetation too tall and dense for them. Plantations of sugar cane, bananas, pineapples or coffee, and fields of maize, if not kept too free of weeds, are likewise frequented by them, as also open brakes of the tall wild cane *Gynerium saggitatum*. A well tended lawn about a cottage is likely to have its pair of Black-striped Sparrows, if clumps of dense shrubbery, hedges or neighboring thickets offer convenient concealment. When all is quiet, the trim birds hop, never walk, over the grass in search of food, but at the first suspicion of danger dart into the neighboring bushes. One often sees them, too, along grassy roadways bordered by hedges or low thickets; but they consistently avoid heavy woodland. They live in pairs throughout the year, never flocking.

The Black-striped Sparrow is the only Central American bird I have known to come to a light. One dark night in late June, a small bird suddenly flew in through the open door and came to rest in the opposite corner of the room. Bringing a light near for a better view of my visitor, I found that it was one of the Black-striped Sparrows who lived in my dooryard. Apparently it had been alarmed by some nocturnal prowler and, bewildered, had turned toward the lighted doorway. Disturbed by my movements, it several times fluttered up against the wall. Then it flew close over the kerosene lamp and singed its feathers. Finally I managed to catch it and put it on a curtained shelf, where it became still in the darkness. At dawn it flew out through the open door.

One morning in May while I sat at breakfast, I witnessed a strange performance of a Black-striped Sparrow, possibly the one who had come to my light. The sparrow was hopping over the short grass of the lawn when a big mouse emerged from a neighboring patch of high grass and began to chase it. The sparrow hopped rapidly away, while the rodent galloped in pursuit. Only after the bird had led the mouse quite a chase, keeping just beyond its reach, did it take wing. What the nocturnal mouse's motive was in giving chase by daylight I could not imagine; an observation made some years later suggested that the bird might have been trying to capture baby mice for food, thereby arousing the enmity of their mother.

#### FOOD

Much of the Black-striped Sparrow's foraging is done in dense concealing vegetation; and when in the open it is shy and distrustful in the presence of man, making it difficult to learn what it eats. But I have seen enough to be convinced that its diet is varied, including insects, seeds, berries and soft fruits. One pair whose nest I watched brought tiny frogs to their nestlings; and another came with small lizards and what appeared to be a new-born mouse.

In the middle of March, 1945, I first saw a Black-striped Sparrow visit my feeding shelf close by the house. The shelf, about 7 feet up in a guava tree and 50 feet from the nearest sheltering hedge, was not in a position to make it attractive to the sparrows and drew chiefly the more arboreal tanagers; but the weather had been severely dry and food was then apparently not so abundant as it normally is. From time to time in the next two months I saw a single sparrow on the table, where it did not seem well at ease and after a hasty meal would dart down into the nearest shrubbery. In May, after weeks of rain had made other foods more abundant, its visits ceased; and I have no further record of its presence at the table until the following December. At the end of the year I moved the board to a burío (*Heliocarpus*) tree at the other side of the lawn, where it was higher—12 feet up—but almost directly above a very dense mass of shrubbery that filled a gully and close by a low jícara tree that afforded excellent concealment in its full, compact crown. This new position was far more agreeable to the Black-striped Sparrows. Within two hours after the shelf was moved one of them visited it; and a few days later for the first time I saw a pair on the board together. After eating, they would dive sharply down into the bushes which filled the gully, behavior which contrasted strongly with that of the visitors of other species, which would leave by flying out or up, but rarely so sharply downward.

The pair of Black-striped Sparrows now became constant attendants of the table, and they or their successors continued their regular visits in the next seven years. Through much of the year they would make many visits in the course of a day; but at certain seasons their attendance fell off, apparently because they were temporarily finding foods more attractive to them than bananas on the shelf. In mid-April, 1947, they built a nest in the privet hedge almost below the feeding shelf. The site was unusually high and exposed for so retiring a bird, and its chief attraction seemed to be its proximity to an unfailing source of food. Two weeks before this nest was started, a Black-striped Sparrow was eating banana when a female Song Tanager flew up to take her share. The sparrow rushed at the tanager and caused her to rise into the air, then, continuing the attack, darted up beneath her and struck her hard on the breast with its feet. They separated at once and went different ways. In a moment the tanager returned to the table while the sparrow flew away. This was the most violent assault that I have witnessed at my feeding shelf in the ten years that it has been in operation. In view of the closeness of the sparrow's nest site, it seems likely that this attack was motivated by the instinct to defend a breeding territory rather than by the desire to monopolize

the food. Although the sparrows were successful in their nesting and later introduced a fledgling to the table, I saw no further attacks on the other visitors. When, because bananas were scarce, I placed halved oranges on the board, the sparrows would come to sip the juice.

Some years later, when the banana plantation suffered from the sigatoka disease and the board perforce often stood bare, the sparrows in the garden formed the habit of coming to share the maize thrown out on the lawn each morning and afternoon for the chickens. While the poultry fed, they lurked in the shrubbery, darting or hopping out short distances to snatch a grain that fell close to them, then bearing it hastily back to shelter to eat it unseen. Later, when the chickens had gone off to scratch in the bare ground, they hopped over the open lawn at their leisure, retrieving stray grains. They

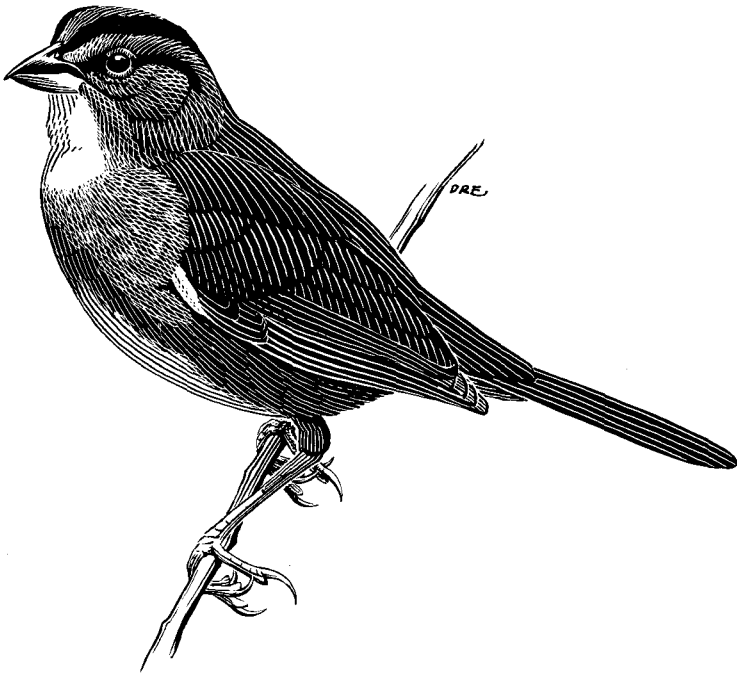


Fig. 18. Black-striped Sparrow

did not disdain half-rotten maize that the well fed chickens refused to touch, and they mashed the grains well in their strong bills before eating them or passing them to a fledgling.

#### VOICE

The song of the Black-striped Sparrow is a delightful performance, easily distinguished from that of any other bird I know. Although there are numerous individual variations, the song of this race appears fairly constant in type. The tempo, at first slow and measured, is gradually increased to a rapid crescendo. One sparrow that I often heard in El General would start out in a hesitant fashion, *tock tock chuck, tock tock chuck* — generally two clear notes followed by a slightly harsh one. After continuing so for a short while, he dropped the slurred note and repeated a soft whistle many times with increasing rapidity. For several months in 1947, I awoke every morning with the



song of a Black-striped Sparrow in my ears. This bird, who slept in the dense foliage of a bush or low tree in front of the house, was an exceptionally fine musician. He began each song with soft, clear whistles, uttered with deliberation, alternately high and low in pitch. After delivering a variable number of these well spaced notes, he accelerated his tempo; the whistles followed each other with increasing rapidity and rising pitch, until the performance tapered off with something very like a fine trill. Sometimes the first low notes of a new song quickly followed the previous finale; sometimes there was a distinct interval between songs. This singing was continued for many minutes, until the day grew brighter and the songster flew from his roost.

The Black-striped Sparrows begin to sing in the early dawn and are among the first birds to raise their voices at daybreak. During the early months of 1944 a sparrow that roosted in the hedge behind my house would often break the stillness of the night with a single clear song, uttered apparently as he awoke in the darkness or by moonlight, many minutes before other birds became vocal with the advent of day. After this one challenging song he would remain silent for a period ranging from ten minutes to an hour, when the brightening in the east stimulated him to more sustained singing. Rarely he would give another isolated song in the interval between his earliest notes and his regular singing. At times when I arose before daybreak to visit some distant bird's nest, the ringing of my alarm clock would be answered by the sparrow's first song; the bell's shrill notes woke him as well as me. Rarely he would sing out in the darkness of the early part of the night. Four years later, a sparrow who roosted in a dense bush close by his mate's newly built nest in front of the house also awoke in the darkness of many a March night to sing once or twice, then became silent until daybreak.

At dawn the Black-striped Sparrow sings from his roost in a bush or low tree with compact, sheltering foliage. Later in the day he seldom chooses a high or exposed perch but uses some obscure position in the bushes.

In Costa Rica I have heard Black-striped Sparrows sing in every month of the year, but they perform most freely during their long nesting season from February to August. In the basin of El General, between 2000 and 3000 feet above sea level, these sparrows often begin to sing early in January. At first they are heard chiefly at daybreak, but by February many are in full song and carol through much of the day. Some males, however, seem not to begin to sing until past the middle of March. Thence the period of fuller song extends into August; yet some males sing a little at daybreak, and perhaps a few snatches later in the day, through the last months of the year. Through this long period there are fluctuations in the volume of song caused by the weather and probably also by molting. When March is hot and very dry, there is a distinct decrease in the Black-striped Sparrow's singing, to be followed by another increase after the first rains of late March and early April have refreshed the atmosphere, revived the vegetation, and aroused dormant insect life. In June, which in El General may be a wet and gloomy month, there is a corresponding period of reduced song; but a relatively dry July or August, with fine sunny mornings, may stimulate much singing.

So far as I have been able to learn, only the male Black-striped Sparrow sings. But members of a mated pair, when they alight side by side after a temporary separation, greet each other with a sort of song, albeit one devoid of melody. Both utter simultaneously a somewhat whining note, rapidly repeated with falling inflection. The pair remains mated through the year, and this peculiar utterance may be heard in every month. It corresponds to the "mate-call" of the Brown Towhee described by Quaintance (1941: 153). In western Ecuador I heard a pair of Black-striped Sparrows, of the race *chrysoma*, greet each other with notes very much like those used by their Costa Rican relatives for the same purpose.

The most common call of the Black-striped Sparrow is a deep nasal note, usually repeated a number of times in a deliberate manner, and which I find it impossible to paraphrase. This sounds back and forth between the members of a pair when separated and also, uttered with another inflection, expresses alarm, as when the nest appears to be in danger. A very different utterance is a high, sharp whistle or squeal, generally given just once, often as the sparrow takes wing. This appears to be a "signal note" to advise the mate of the bird's position.



Fig. 19. Nest of Black-striped Sparrow on the ground in a banana plantation, near Almirante, Panamá, April 2, 1929.

The language of the race *chloronotus*, as I heard it in the Motagua Valley of Guatemala in 1932, is noticeably different from that of the more southern race, *richmondi*, which we here chiefly consider. It had two songs, one a pretty, ringing *ching ching ching ching ching*, and another which reminded me of that of the Cardinal, although it was not so loud and clear. No utterance that I have heard from *richmondi* remotely resembles the Cardinal's song. The call of the Guatemalan bird was a sharp *pink*, more metallic and less nasal than that of its Costa Rican relative.

#### NEST BUILDING

In El General the Black-striped Sparrow sometimes begins to build in January, but this is unusual and the height of the breeding season does not come until April. The bulky domed nest is placed low in a clump of grass or weeds, a tangle of vines or a bush, more rarely in a pineapple plant or among the bases of the stems of sugar cane, bananas or some other cultivated plant. Of 51 nests whose heights I have recorded 5 were on or within an inch of the ground; 9 were between 2 and 6 inches of the ground; 16 were between 7 and 12 inches; 10 between 1 and 2 feet; 7 between 2 and 3 feet. The remaining 4 were at heights of 48, 48, 50 and 72 inches. This last, 6 feet up in the crown of a

tree fern in a fairly clean and open pasture, was in a situation as surprising for its exposure as for its elevation. Half the nests were at heights varying from 7 to 24 inches.

I was familiar with the secretive Black-striped Sparrow for many years before I could learn any details of its behavior at the nest. When situated in bushy pastures and similar vegetation, the roofed structure often faces a narrow cow path or other opening which offers a site for a blind, but usually at such close quarters that the shy bird will not sit facing the tent, behind which are more bushes which prevent its being moved farther back. Even when occasionally I found nests on more open ground and set the blind a good distance off and then, after a period to permit the bird to become familiar with it, advanced it gradually toward the nest, the female would neglect or abandon her eggs. It was not until the sparrows established themselves in my dooryard and visited the feeding shelf that I had a pair confiding enough for satisfactory studies of nest life. Before long they would build or incubate while I watched seated without concealment across the open lawn; and one female remained calmly covering her eggs while I set up the brown tent eight feet in front of her doorway. This is only one example of shy birds that became more confident and satisfactory for study as a result of frequenting the tray where I placed bananas for them.

The first of these nests in my dooryard was found in 1946 in tall grass, close by a shed where I could hide myself. When I began to watch at 6:35 a.m. on April 4, the female was lining her domed structure with grass blades and straws that she collected on or near the ground at no great distance from it. She would gather a good billful before starting for the nest. Then she would rise and fly low over the grass, the yellow edges of her wings conspicuous as she came toward me. Upon reaching her nest she dropped out of sight in the tall grass, and I could not watch her arrange what she brought to it. Between 6:35 and 7:00 she brought 23 billfuls, while her mate sang in the neighboring hedge. Then the pair flew out of sight and stayed away until 7:23, when the female resumed active building. By 8:00 she had brought 24 additional billfuls to the nest. During this period of work the male sang little. After 8:00 the pair went away, and I waited until 9:00 without seeing them again. When I returned at 10:40 they were not at work. I then placed a green leaf in the doorway in such a fashion that a bird passing through would brush it out; but in the evening it was still where I had set it, indicating that the nest had not been entered after 10:40 a.m.

The next morning the female sparrow was already at work when I resumed my watch in the shed at 5:45, and in the next half hour she added 20 billfuls of material to the nest. From 6:15 to 6:48 the structure was not visited, but from 6:48 to 7:00 five billfuls were brought. From 7:00 to 7:37 the pair were again absent, but between 7:37 and 8:00 the female brought material 6 times. The work was slowing down as the nest appeared to be nearing completion. Only twice on the two mornings did both members of the pair come to the nest at the same time bringing material. Unfortunately, I could not see whether both arranged their straws in the nest. It was clear that the male sparrow made at least an occasional gesture of helping to build, but most if not all of the work was done by the female. Although I could not distinguish the sexes by appearance, the male often identified himself by his song, delivered as he perched or hopped about in the neighboring hedge. The female worked in silence. Several times the male chased intruders of his own kind, and once the pair united in driving off a trespassing Black-striped Sparrow.

At a nest built in the privet hedge in front of my house the following year, I saw no evidence that the male helped with the work. Once he seemed to feed his mate near the nest while she labored, but I could not actually see food in his bill. This female

worked more slowly, bringing material only 20 times in the 2 hours and 20 minutes between 6:30 and 8:50 a.m.; 11 of these trips were made in the hour between 7:30 and 8:30.

In all, I have devoted a total of nearly 18 hours in the first half of the forenoon to watching the building of 5 nests, all close by my house. The effective work appears to be done wholly by the female. On one other occasion I saw a male carry material while his mate was actively building, but he dropped the leaf 10 yards from the nest. Much of the time he loiters close by, often singing, and on rare occasions bringing a morsel of food to the unfinished nest. If his mate is not there to receive it, he eats the food himself. The females work most actively early in the morning and accomplish little after eight or half-past eight o'clock, even when building will be resumed next morning. On some days nothing is added after this hour, as one can prove by putting a green leaf in the bottom of the nest, which at nightfall will have no new material overlying it. A typical record is that made at nest 44 while the female was lining the bottom. Between 6:10 and 8:10 her visits to the nest during successive half-hour periods numbered 17, 16, 12 and 0. In the following 10 minutes (8:10 - 8:20) she came 3 times more, and a few pieces of material were brought later in the day. The most active spurt of building I have witnessed is that recorded earlier—23 trips with material in 25 minutes. In my 17.6 hours of early morning watching at all the nests, material was brought 229 times; but this includes long intermissions when the nest was wholly neglected.

If the nest faces a lawn or open ground, the female often approaches it by hopping rapidly, at times for considerable distances, bearing in her bill large pieces of material up to twice her own length. She prefers broad strips of monocotyledonous leaf for the outer shell; and sometimes I have helped her by placing close by the nest a supply of such strips, which she promptly uses. Some of the pieces that she chooses are so broad and heavy that she tries in vain to carry two at once. But later, when selecting fine straws for the lining, she gathers a whole sheaf in her bill before proceeding to the nest.

Despite the leisurely pace of building, each of the 4 nests whose construction I followed most closely was completed in 5 or 6 (or possibly in one case 7) days. One of these, a replacement nest that I had the good fortune to find just as the female sparrow was laying the first foundation pieces, was finished in 5 days. In this instance the first two days were devoted to bringing coarse materials for the foundation and roof, the third to fetching mixed coarse and fine materials, and the last two to fine pieces for the lining.

The finished nest of the Black-striped Sparrow is a bulky, oven-shaped structure with a wide, round doorway in the side. The thickness and completeness of the roof varies greatly; in some nests it covers the entire chamber and is compact enough to shed heavy rain; in others, especially those built late in the season, it is slight and loose and may extend over only the back of the nest, in which event the opening faces obliquely upward. But many late nests are as well built as early ones. At times the top of the nest is peaked rather than domed; and the high roof causes the doorway to be oval in shape, much higher than wide. The materials of the nest are usually coarse and include dead leaves, grass blades, pieces of dry vine, tendrils, weed stems, roots, and pieces of bracken fern—the components of any single nest depending on what the locality affords. One nest was built on the ground in a banana plantation, in grass and beside a large, dry banana leaf, several strips of which, still attached to the massive midrib, had been pulled over the roof, giving excellent concealment and protection. The lining is of fine grass stems or fibers. The chamber of a typical nest measured  $4\frac{1}{4}$  inches in height by  $3\frac{3}{4}$  in diameter.

## THE EGGS

At one nest, built to replace another which had been pillaged, the first egg was laid the day after construction was finished. At two other nests the builder waited a day after completing the lining, laying her first egg early in the morning of the second day. At 3 additional nests, less closely observed, the interval between the termination of building and laying the first egg was 1 to 3 days. The first egg of a set is deposited at or soon after sunrise, usually between 5:30 and 6:40, and the second on the following day at a slightly later hour, usually between 7:00 and 8:15 (for details see Skutch, 1952:50). Thus the interval between the laying of the two eggs is definitely more than 24 hours, sometimes 25 or 26. Of 54 nests that I have found in Central America, 50 contained two eggs or nestlings; a single unusually early Costa Rican nest discovered in mid-February held three eggs, while the remainder, with a single egg or nestling, probably did not contain complete sets. Half a dozen additional records published by various authors give the size of the set as two eggs. The eggs are pure, immaculate white and somewhat glossy. The measurements of 28 eggs from Costa Rica average 25.2 by 18.4 millimeters. Those showing the 4 extremes measured 27.0 by 18.7, 26.6 by 19.1 and 23.8 by 17.5 millimeters.

A nest of the Black-striped Sparrow of the race *chloronotus* was found near Los Amates in the Motagua Valley of Guatemala on May 23, 1932. It was hidden among dead leaves on the ground at the top of a low bank beside a footpath at the edge of a banana plantation. The half-covered structure was composed of strips of dead leaves, rootlets and tendrils and was lined at the bottom with fine fibers. The two pure white eggs measured 20.6 by 16.7 and 20.2 by 16.7 millimeters, hence were smaller than the smallest that I measured of the considerably larger race *richmondi*.

The distribution by month of laying of 53 nests in the valley of El General, 2000 to 3000 feet above sea level, is as follows: January, 1; February, 5; March, 6; April, 16; May, 9; June, 7; July, 6; August, 2; October, 1. All the other nest records from Central America that I have seen fall in the months of April, May, June, and July.

## INCUBATION

Only the female incubates. At all of the five nests examined in the night between the laying of the first and second eggs, the female was found sleeping on the single egg. This additional warming received by the first egg results in its earlier hatching, sometimes on the day before the second egg hatches.

My early attempts to study the rhythm of incubation of the Black-striped Sparrows were balked by their extreme shyness in the presence of the little brown blind from which I have watched the nests of hundreds of other birds of many species. Only after the sparrows began to visit my feeding shelf for bananas and to nest in my dooryard shrubbery did I succeed in making a satisfactory record of the movements of an incubating bird. Finally, as already told, they became amazingly tolerant of my presence; but at a transitional stage, when I was not sure how much they would trust me, I decided to watch the nest in the privet hedge at the top of the high bank in front of my house. From somewhat distant points in the pasture below, this nest could be seen vaguely in the foliage; but the sparrow, of course, could not be viewed as she sat in the nest so far above the level of my eyes, nor could she see the blind while covering her eggs. But by this time I had become less exacting in my requirements for favorable observation of this species and contented myself with timing, over a period of 11 hours, her comings and goings from the doorway that was partly visible to me. When I watched through the morning of May 1, 1947, the sun shone; but rain fell during much of my afternoon vigil the following day. I timed 7 completed sessions in the nest, ranging from 33 to 99

minutes and averaging 59.4 minutes, and 9 recesses lasting from 12 to 25 minutes and averaging 19.4 minutes. The female sparrow devoted 75 per cent of the time to incubation; and I saw nothing to indicate that her mate took a share in the task.

On leaving her eggs the female sparrow would often hop and flit up to the feeding shelf to eat banana before flying off in search of other foods. Sometimes she would again eat banana at the end of her outing, then fly sharply downward from the board to the hedge where her nest was situated. In the morning her mate sometimes escorted her to near the nest, but after noon he was most neglectful. At half-past seven in the morning he came to the nest with laden bill and fed his sitting mate. After sunrise he sang little except in a single period of ten minutes in the middle of the morning. Once he chased a Buff-throated Saltator, bigger than himself, from a small tree above the nest.

By 1948 the pair of Black-striped Sparrows in my garden had lost all distrust of the blind. Their nest among the great yellow trumpets of an Allamanda bush was well placed for observation. But now, when all other conditions favored my study of this species, politics interfered. The country was in the throes of a bloody revolution and my watches from the blind were again and again interrupted by false rumors that vandals were approaching our neighborhood. Still, during a total of 12 hours of watching divided between several days, I managed to time 7 completed sessions of the female, which ranged from 47 to 94 minutes and averaged 70.3 minutes, and 8 recesses ranging from 13 to 35 minutes and averaging 21.9 minutes. She warmed her eggs for 76 per cent of the 12 hours covered by my record, a constancy scarcely different from that of the sparrow, probably the same individual, that I studied the preceding year. On the morning of April 14 she sat for more than 125 minutes continuously, but unfortunately I was called from the blind before she completed this unusually long session. She was quite regular in beginning her first outing of the day; on four mornings the hour of her departure varied only from 5:37 to 5:41.

In the early part of the incubation period, the female sparrow, on leaving her eggs, usually turned sharply to hop slowly and laboriously through the thickness of the densely branched Allamanda bush, emerging from it a minute later on the side behind the nest. Before the eggs hatched she often neglected this precaution and went directly from her doorway, which faced the open lawn. After leaving the nest she often paused to stretch her wings. Once clear of the bush, she would either hop away over the grass or fly low, and after she had gone a short distance she would give the sharp signal call for her mate. As soon as they were re-united, which sometimes occurred on the feeding shelf, they raised their voices together in the greeting note. After an excursion with him, and sometimes another visit to the bananas on the neighboring board, she returned to her nest inconspicuously by working her way slowly through the dense bush that supported it. Once I saw the male come silently and give his sitting mate a morsel. Again, when the first egg was on the point of hatching, he arrived in her absence with a small lizard, and after looking into the chamber, swallowed his offering.

The period of incubation is between 13 and 14 days. Two early determinations, based on daily visits to the nest, showed this period to be about 14 days. At 3 later nests, situated close to my dwelling where they could be frequently examined, the interval between the laying and hatching of the second egg (which was marked with pencil) was as follows: nest 42, between 13 days  $4\frac{1}{4}$  hours and 13 days  $9\frac{1}{4}$  hours; nest 44, between 13 days 10 hours and 13 days 23 hours; nest 49, between 13 days  $1\frac{1}{4}$  hours and 13 days  $4\frac{3}{4}$  hours.

#### THE NESTLINGS

At the nest built in 1948 in the Allamanda bush beside the house, I watched from a blind while the eggs hatched. The first was chipped when the female began the day's first

recess at 5:41 on the morning of April 15. At 9:24 she began a long session which continued for 83 minutes. At 10:30, while in the midst of this session, she reached beneath her breast, picked up the cap of an empty shell and ate it, thereby revealing that the egg had hatched. Seventeen minutes later she left for an outing which lasted 22 minutes. On her return she seemed to feed the nestling, but since her back was toward me, I could not be sure of this. Then she resumed brooding and while sitting ate the main part of the empty white shell. By 11:25, almost an hour after I learned that the egg had hatched, the male had not yet seen or fed the nestling, although not long before it hatched he had come to the nest with the small lizard already mentioned.

The second egg hatched in the night; and by the time the female left the nest for her first recess on the morning of April 16 the shell had vanished, evidently having been eaten by her before there was enough light to see clearly. She fed a nestling at 6:04 while the male sang not far off; and at 6:23 he brought a morsel, which he gave to his mate for delivery to the young. In the 5 hours following the female's first morning departure the 2 nestlings were fed 18 times — at least 9 by the male and 7 by the female, and twice more by an unidentified parent. When the male coming with food found his mate sitting, he passed it to her for delivery, but in her absence he fed directly. Once the mother spent 3 minutes patiently trying to make the young swallow food that was too large for them. She brooded for 6 periods ranging from 10 to 81 minutes, with an average of 35 minutes, and she took 7 recesses ranging from 8 to 16 minutes, with an average of 12.4 minutes. Thus she covered the newly hatched nestlings for 74 per cent of the 5 hours, which was only slightly less than her constancy in sitting toward the end of the incubation period.

In 1947, when the 2 nestlings in the privet hedge were 9 days old, I devoted 3 hours of the early morning to watching their nest. In the successive periods of one hour between 6 and 9 o'clock they were fed 14, 3 and 10 times, a total of 27 feedings in the 3 hours, or at the rate of 4.5 times per nestling per hour. Both parents provided for them; and 6 times both came to the nest at about the same time, sometimes standing side by side in the wide doorway and delivering the food simultaneously.

To learn something of the care of nestlings about ready to leave the nest, I devoted 11 hours on April 26 and 27 to watching the family in the Allamanda bush. These youngsters, hatched on successive days, were from 10 to 12 days of age in the interval covered by my observations. They were well clad with feathers and no longer were brooded by day. They were fed 99 times, or at the rate of 4.5 times per hour for each of them. The number of feedings in a single hour ranged from 15 in the early morning, and 12 between 3 and 4 o'clock in the afternoon, to 5 in the middle of the morning and again from 2 to 3 o'clock in the afternoon. Although both parents brought food I could seldom distinguish them, because now the male rarely sang. As at the nest in the privet hedge the preceding year, there was a strong tendency for the parents to come together: 7 times they stood side by side in front of the nest, and 8 other times they came within the same minute.

Both parents coming with food habitually approached the Allamanda bush by hopping over the smooth lawn for a few or many yards, never flying directly to the bush. Although the nest was most exposed to the front and to the right, they never came to it by this most direct and open route. Invariably, even when they approached from the right, they entered the bush behind the nest and hopped through its close-set branches, where they were invisible until they reached the doorway from the left.

In their mode of leaving they were less consistent. On April 26 they went off the less conspicuous way, through the middle of the bush, after nearly half of their visits; but the next day they chose the hidden route after only a quarter of their visits to the

nest. After the others they flew off the direct and easy way, to the right. It will be recalled that at the beginning of incubation the female usually came and went by the sheltered way through the midst of the bush, but that before the eggs hatched she became more careless and often left by the open route. After the eggs hatched she more often chose the less conspicuous way of leaving. When the male began to bring food, he nearly always came and went through the bush, although exceptionally he would neglect this precaution and run the risk of betraying the nest's position by a more direct departure. Until the young left the nest, the parents wavered between the concealed and open routes of departure, with a tendency to leave by the latter more often as the moment of the youngsters' emergence drew near. With a dropping to carry away in the bill, they were apt to prefer the unobstructed route of departure. At other nests, too, the parents had special sheltered routes for coming and going.

The parent sparrows' mode of approach under cover, their rapid turning with tail toward me in order to deliver food, made it difficult for me to distinguish the kinds of food they brought. As a rule food was carried conspicuously in the bill rather than inside the mouth or throat. Insects seemed to form the bulk of the meals, and often I glimpsed a grasshopper or other orthopteran in a parent's bill. There were also larvae of various sorts, some quite big. A pink, caudate object that I saw imperfectly seemed to be a new-born mouse, which a nestling gulped down with an effort. If my identification of this object was correct, it might help to explain the observation that I made several years earlier, when I saw a mouse or small rat chasing a Black-striped Sparrow over the lawn. Although the parent sparrows often visited the feeding shelf to eat banana, they only rarely brought this or other fruit to the nestlings. The same was true at the nest in the privet hedge the preceding year. These parents included small frogs in the fare they supplied to their young.

While attending these older nestlings, the parents nearly always carried off the droppings and only rarely swallowed them. When both nestlings presented a dropping to a parent on a single visit to the nest, the first was eaten and the second carried off in the bill. With a dropping to carry away, the parents usually chose the direct, unobstructed mode of departure rather than the hidden route through the bush.

In a *Dracaena* bush about ten feet from the sparrows' nest a female Song Tanager was building. Several times I witnessed slight clashes between this tanager and one of the sparrows, but it was not clear to me which was the aggressor. Usually the adversaries ended their encounter by dropping to the ground a few feet apart and lingering there for a minute or two. In one of these scuffles several small, downy feathers were lost, but I do not know by which of the two birds. Then, after resting on the ground a moment, the sparrow chased the tanager. From their greater pugnacity, and the fact that they had nestlings to protect, I suspect that the sparrows usually assailed the tanager, rather than the reverse.

At hatching the Black-striped Sparrows bear sparse gray down which fails to hide their pink skin. Their eyes are tightly closed. Their mouths are red within and have conspicuous yellow flanges at the corners. The nestlings develop rapidly, and when they are 6 or 7 days old their feathers begin to unsheath. Three days later they are well covered, on the upper parts at least, with olive-green feathers. This nestling plumage lacks the dark head stripes so conspicuous in the adults. After the young are clothed with feathers the female no longer broods them by day, at least in fair weather. At the nest in the *Allamanda*, the female slept over the nestlings for the last time when the elder was 10 and the younger 9 days of age, but during their last 3 nights in the nest they were alone. At the nest in the same bush the following year, 1949, the single surviving nestling was brooded during its final night in the nest, when it was 12 days old.



While I watched at the nest in the Allamanda in 1948 on the morning preceding that on which the two nestlings left, they were active and restless and preened often. Frequently after receiving food they would rise up in the nest and stretch forward, revealing their streaked breasts and looking out in the direction taken by the departing parent. Thrice after being fed a nestling hopped to the doorsill but immediately returned inside. Since the oldest was 12 days of age and quite old enough to leave, I fully expected to witness its departure; but after 8:30 both rested quietly in the nest and gave no indication that they were about to leave. At meal time they made a harsh, buzzing sound.

When I resumed my watch of this nest at dawn next morning, both nestlings were resting quietly. At 5:36 a parent came through the bush and fed one of them. While the attendant was at the nest one of the youngsters hopped out in front, but at once returned inside. Then one of the two preened vigorously inside the nest. At 5:40 one youngster, then the other, hopped out of the nest. At the moment both parents were approaching with food but still a good way off. I saw or heard them do nothing which I could interpret as an attempt to call the youngsters forth; their emergence was wholly spontaneous. But when the parents came near and saw one of the fledglings at the edge of the bush, they promptly led it away, running over the lawn ahead of it with short, rapid steps, wings and tail dragging. The young sparrow followed by hopping after them. When some well-grown pullets approached, their curiosity stirred by the excitement among the sparrows, the parents fluttered in the faces of the relatively huge birds, first bewildering them, then causing them to turn and run. Soon the fledgling gained the shelter of a neighboring bush, whereupon the parents flew up into a higher bush and voiced the greeting song.

Meanwhile the other fledgling lingered in the Allamanda bush that held the nest. At 5:50 a parent visited the empty nest and went away, apparently not taking notice of the youngster who rested a yard off. From time to time it voiced a sharp *tup*. At 6:00 this fledgling became restless and hopped over the outside of the bush, calling frequently. The parents came together, one at least with food in its bill. Instead of going directly to the youngster, they approached it through the thickness of the bush. Then the young sparrow, closely accompanied by both parents, hopped rapidly over the lawn to a larger Allamanda bush, 25 feet from that which held the nest.

Leaving the blind then, I found the first fledgling resting quietly and inconspicuously in the middle of the bush to which the parents had led it. As I drew near the old birds voiced low, sharp, metallic notes, somewhat like those of the Cardinal, and also the usual full, nasal call. I cannot recall having previously heard the metallic note from these birds. Although the adult sparrows did not entice their young from the nest, once they had emerged in response to their own inner impulses, the parents made pointed efforts to lead them to safe concealment. And this, in my experience, is typical of small birds that nest near the ground.

The older of these nestlings left the nest when only a few hours less than 13 days of age. The second was between 12 and 12½ days old. Eleven other nestlings left at ages varying from 11 to 12 days. Five nestlings left in the early half of the forenoon, but one took its departure on a rainy afternoon.

#### THE YOUNG AFTER LEAVING THE NEST

On May 21, 1947, two young Black-striped Sparrows left the nest in the privet hedge in front of my house, aged 11 days. For the next two weeks the parents continued to make frequent visits to the feeding shelf, eating freely of banana and carrying many billfuls down into the dense shrubbery on the slope below, where their youngsters lurked so closely hidden that I did not succeed in glimpsing them. On June 7, I saw one of the young sparrows for the first time since it left the nest. It was in the densely leafy

crown of the low calabash tree close by the feeding shelf, in company with a parent. Now at the age of four weeks it was about as big as the adults but its plumage was somewhat different. Its head, unmarked at the time of leaving the nest, was now striped in the same pattern as the parents'; but because the stripes were lighter and the ground color a darker and less pure gray, they were not so conspicuous. The remaining upper plumage was greenish-olive of a darker shade than on the adults, and the breast bore conspicuous dark streaks on a lighter grayish-olive ground. The corners of its mouth were still conspicuously yellow.

During the following ten days the young sparrows continued to hide in dense foliage, but not so closely as before; and occasionally I saw one of them. The parents still carried many billfuls of banana to them. They had been out of the nest nearly a month before they began to hop over the lawn in company with their parents. On June 21, just a month after it left the nest, I saw a youngster on the feeding shelf in company with a parent who gave it banana. But it was even more shy than the adults, and flew away just as it was about to receive another billful. Three days later I several times saw the youngster on the shelf, alone or with a parent. Once it fed itself — the first time I saw it do this, at the age of 45 days — but at other times it was helped to food by a parent. On July 3 I first saw the youngster on the board with both parents, one of which put pieces of plantain into its mouth. Later that day one of the parents carried down a billful of plantain into a bush and fed it. But the youngster was now becoming more independent of parental care and repeatedly came to the table alone, helping itself freely.

As late as July 7, the parents were still feeding the youngster. On three separate occasions in an hour I saw one give it food on the table, where it was helping itself quite competently; and once the parent carried the banana to a neighboring bush and there passed it to the young bird. This was the last time that I saw the young sparrow receive anything from its parents. It continued to make frequent visits to the feeding shelf; but soon the parents became antagonistic to their offspring and tried to drive it away. On July 13, I several times saw one of them chasing it mildly, and a number of times more I heard sounds which suggested that the same thing was happening. In the following days these pursuits were often repeated, both in the bushes near the feeding shelf and in the hedge surrounding the garden. The parent would fly again and again at the youngster, who flew more or less in a circle so that no actual fighting occurred. Despite the fact that its presence was no longer agreeable to its parents, the young sparrow continued to eat at the feeding shelf in the middle of their territory until about July 26, after which it disappeared and I saw it no more. Thus this Black-striped Sparrow left the nest when 11 days old, began to stay less constantly in concealment when 28 days old, was first seen to feed itself when 45 days old, received additional food from the parents until at least 58 days, began to be chased away by them when 64 days old, and vanished from their territory when about 77 days, or at  $2\frac{1}{2}$  months of age.

So far as I could learn, this pair of sparrows did not attempt to rear another brood in 1947. But the following year they built four nests, of which the first was unsuccessful; from the second, that in the Allamanda to which we have devoted so much attention, two young were fledged. After the departure of these on April 28, their parents built twice more; and with this complication the subsequent history of these two youngsters followed a course somewhat different from that of the young of the preceding year. On the day of quitting the nest, at the ages of 12 and 13 days, they vanished, and for the next fortnight remained so well hidden that neither was seen again until May 13. On May 23 their mother started her third nest in another Allamanda bush 83 feet from the previous one. While she built, one of the youngsters with streaked breast twice came to the nest bush without being repulsed by her, although the male chased it mildly in a

neighboring tree. It helped itself to the little black berries of a nearby *Miconia* tree, but it also was fed by a parent. The new set of eggs was completed on May 30, and on the following day for the last time I saw one of the parents feed a youngster of the first successful brood. By June 12 these young sparrows were frequenting the shelf to eat bananas. A few days later I saw one of them pick up bits of wood and herbage from the lawn, as though testing their edibility, then dropping them again; and next morning one toyed in the same manner with fragments of bark or dead leaf from a guava tree. On June 28, twice I saw the two young sparrows come to the feeding shelf together; but each time one drove the other from the board and the second waited nearby until the first had finished eating. The young sparrows also tried to chase birds of other kinds from the table, manifesting a degree of pugnacity unusual among the guests who ate there.

By the end of June, these youngsters no longer accompanied their parents, who on June 10 had lost the eggs from their third nest, and unknown to me had built a fourth, 250 feet distant from it and 178 feet from the second. When on July 6 I discovered this latest nest, it already held two nestlings a few days old. The sparrows hatched in April did not come near the nest while I watched, although they continued to meet their parents at the feeding shelf. On July 10, a parent chased one of these youngsters in front of the house. Although they continued for the next month to come to the shelf for bananas, their visits became furtive as a result of much opposition from the parents, who were now carrying food to the young of the later brood. On August 8 I last saw the old birds pursue the youngsters hatched in April. By this time they had become difficult to distinguish from the adults, and I made no further records of them.

The young of the second successful brood left the nest on July 13 and were not seen again until August 18, when one came to the shelf and was fed there by a parent. It did not then help itself and was not seen to do so until August 26, when 56 days old. The following day it was on the table with both parents, one of whom chased it when it begged for banana; but later it was fed. The parents were last seen passing food to one of these youngsters on September 2, when it was 63 days old. By the end of the month they had become hostile to it. As late as October 9, two parents and one of the youngsters hatched at the beginning of July were together behind the house, picking up spoiled grains of maize that the chickens disdained to eat. I noticed no antagonism then, but later in the day I saw one member of this family chase another. This was the last time I found the three together.

Another family remained united far longer. In 1952, I was away from home during April, May and June. Returning early in July, I found in my dooryard a pair of sparrows with a full-grown youngster, at least a month old. These three sparrows continued to keep company amicably until the middle of December, when the youngster was nearly seven months old and had long been indistinguishable from its parents.

To sum up, after leaving the nest at the age of 11 or 12 days, the young sparrows remain in hiding until they are 27 or 28 days old, when they are practically full grown and can fly well. One was first seen feeding itself at 39 or 40 days, another at 45. When a second brood was reared, the parents were not seen to give food to the earlier brood after their 46th day; but when no subsequent brood was attempted, feeding continued to the age of at least 58 days in one instance and to 63 days in another. Thus over a considerable period the young make an attempt to provide for themselves but their efforts are supplemented by their parents. A youngster only 40 days old was mildly chased by its father in the vicinity of a nest its mother was building but later was fed by a parent. The parents became more consistently aggressive toward the young when these were from two to three months old; but in one instance the family continued

amicably together for over half a year. Compared with the tanagers, the finches that visit my feeding shelf, both the Black-striped Sparrow and the Buff-throated Saltator, become hostile to their offspring at a far earlier age, although they may feed them just as long. This is correlated with the stronger territorial instinct of these two finches.

#### ACQUISITION OF THE ADULT PLUMAGE

With these young sparrows of known age I was able to follow the acquisition of the adult plumage. When they emerged from concealment at the age of about one month the youngsters were, as we have seen, clad in full juvenal plumage, which differed conspicuously from that of the adults in several respects. The upper parts were duller, less greenish and more olive, than on the adults, and the head stripes were far less prominent because they contrasted less with the ground color. The under parts were strongly tinged with pale olive, instead of clear light gray as in the adults; and the breast bore conspicuous dark streaks, although that of the adults is immaculate. When about two months old, the youngsters' progress toward adult coloration had become sufficiently prominent to be noticed with binoculars. The first sign of the postjuvenal molt that I could detect was the disappearance of stripes from the breast, which at the same time was losing its greenish cast and becoming clear light gray as in the adults. This change went rather rapidly; and after about two weeks more the streaks had all but vanished from the under surface, except for traces in the center of the breast or on the upper chest, where the molt had not yet encroached. The molt of the upper surface proceeded more slowly; and when the young sparrow was three months old, with only a few remaining streaks on its under parts, the upper plumage was decidedly more dingy than on the adults and the head stripes were less sharp and clear. When nearly four months old, however, the young birds had become difficult to distinguish from their parents.

The foregoing remarks refer chiefly to two sets of young sparrows hatched early in the season, in April and early May. A brood hatched at the beginning of July went through the molt somewhat more rapidly, so that at the age of eight weeks most of the stripes had already gone from their under parts, and ten days later only faint traces of them were discernible in the center of the breast. When three months old, I could distinguish these youngsters from their parents only by the more olive hue of the light interspaces on their striped crown; and ten days later young and adults were confusingly similar.

#### DISTRACTION DISPLAY

In Costa Rica I have seen a Black-striped Sparrow feign injury while it had eggs or young in the nest. The behavior of the parents, who with dragging wings and tail led their newly emerged fledglings across the lawn away from the nest in the Allamanda bush, suggested a typical distraction display. Although the young were not then threatened by any visible peril (I was in the blind where I had already passed many hours), they were in an exposed and potentially dangerous situation; perhaps the parents' awareness of this was in itself sufficient to cause them to assume an attitude associated with a threat to their young. A parent Striped Brush-finch, as told in the life history of that species, assumed a similar posture when leading a youngster toward a sheltering thicket; but in this case my presence must have seemed an imminent threat to them.

Some years earlier, a Black-striped Sparrow with older offspring gave me what was, in its instantaneous effectiveness, the most convincing demonstration of injury feigning that I have ever witnessed in any bird. On the morning of June 17, 1935, at Puerto Limón, Costa Rica, I watched a family of Black-striped Sparrows consisting of a fledgling recently emerged from the nest and hardly able to fly, two young birds fully grown but still in the juvenal plumage with streaked breasts, and the parents of these three youngsters. Apparently the absence of dense, tangled vegetation was responsible

for the fledgling's being in the open at an age when most of its kind stay well concealed. I kept a close watch to see whether the full-grown young sparrows would give food to the fledgling that was to all appearances their younger brother or sister; but although the five kept close company, I failed to see the young of the earlier brood help the parents to attend the later one. Presently a dog came by, followed by a nurse-girl and child, and seeing the birds on the bare ground beneath the shrubbery, rushed after them. The fledgling had ventured forth from the bushes on to the bare soil and would certainly have fallen a victim to the dog had not one of the parents quickly placed itself in front of the animal. Fluttering over the ground just ahead of the dog, it led it rapidly away from the helpless little bird. The dog was still vainly pursuing the parent when both passed out of sight in the shrubbery.

At my Guatemalan nest of the Black-striped Sparrow, twice I saw one of the parents feign injury. One day when I surprised the female brooding her nestlings, she continued to sit while I stood looking down at her for a few moments. She then darted out and half walked, half fluttered with drooping wings until she was a few yards distant from me, whereupon she limped along more slowly and beat her wings on the ground more deliberately, trying to lure me away. Soon she vanished in the neighboring brake of giant canes and voiced low but sharply metallic *pink*s. When I re-visited the nest two days later, I found the nestling alone and took it in hand to examine its plumage. Its metallic cries brought one of the old birds from the cane brake. The distressed parent crept painfully to and fro on the ground before me in a hump-backed attitude, beat its wings against its sides, or spreading them more widely, against the fallen leaves, and answered its nestling with metallic *pink*s. Rarely it made a little jump into the air.

#### SEQUENCE OF BROODS

My first evidence for the existence of a second brood in this species was obtained at Limón, Costa Rica, where on June 17, as told in the foregoing section, I found a pair accompanied at the same time by well-grown juveniles and a fledgling which could scarcely fly. In 1939, I kept under observation a nest from which two 11-day-old fledglings departed on May 30. Forty feet distant from this I found, on June 14, a nest with two fresh eggs belonging, apparently, to the same pair. In 1948, the female of the pair of sparrows in my garden started her first nest about March 11, laid her eggs on March 18 and 19, and lost them on the afternoon of March 23. Three days later, she began the nest which has already received so much of our attention. In this the eggs were laid on April 1 and 2, and from it two young departed on April 28. By May 23 this female, still followed by her offspring of her first successful brood, started her third nest, 83 feet distant from her second. Here the eggs were laid on May 29 and 30, but were lost about June 10. The sparrow then built her fourth nest so far away — 178 feet from the second and 250 from the third — that I did not find it until July 6, when the nestlings were several days old. Calculated from the date of their departure, these young sparrows hatched from eggs laid about June 17 and 18. Thus between March and June this female sparrow built four nests and laid four sets of two eggs each, and the second and fourth of these nestings were successful. The interval between the loss of one set of eggs and the beginning of laying in a newly built nest was 9 days in the first instance and 7 or 8 in the second. In 1939, the interval between the departure from the nest of one brood and the laying of the next set of eggs was about 12 days. In 1949, the pair of sparrows in my garden brought forth a single fledgling on April 23 and 12 days later the female laid the first egg of her second set in a new nest, 20 feet distant from the first.

At this second nest of 1949 the eggs were left unattended after about a week of incubation, and the number of feathers strewn about the nest suggested that the female had

been surprised and captured by some predator while sitting. From mid-May until the following January the male lived about my house in a solitary state. All through the long wet months of the second half of the year, he sang almost every morning at day-break and at times later in the day. Although mated sparrows are somewhat tuneful during this period, the lone male seemed to sing more than they. In February, 1950, he vanished; and in the following two breeding seasons there was no nest close by my house, where for four years a pair had reared thier families.

#### SUMMARY

Black-striped Sparrows inhabit the Humid Tropical Zone and in favorable localities in Costa Rica extend up to nearly 6000 feet above sea level, but at this high altitude they appear to be migratory. They prefer low, dense vegetation interrupted by grassy openings and they are found in bushy pastures, recently abandoned croplands, weedy plantations, roadsides, and dooryards with abundant shrubbery. They live in pairs at all seasons, never flocking.

Much of their food is found while hopping over the ground; they never walk. Their diet includes insects, small frogs and lizards, berries and soft fruits, and seeds, including dry maize.

The male's song, a beautiful accelerated crescendo, is in El General delivered in every month, but it is given most freely from February to August. Apparently only the male sings; but upon coming together the members of a pair greet each other with a peculiar refrain, which they utter simultaneously.

In El General exceptional pairs begin to nest in January, but the greatest nesting activity occurs from February to July, with a few late nests in August or even October.

The nest, placed in low vegetation rarely more than three feet above the ground, is a roofed structure with a wide opening in the side. The effective building is all done by the female, who works chiefly in the early morning and at a leisurely rate. The male stays close by, often singing, sometimes bringing food to his mate, and on rare occasions carrying a bit of building material. The nest is completed after five, six, or seven days of work.

Costa Rican sets consist of two or very rarely three pure white eggs. The first is laid about sunrise and the second slightly later on the following day, making the interval between layings 25 or 26 hours.

Only the female incubates. Her sessions are usually long, ranging from half an hour to over two hours. One female sat for 75 per cent of 11 hours and another for 76 per cent of 12 hours of observation. At long intervals the male brings food to her in the nest. In approaching or leaving the nest she usually takes advantage of surrounding vegetation to screen her movements. The period of incubation is between 13 and 14 days.

The nestlings, hatched with sparse down, are brooded by the female and are fed by both parents. Rates of feeding averaged 1.8 times per hour per nestling for day-old young and 4.5 times per hour for older nestlings.

When 11 or 12 days old the young leave the nest, usually in the forenoon. From one nest both youngsters left spontaneously, without parental urging.

After leaving the nest, the young hide inconspicuously in dense vegetation until about four weeks old, when they are practically full grown. One was first seen feeding itself when it was about 40 days old, and another when it was 45 days. But the parents continue to feed the young until they are 46 days old, or even 63 days if no later brood is reared. Some parents try to chase the young from their territory when they are two or three months old, but in one instance a young sparrow lived amicably with its parents for over half a year.

Young recently out of the nest differ from the adults in their duller plumage, less prominent head stripes, and the conspicuous streaks on their breasts. They acquire adult plumage by a molt which is completed when they are about four months old.

On rare occasions the parents give a distraction display when their young seem to be in danger. One such display was effective in leading a dog from fledglings.

Two broods may be reared in a season. In two instances, the interval between the departure of the young of one brood and the resumption of laying was about 12 days. When eggs are lost, a new set may be begun from 7 to 9 days later.

## GENERAL SUMMARY OF INFORMATION ON THE FRINGILLIDAE

The finches are a huge, nearly cosmopolitan, fairly homogeneous family of small or middle-sized passeriform birds, containing, according to Mayr (1946:67) 426 species. Well represented in both tropical and temperate zones of the New World, a few species also breed in the Arctic, while others nest in vegetation above timberline on lofty mountains. Many finches are very plainly attired in browns and grays, but others are brilliant. So large a family naturally contains a great range of coloration, yet in brilliancy it can hardly compare with the related but far smaller family of the tanagers. Many extra-tropical species are highly migratory and some of these exhibit conspicuous seasonal changes in coloration. Tropical species, at least in America, are for the most part sedentary and wear the same colors throughout the year. In tropical America finches are most abundant in clearings and savannas, but a number of species dwell in the rain-forest.

The food of finches is notably rich in seeds and fruits, but it includes many insects also. The seedeaters (*Sporophila*) and grassquits (*Tiaris*, *Volatinia*) specialize on the small, green seeds of grasses; goldfinches (*Spinus*) are especially fond of the seeds of thistles and other Compositae. The crossbills (*Loxia*) have bills highly modified for extracting seeds from pine cones. The thick bills of grosbeaks are well adapted for crushing hard fruits and seeds; the Blue-black Grosbeak is fond of dry maize. Many species forage on the ground. Towhees, Fox Sparrows and Large-footed Sparrows scratch the dead leaves aside by kicking with their feet, but species of *Atlapetes* flick them away with side-swipes of the bill. Even these ground feeders progress by hopping rather than walking over the ground.

Voice is richly developed in this family, which in the tropics as well as in the temperate zones contains some of our best songsters. Peculiar dawn songs appear to be rare in the family; they are more frequent in families vocally less gifted. Possibly the Yellow-throated Atlapetes and the Yellow-thighed Sparrow, both weak singers, might be considered to deliver dawn songs. Special greeting songs or responsive songs, which serve in place of simpler call notes to keep the pair together, occur in tropical species which remain in pairs throughout the year; greeting songs occur in the Black-striped Sparrow and Yellow-thighed Sparrow and responsive songs in the Buff-throated Saltator. Such songs are delivered equally by the two sexes. Flight songs are given by the Streaked Saltator, Lark Bunting, several species of longspur (*Calcarius*), Misto Seed-finch, Indigo Bunting, and others. The little Blue-black Grassquit leaps several feet straight up from its low perch to deliver his song notes, falling back to the same position and repeating this again and again interminably. Although song is used chiefly to advertise possession of territory and hence is delivered in solitude, a number of finches sing socially in flocks, among them the Dickcissel, Yellow-faced Grassquit, goldfinches and siskins of a number of species, and the Misto Seed-finch (Hudson, 1920:68). Among finches, song is not often heard from the females, except as they sing greeting songs and responsive songs. Yet in the North American Cardinal, a fine songster, the songs of male and female are alike, and they sing in antiphonal fashion (Laskey, 1944:28). The female Orange-billed Sparrow delivers a tinkling song only slightly inferior to that of the male.

Nuptial feeding has been frequently recorded for this family. Lack (1940:177) gives numerous examples among finches of Europe, North America and the Galápagos Islands. In Central America, I have seen the male feed the female in the Buff-throated Saltator, Streaked Saltator, Variable Seedeater, Blue-black Grosbeak, and the Lesser Goldfinch (*Spinus psaltria*). The feeding was performed chiefly at the nest during incubation, but a Buff-throated Saltator fed his mate while she built. In American Goldfinches (*Spinus*



*tristis*) and related species of *Spinus* the male brings his incubating mate so much food that she needs to find little for herself and so incubates or broods almost continuously; but with most other finches the amount of food brought during incubation of itself seems negligible.

Polygamy is well developed in the Corn Bunting (Witherby *et al.*, 1938:111), and is occasional in the Song Sparrow (Nice, 1937:88), and White-crowned Sparrow (Blanchard, 1941:20). I have found no evidence of this among Central American finches. Gross (1952) observed an instance of polyandry in the Variable Seedeater.

The nest is placed in trees and bushes, or amid grass, or often on the ground, rarely in a hole or crevice among rocks (*Sicalis*, *Plectrophenax*, *Leucosticte*), or in a closed nest built by some larger bird (*Sicalis*). Typically the finch's nest is an open structure, usually well built, at times flimsy. Among Central American species, the Orange-billed Sparrow builds a well roofed nest on the ground in the forest, the Black-striped Sparrow a more or less covered nest in low herbage. *Tiaris* makes a closed nest with a narrow doorway in the side.

The nest is built most often by the female alone. As an exception in this family, the male Yellow-faced Grassquit may take the leading share, especially at the outset of building. The male Striped Brush-finch at times helps to build but is not consistent in this, and the same may be said of the male Rose-breasted Grosbeak (Ivor, 1944:94). According to Witherby *et al.* (1938:51-153), the male is credited with building only in the crossbills (*Loxia*), of which it is said that he takes a small part. An abnormal male Song Sparrow built a nest when he had no mate, and later when he was mated he helped the female to build (Schantz, 1937:189).

The eggs are quite variable in this family. They may be pure white, without markings (*Atlapetes*, *Arremonops*), but usually they are white, cream, gray, blue-gray or even bright blue (*Saltator*), more or less heavily marked with reddish-brown, brown, lilac, or black. The set nearly always consists of two eggs in the Central American species of *Saltator*, *Arremon*, *Arremonops*, *Sporophila*, *Cyanocompsa*, *Atlapetes torquatus* and *A. brunnei-nucha*; sets of three are exceptional in these groups. *Tiaris olivacea* lays two, three or exceptionally four eggs. Northern finches have far bigger clutches, five or six being a common number in the British Isles, while in the Arctic the Snow Bunting may exceptionally produce sets of eight.

Incubation is nearly always performed by the female alone. The Rose-breasted Grosbeak and the Black-headed Grosbeak, of which the males regularly share the work of incubation, singing while they sit, are quite exceptional in the family. Of the Linnet, Serin, British Bullfinch, and a few other species inhabiting the British Isles, it is stated in the *Handbook of British Birds* that the male "sits for short periods" or "takes a small part" in incubation; but one wonders how regularly such behavior occurs. The rhythm of incubation is variable in the family, and even in a single species. The large saltators are on the whole surprisingly impatient sitters, rarely remaining on the eggs for as long as an hour at a stretch, and seldom more than half an hour. Species I have studied in which the sessions averaged over an hour in length were the Blue-black Grosbeak, Orange-billed Sparrow, and Red-eyed Towhee; and one Variable Seedeater out of four watched on the nest had an average session of 74 minutes, although the averages of the other three ranged from 15 to 25 minutes. The species studied kept their eggs covered from 60 to 80 per cent of the daylight hours, except in the case of an Americal Goldfinch, which was fed so liberally by her mate that she sat 95 per cent of the time, and an unusual Blue-black Grosbeak who also sat for 95 per cent of the time.

Incubation periods of finches range from 10 to 15 days. The short periods of 10 and 11 days are chiefly for the genus *Carduelis*, as recorded in the *Handbook of British Birds*.

Aside from these, the periods for both north temperate and Central American finches fall largely between 12 and 14 days. The Striped Brush-finch with its long period of 15 days is exceptional.

The nestlings of finches typically bear sparse natal down and have tightly closed eyes. The Yellow-faced Grassquit is exceptional in its completely naked, downless state at birth. The interior of the mouth is usually red, regularly so in the species I have studied. The nestlings are brooded by the female alone, except in the Rose-breasted Grosbeak and probably other species of which the male is reported to incubate. Nearly always both parents feed the nestlings, although the polygamous Corn Bunting is said to do so rarely. Food is usually brought in the bill or mouth, but it is regurgitated by numerous genera, including *Tiaris*, *Sporophila*, *Spinus*, *Carduelis*, *Chloris*, *Pyrrhula*, *Carpodacus* and *Loxia*. Many finches feign injury when eggs or young appear to be in danger; but the habit is far from universal in the family and is distinctly rare among the Central American members.

The nestling period is difficult to determine with exactness because of the ease with which young finches, especially of the ground-nesting species, are frightened from the nest. For the majority of finches it lies between 9 and 15 days. The shortest nestling periods are of species that nest on or near the ground, whose young often leave before they can fly. Exceptionally long periods of from 17 to 24 days are recorded for the crossbills.

Helpers at the nest have rarely been recorded in this family. Brackbill (1944:50) watched a young Cardinal, which he estimated to be about 2½ months old, help the parents feed nestlings. A semi-captive Rose-breasted Grosbeak fed nestlings in a neighboring nest when the male parent neglected them (Ivor, 1944:99). A male Oregon Junco fed nestlings of the Bewick Wren while his mate incubated on the other side of the same garage (Williams, 1942:245-246). A female Towhee fed fledgling Mockingbirds in Florida (Westwood, 1946:399).

In many species of non-migratory finches in tropical America, the young of both sexes acquire a plumage nearly or quite like that of nesting adults when they are a few months old. But the males of some species of *Sporophila* and *Sicalis* (Cherrie, 1916: 188, 194), as in the Purple Finch in the north, may breed in a transitional plumage.

## FAMILY THRAUPIDAE

### SCARLET-RUMPED BLACK TANAGER

#### *Ramphocelus passerinii*

##### CHARACTERISTICS AND HABITAT

Everywhere velvety black, except a patch of the most intense scarlet covering his rump, lower back and upper tail-coverts, the male Scarlet-rumped Black Tanager or Song Tanager is one of the most strikingly colored birds in a family renowned for brilliance and variety of color. As he rests on some high, exposed perch, apparently oblivious that he is a shining mark for birds of prey, the bright scarlet of his rump catches the eye even at a distance of a hundred yards (see frontispiece). The female, as in other species of *Ramphocelus*, is far more soberly clad. Her head and neck are brownish, her back olive with a greenish tinge. The color of her rump varies, apparently as a matter of age, from dull yellowish to a fairly bright orange. A corresponding variation is found in the color of her chest, which as a rule matches the rump, being orange on those individuals which have an orange rump, yellowish on those which have a pale yellow rump. Her lower breast and belly are dull yellowish-olive, her wings and tail a nondescript shade of brown. In both sexes the thick bill is light blue with a black tip, and the eyes are red, brighter in the male. The male's feet are blackish, the female's plumbeous.

The Song Tanager of the race *Ramphocelus passerinii costaricensis* is confined to the Pacific side of Costa Rica, from Puntarenas southward, and adjacent parts of the Republic of Panamá. It breeds from sea level up to at least 4000 feet, and it appears to be strictly resident wherever found. In this region heavy rainfall, high forests and generally lush vegetation create an environment which more closely resembles that of the Caribbean lowlands of Central America than that of the more northerly portions of the Pacific side. The form *costaricensis* was described as a distinct species by Cherrie in 1891, but in accordance with more modern taxonomic concepts has been reduced to the status of a subspecies of *Ramphocelus passerinii*. It is an obvious product of geographic isolation, for the ranges of the scarlet and black tanagers inhabiting the opposite coasts of southern Central America are separated by the lofty Cordillera, even the passes in which are above the altitudinal limit of this heat-loving species.

Although closely related forms of birds are nearly always more readily distinguished by the males than by the females, the situation with *Ramphocelus passerinii* is just the reverse. The scarlet and black males of the two subspecies, *costaricensis* and *R. p. passerinii*, are far too similar in appearance to be distinguished in the field; young males and females are also rather similar. But the more richly colored females of *costaricensis*, with their bright orange chests and rumps, may be distinguished at a glance from their counterparts of the Caribbean coast, which have no color of corresponding brightness in their more uniformly olive and buff plumage. The phenomenon of greater geographic variation on the female than on the male side has been called heterogynism. It occurs, according to Mayr (1942: 50) "most often in species in which the male is black or otherwise very intensely colored, whereas the female is brownish or grayish. The obvious explanation for this phenomenon is that the male has reached an intensity of pigmentation which is far above the threshold at which pigment formation is influenced, while the females in their less intense coloration are in a sensitive zone." This explanation seems entirely applicable to the situation found in *Ramphocelus passerinii*.

I have been able to detect no important differences between the habits of the scarlet and black tanagers inhabiting the opposite sides of the continent, with a single outstanding exception. *R. p. costaricensis* is in my experience a far more songful bird than *R. p. passerinii* as I have known this race at various points along the Caribbean side of Central America. The tanagers are a family not particularly gifted in voice; some of the most brilliant species possess no utterance worthy of the name of song; and others which are capable of musical expression use their voices all too seldom. Not only is *costaricensis* far more musical than *passerinii*, but it produces a greater volume of song



Fig. 20. A new clearing in the lowland forest at San Pedro in the valley of the Río Grande de Térraba, Costa Rica, adjoining the region known as El General. Lofty forest of this type, its dominant trees 125 feet or more in height, once covered much of the valley of El General.

than any other Central American tanager that I know. Hence I believe that this bird may fittingly be called the Song Tanager. It is of interest that while the females of the two races of *R. passerinii* differ most obviously in coloration, the males differ in songfulness.

The Song Tanager, like other species of *Ramphocelus*, is a denizen of secondary vegetation rather than the heavy forest. Its favorite haunts are bushy pastures, plantations of all sorts, roadside and riverside thickets, and abandoned grain fields grown up with an impenetrable tangle of young trees, bushes and vines. It may penetrate the more open edges of the forest in search of food, but it never ventures far into their gloomy undergrowth. In the Térraba Valley of southern Costa Rica this is one of the most abundant and conspicuous of the birds of the cleared lands, being no less common here than its related race in the Caribbean lowlands of Central America.

Sociable by nature, Song Tanagers travel in straggling flocks so loose and ill-defined that it is difficult to determine the number of individuals which compose them. Often between six and a dozen birds are found together. Even at seasons when all the males are in adult plumage, they are outnumbered by the females, in the ratio of about three to two, or even two to one.

Even during the breeding season these tanagers are gregarious, recognizing no indi-

vidual nesting territories. Nests are, indeed, rather widely scattered instead of being aggregated into crowded colonies like those of many species of the Icteridae, yet at times two or three are built close together. Song Tanagers are most peaceable birds, never fighting among themselves, whether over breeding territories or other matters. Sometimes an excited chattering has drawn my attention to a group of these tanagers in time to see one individual, usually a male, dash at another; but the momentary flare-up was always ended before I could discover what it was about; and there was little if any physical contact between the disputants. Even in the females' occasional quarrels over nests and nest sites, there is no actual fighting, the rivals limiting themselves to posturing with open bills.

At my feeding shelf as many as eight Song Tanagers of both sexes sometimes crowd upon a board only fifteen inches square while others await their turns among the surrounding branches. Yet I have never in the course of three years seen any real quarrelling here, nor have I found any evidence that one individual dominates another. Sometimes, when one bird while feasting upon bananas feels itself too closely crowded by another, it will lower its head and open its bill, pointing this toward the too eager neighbor. The bird so threatened may either withdraw to a more respectful distance or may assume a similar posture, whereupon the two glare at each other across the banana for a few seconds. But the disputes never go beyond this point. Nor have I ever witnessed any fighting between the Song Tanagers and the other birds of a score of species, some larger and others far smaller than themselves, which at one time or another have shared the board with them. The birds on the board eat bananas in about the same relative proximity as men at a crowded banquet table, and as a rule they manifest annoyance only when one, figuratively speaking, pokes its elbow into its neighbor's ribs.

The Song Tanagers are at all times shy, nervous, excitable birds. Although they forage and often build their nests close beside the dwellings of men, they show little confidence in mankind, and doubtless with good reason. Usually the females fly from their nests if they see a man still a long way off; and I have known one to abandon her nest permanently because I had set up a blind at a distance at which few other small birds, even of shy forest-dwelling species, would have been upset by its presence. Happily I have noticed a marked diminution in the shyness of those Song Tanagers that nest in my yard in the four years in which I have fed and protected them here.

Often a number of Song Tanagers will gather in an excited knot in some bush or tree, flying uneasily from branch to branch and reiterating their nasal complaints. On several occasions that have come to my attention, the cause of their commotion was nothing more formidable than a big, brown or gray moth, with wet bedraggled wings and apparently in a moribund condition, clinging feebly among the foliage. Each ineffectual flutter of the harmless insect would cause renewed spasms of excitement among the assembled Song Tanagers. Often their cries had drawn a number of small birds of other species—hummingbirds, flycatchers, wrens, finches—as interested onlookers. After a while the birds would drift away. But now and again a Song Tanager would pass by, notice the moth, and raise a loud outcry which drew other birds about it once more. Of all those gathered about the moth, these tanagers were by far the noisiest. Frequently I have heard the Song Tanagers about my house complaining in the manner described and gone out to investigate, without being able to discover any cause of their uneasiness. Once, however, when a knot of these birds were calling excitedly in the hedge at the rear of the yard, careful scrutiny of the close-set branches disclosed a seven-foot mica (*Spilotes pullatus*), a non-venomous snake which preys on birds' nests.

One morning, when a female Great Antshrike passed through the yard, flitting inconspicuously from bush to bush, it was followed by a noisy crowd of excited Song

Tanagers. One tanager that I was watching left her nest to join in the pursuit. The visiting antbird was, so far as known, perfectly harmless, but she was the first of the kind that I saw in the vicinity of the house and doubtless she also was the first of her kind that these Song Tanagers had seen. Their excitement probably arose merely from the strangeness of this bird which is not much larger than themselves.

#### FOOD

The food of the Song Tanagers is diversified, including a wide variety of both fruits and insects. They are very fond of ripe bananas and plantains. At my feeding table, the number of bananas they consume in a day seems to vary inversely with the abundance of ripe berries in the surrounding thickets. Chief among these wild fruits are the small, sweetish, black or deep blue berries of a number of species of the melastome family. The little white berries of the scrambling shrub *Tournefortia bicolor* are also eaten by them in season; and they enjoy the fruits of the spiny pejivalle palm (*Guilielmia utilis*). During the nearly rainless early months of the year, when succulent fruits are not abundant, the Song Tanagers eat the dry green fruits of the Cecropia and are among the birds responsible for scattering this rapidly growing tree far and wide over the countryside. Their animal food includes a variety of insects, caterpillars and spiders, which they find in the foliage. They not infrequently hunt upon the ground in grassy places, capturing small grasshoppers. On wet afternoons when the winged termites fill the air, the Song Tanagers demonstrate considerable skill in capturing these slow-flying insects on the wing. Once, in an opening made by lumbering operations just within the edge of the forest, I found a number of Song Tanagers which, together with wintering Russet-backed Thrushes, had gathered around a swarm of army ants, apparently more interested in the small invertebrate fugitives from the army than in the ants themselves.

At my house we make a practice of throwing out empty egg-shells for the hens because other sources of lime are difficult to procure in this region devoid of calcareous rocks. The female Song Tanagers drop down to the ground and eagerly devour the empty shells of the domestic hen, just as they eat the empty shells of their own eggs. One afternoon when I cleaned out a box of old papers, two naked recently born mice fell out on the ground. After I went away, a female Song Tanager flew down, took a mouse in her bill, bruised it as much as she could, and then carried it to her nest near by and gave it to a nestling. The young tanager found difficulty in gulping down this piece of food that was almost as big as itself, but it finally was successful.

#### ROOSTING

As a roosting place, the Song Tanagers prefer low, dense vegetation rather than the thorny orange trees so attractive to many other species of the family; yet occasionally they will roost in an orange tree. For several years a number of Song Tanagers roosted nightly in the high, thick hedge of *Stachytarpheta Frantzii* at the back of my yard. The manner in which they straggled into the hedge before sunset, coming from both sides, then sometimes flying out again before they finally settled down, made it impossible to count the number that slept here, but there were at least a dozen. After entering the hedge, they would often move for considerable distances along its length, hopping through the close-set branches at the center, where they were difficult to see. Once inside the hedge they were silent, and long before it was dark they would remain motionless in the places they would occupy during the night. But often a few late-comers would hurry into the hedge as the light grew dim. Other Song Tanagers roosted in the dense wall of bushes and vines at the edge of the neighboring forest, beside the open pasture.

## DISEASE

Song Tanagers are apparently not infrequently afflicted by a strange malady of a kind I have seen in no other species of bird. The chief external symptom of this disorder is a sort of paralysis, sometimes complete. In the afternoon of May 22, 1937, I came upon a full grown young bird afflicted by this disorder. Whenever it tried to fly, it rose up steeply into the air and then slipped backward, usually coming down on the ground again at a point behind that from which it had risen. Finally, in attempting to escape me, it fell into the center of a shallow brook, although the water was well behind it when it started to flee in the opposite direction. I rescued the bird and found that it would not perch and would not take the food I offered it. After a while, hearing others of its kind in the yard, it began to call loudly and to plead for food in the usual whining voice of the fledgling Song Tanager. After the worst of the afternoon rain was over, I placed the sick bird among the bushes at the edge of the yard. Since it could not perch, it rested upon the ground. But its loud cries brought a female Song Tanager who was apparently its mother; she was followed by a second young bird as big as herself. The mother fed her sick youngster and a second female Song Tanager did so at least once. I believe that the latter was the mother of fledglings which that same day had left their nest in a lemon tree on the opposite side of the cabin; passing with food for her own offspring, she was deflected from her course by the loud cries of the sick one and moved to give it the food she carried in her bill. Later she came a second time toward the sick bird with food but eventually passed by in the direction of her own fledglings. The diseased tanager vanished in the night.

On the afternoon of June 11, 1942, while crossing the pasture in front of my house, I came within an inch of stepping on a female Song Tanager. She had been lying in the grass, and she fluttered aside just in time to avoid being crushed. She could not fly and was easily captured—an adult in fine plumage, with a bright orange breast. Although I could detect no external lesion, she could neither fly nor make coordinated movements of her wings, but only flutter in a helpless fashion. She held her tail turned always a little to one side and seemed to be partially paralyzed. Yet she caught my thumb in her bill and gripped it so tightly that I was obliged to insert a twig between her mandibles and pry them apart in order to effect my release. Taking her into the house, I placed her in a box, but next morning I found her dead.

A third Song Tanager afflicted in much the same fashion was a fledgling that in attempting to leave the nest had fallen beneath it.

## VOICE

A nasal *ac* or *wac* is certainly the most common call note of this species. This monosyllable is uttered by birds of both sexes as they go about their routine activities, such as foraging and nest building. Another call note, not so often used, is a sharp, dry *pzzt*; this is uttered on taking flight, and is used by both sexes for calling the absent mate. *Pzzt weet* seems to be a variant of this call. A queer utterance is *zzt not churry not churry*, delivered sharply and rapidly. It is used when two Song Tanagers come together, whether they be male and female or two females, and appears to be an expression of excitement. I heard a variant of this phrase used while two females contested the possession of the same nest. A sharp *whip* is delivered when the bird is alarmed or uneasy; it was given, for example, by a male tanager who feared to approach the food table while I stood too near, and it is used when the nest appears to be in danger. These are the principal non-musical utterances of the Song Tanagers in the valley of El General; each is subject to modulations which may express varying intensities of feeling, or possibly even convey distinct information.

Among Song Tanagers, song appears to be strictly confined to the males; at least, I have never heard a female sing, even in an undertone, as the females of so many kinds of song birds do. Song Tanagers are methodical rather than brilliant musicians. Their song has small range and lacks variety; it consists of the tireless repetition of a simple phrase of three or four notes. There is, however, considerable variation in the songs of different individuals, both in tone and phrasing. Some have rich, full voices; others sing in far slighter and weaker tones; an occasional individual sings with a nasal twang. At times the song of the Song Tanager bears a surprising and even confusing resemblance to that of the Yellow-green Vireo. One male sang *viree-viree-vireo-viree-vireo* . . . and so on, for many minutes without interruption, as tirelessly as any vireo. The disyllabic phrases were separated by brief but perceptible pauses, just as in the vireo's song. The tone, too, may bear a confusing resemblance to that of the vireo, but as a rule it is deeper and more powerful.

Song Tanagers sing chiefly at dawn and early in the morning, and in cloudy weather later in the day. Because during the early part of their nesting season, at least, mornings are likely to be brilliantly sunny while afternoons are usually cloudy, if not rainy, the birds perform more often in the afternoon than through most of the morning after sunrise. At dawn they often sing from a low perch close by their roost, but in full daylight they more often choose a fairly high and exposed one—the top of a bush or low tree, yet rarely if ever in the higher tree tops. While singing they often raise and spread the scarlet feathers of their rump, making themselves, if possible, even more conspicuous to the eye than they ordinarily are. They appear entirely to disregard the possibility of an attack by a hawk; but I have never seen one come to grief from this seeming lack of caution. I have never been able to discover any definite spatial relation between the perch chosen by the male for singing and the nest of his mate.

Although in 1944 I heard a Song Tanager sing very briefly on January 29, I have never found these birds singing with frequency before late February or, in most years, early or even late March. They begin to sing earlier when the dry season, which normally covers the first two or three months of the year, is short and relieved by occasional afternoon rains, than when it is long and severe. The first refreshing shower at the end of a pronounced dry season seems often to stimulate the Song Tanagers' earliest essay of song. In 1939, when I lived below San Isidro del General in the rain-shadow of the coastal range which separates the basin of El General from the Pacific, the first three months of the year were practically rainless. On March 28, the sky was heavily overcast at sunset and a few ineffectual droplets fell, presaging the beginning of the rains. The following day I recorded in my journal that Song Tanagers "have begun to sing within the past few days, and now tirelessly repeat their simple little phrase at dawn." The following year, when I again dwelt under the rain-shadow of the coastal range, but higher up the valley, I heard the first song on March 15 after the passing of the afternoon shower which broke the long drought. In 1943, a relatively wet year, I first heard the tanagers on my farm sing at daybreak on February 19, then not again until the twenty-first, when they sang several times in the course of the day. The year 1944 was somewhat drier, but there were a few showers in February and a hard one on the afternoon of the twenty-fifth; I recorded the first song on March 3, not counting the unseasonal and isolated song that I heard on January 29. The following year, 1945, was devastatingly dry in El General, the drought not coming to an end, even on the seaward-facing slopes on the northern side of the valley where my farm is situated, until late in March. I heard the first song of the Song Tanager on March 9, a week before the first light drizzle that broke the drought, but eighteen days later than the first song heard in the same spot in the far wetter year 1943.



Once they have broken their long silence of six or seven months, the Song Tanagers become rapidly more tuneful. A week after their first isolated songs are heard they are in full chorus. Soon they produce more melody about my house in southern Costa Rica than any other bird. Their period of song here is long, covering nearly half the year. Thus in 1944 the tanagers began to sing early in March and continued until about the middle of August, after which they were not heard, although later in the month one was found singing freely in another part of the valley. In this locality the majority of the males stop singing about the end of July or in early August, although an exceptional individual may sing heartily during the second half of the month.

In 1944, and to a less extent in 1945, I devoted considerable attention to the singing at daybreak of the Song Tanagers that roosted in the dense *Stachytarpheta* hedge along the western side of my yard. At least four males slept in the hedge, or possibly one of them roosted amid the dense vegetation at the edge of the forest adjoining the hedge at its southern end. At dawn all four sang in positions close to the hedge where they roosted. One, bird A, usually but not invariably was the first to break silence; he took a position on the rail of a pen that enclosed and protected a small tree close beside the hedge. Later he changed his station to the topmost of the three gate bars which interrupted the hedge. For a while in April he roosted in the big orange tree north of the gate instead of in the hedge to the south of it, as formerly, but still he sang from the gate bar. At the beginning of the season, B sang from a fallen log beneath the hedge. Later, after A shifted to the gate bar, B took over the former's station on the pen that enclosed the tree. C and D sang on brush piles just outside the hedge at the southeast and southwest corners, respectively. All four of these birds habitually performed from perches not over five feet above the ground; but at times C would mount to the branches of a Spanish plum tree that rose above the brush pile where he usually sang and continue to sing here at a height of about twenty-five feet. After A abandoned the tree pen, where he was close to B, in favor of the gate bar, each singing male tanager was a hundred feet or more from his nearest neighbor.

These singing posts were obviously selected because of their nearness to the roost of the Song Tanagers. They bore no relation to the nests, which with a single exception were situated in other parts of the yard or in the surrounding pastures, and they were almost never used for singing later in the day. With nearly all song birds, as is well known, the singing perches are situated in the nesting territory; but the Song Tanager has lost, if it ever had, the territorial habit. Yet this choice of definite positions for singing seemed to be the manifestation of a vestige of the territorial instinct. The four singing posts were well separated, and there was at least a slight tendency to defend them from the intrusion of other male Song Tanagers. On rare occasions I saw one male chase another in the vicinity of a singing post; but such manifestations of enmity were of the most transitory sort and were over in a trice, without ever a resort to force. The attachment to these singing perches was strong, and two birds at least, A and C, continued until mid-July to come at dawn to the stations they had chosen for singing in March. Although I have known other birds, as Melodious Blackbirds and wintering Orchard Orioles, to sing in their roosts before falling asleep in the evening and again upon awaking at dawn, I am not aware of any other species that selects and maintains as individual property, singing posts related spatially to the roost but bearing no relation to the nest site.

At the height of the nesting season in March, April and May, the Song Tanagers began to sing in the earliest dawn, while it was yet so dark that they could scarcely be seen. If there was a moon, they might even awake and raise their voices by full moonlight, but never before the first brightening in the east. A was usually, but by no means

invariably, the first to begin; it was easy to distinguish his weak but pleasant voice from from the fuller tones of his neighbors. As a rule, the birds would start singing in the hedge where they had roosted, and after one or several minutes emerge and go to their regular posts. Sometimes they would pause and sing a few verses in some intermediate exposed position, as on a spray at the top of the hedge, or in one of the madre de cacao trees that grew above it, before proceeding to their regular places. Although early to begin, theirs were by no means the first voices in the dawn chorus, as the following schedule, made on March 21, 1944, will prove. The dawn was clear, with the last thin sliver of the waning moon in the eastern sky.

3:45 a.m. Black-striped Sparrow sings out once in the darkness.

4:44 The Black-striped Sparrow sings repeatedly.

4:49 Neotropical Kingbird begins his twittering dawn-song.

4:54 Gray-capped Flycatcher begins his harsh dawn-song.

4:55 Gray's Thrush begins to sing.

4:56 Striped Atlapetes begins to sing.

4:57 Chisacheery Flycatcher begins dawn-song. Blue-diademed Motmot heard.

4:58 Song Tanager C begins to sing. Less than one minute later, A begins in hedge.

5:03 A first seen at top of hedge. B begins to sing in hedge.

5:04 A goes to the gate bar.

5:06 B has come out to the tree pen.

5:12 All Song Tanagers have become silent.

5:17 C resumes his song on the brush pile, for no more than a minute.

Thereafter the Song Tanagers sang a little in other places but not at their singing post of the dawn period.

The duration of the tanagers' dawn-song varied greatly from morning to morning. Sometimes they would continue with fair constancy for half an hour or more; often they would stop after only ten or fifteen minutes. At times one would interrupt his singing for a few minutes, then resume it on his usual perch. While the males sang, the females, except those who were on their nests, would linger quietly in the neighboring hedge where they slept. After the light increased, they might be seen hopping about among the branches of the hedge bushes. At times a male, after ending his song, would rejoin the females in the hedge. Only after the light had become strong would the tanagers come out of the hedge, one or a few at a time, and begin their search for breakfast, visiting the feeding table nearby, or flying, males and females together, down to the creek in front of the house.

One morning in March, as the female tanagers were becoming active, one emerged from the hedge and alighted on a wire of the tree pen beside A, who had been singing there. She bent far forward, tilting her tail strongly upward. A promptly mounted her back, but apparently did not attempt coition. After an instant he dismounted to perch beside her again. Here he raised his wing on the side toward her, his left, high above his back, and held it so for a few seconds. Then both flew away. This was the only time I ever saw a male Song Tanager posture with raised wing in this fashion. A few mornings later, a female upon leaving the hedge again alighted on the wire of the pen and postured with raised tail in the same location and in the same fashion as before. Although a male was close by, he did not respond, and soon she flew off.

In March, 1945, four male Song Tanagers began to sing in very much the same positions they had occupied the preceding year. Because they were not marked, it is not possible to be certain that they were the same individuals, but I consider it highly probable that they were. The evidence in favor of this view is especially strong in the case of A, who could be distinguished by his familiar weak song, which as during the preceding year was nearly always heard before the richer voices of his neighbors. As in the

earlier year, he at first sang from the tree pen, but after a few days was displaced from this by another, B, I believe, and thenceforth chose the gate as his regular position. Because the wooden bars had in the interval been replaced by a wire gate which provided no comfortable perch, he now rested atop the post beside the gate.

In the evening before retiring, if the weather was favorable, the Song Tanagers might sing a good deal from trees scattered about the yard before flying into the hedge, but they almost never used at this time the perches from which they sang at dawn. One evening in 1944, however, A sang for a few minutes from the topmost gate bar. Thence he went to a branch of a madre de cacao tree just above the hedge and sang a good while there. Then he disappeared into the hedge and delivered a few songs more before becoming silent for the night. Thus as he retired he sang from the positions he frequently used at dawn, but in reverse order. This was an unusual occurrence.

#### NEST BUILDING

Among temperate-zone birds, the male may begin to sing weeks or even months before the female starts to build the nest. In migratory species, the male often arrives first and sings even before the females appear. But among the nonmigratory birds of the tropics, especially in those species whose song is limited to the breeding season rather than practiced throughout the year, the season's earliest songs are heard at about the same time that the first nests are begun. Sometimes, indeed, I have found the earliest nest well advanced before I heard the first song of the same species. This has been true in my experience with the Gray-capped Flycatcher, Chipsachery Flycatcher, and the Oleaginous Pipromorpha.

In 1943, when the Song Tanagers were not in full song until February 26, a nest well advanced in construction was found on the same date. In 1944, when the first song was recorded on March 3 and song was infrequent before March 6, I found a female building on March 6, and another on March 10. In 1945, when singing was first heard on March 9, the first female was found building on March 15. In 1946, I heard the Song Tanagers' earliest song on February 17, when rain was threatening, and on February 22 I found a newly begun nest. It is of interest that in both 1944 and 1945 the earliest nest found in the vicinity of my house was in the same sour orange tree in the yard. Without much doubt, it was the same female who led off the building in both years.

From what has already been said with reference to the effect of weather on the beginning of singing, it will be clear that nest building begins earlier in wet than in very dry years. Just as the male Song Tanager may, very rarely, sing a few isolated notes well in advance of the general beginning of song, so the females may toy with nest material long before they begin to build. I have only one definite record of this. Early on the morning of January 15, 1944, I saw, in the calabash tree in front of the dining room, a female Song Tanager with a bright orange breast who held some fibrous material in her bill. Soon she dropped this, then pulled some material from an old nest of a seedeater nearby, dropped this too, and flew away. Nearly two months later, a few days after the earliest nest building was detected, I saw two female tanagers perch not far apart in this same tree. One plucked a curled dead leaf and offered it to the other, who seized it and threw it from her, seemingly without interest in it.

Even the male Song Tanager, who never, so far as I know, helps build the nest, may on rare occasions hold material in his bill. On August 6, 1944, as the nesting season was coming to an end, a male rested in a tree in front of the house with a long fiber in his bill. He sang two notes, then flew away with the fiber. On May 26 of the following year, a male plucked a dry inflorescence from a burío (*Heliocarpus*) tree close beside a female (his mate?) that was building. After holding it in his bill for a few minutes, he let it fall.

The female Song Tanager apparently chooses the nest site without the assistance of the male. The site is usually at no great height in a bush or small tree. The plant that supports the nest may grow in a weedy field, or in a more open part of a low dense thicket, or it may stand in the midst of a clean pasture or well tended lawn. Some nests are placed in very exposed positions, while others are so well concealed in the midst of the dense foliage of a thorny orange tree that it is almost impossible to reach them and learn what they contain. Cordoncillo (*Piper*) bushes, and small guava trees, although they afford small concealment, are often chosen as the nest site, doubtless only because they are so common in the haunts of the Song Tanager. At times nests are supported among sugar-canes or other coarse grasses and in tangles of tall bracken ferns.

The extreme range in height above the ground of the 105 nests for which I have recorded this information was from 14 inches to approximately 20 feet. Sixty-six of these nests, or well over one half, were from 4 to 12 feet above the ground, leaving only 18 that were placed at heights of less than 4 feet, and 21 above 12 feet. The nests more than 12 feet above the ground were nearly all built in trees with particularly dense foliage, chiefly orange trees, but also in copalchi (*Croton glabellus*) and in a variety of calabash (*Crescentia cujete*) with a very compact crown. The highest nests were all far better concealed than the average of the nests at lower elevations; if the bird chose a particularly lofty site, she did so because it offered her unusual opportunities for hiding her nest. The guava, one of the abundant trees in the habitat of the Song Tanager, affords poor concealment; and it is significant that although I have found a number of nests in young guavas, I have never seen a high nest in a guava tree. Only 4 nests were less than 2 feet from the ground. One of these low nests was built at a height of 14 inches among weeds in a gully; another was at the same height among the densely clustered sprouts springing from the stump of a guava tree, where it was excellently concealed; the third was 20 inches up in a tussock of Guinea grass (*Panicum maximum*) in a pasture; the fourth, 19 inches up, was in a rather exposed position among weeds beside a creek, and it soon came to grief.

Although nonterritorial, the Song Tanager does not breed in crowded colonies. On the contrary, its nests are as a rule scattered rather widely through suitable areas. Yet at times two or even three nests are placed close together. In 1936, I found two nests with eggs that were only 10 feet apart. On May 1, 1939, I again discovered 2 nests 10 feet apart; each contained 2 eggs and incubation was in progress. A week later I found 2 nests 12 feet apart, each with 2 eggs, and both situated in tussocks of coarse Guinea grass in a pasture. In March, 1944, two females were discovered carrying material and adding it to the same nest, well hidden in the crown of a big orange tree. Soon one of them began another nest only a little over a yard away from the first; but then the two tanagers stole material from each other, with the result that neither bird was able to complete her structure. Later in the year, two females built three feet apart in the dense foliage in the top of the calabash tree in front of the dining room. One of these nests held two eggs on April 18, but the following day it was empty. The second nest received its first egg on April 20, but the next day it also was empty. Again the following year, two female Song Tanagers built at the same time in the top of this same tree, where the dense foliage made it difficult to follow their activities. Their nests were now only two feet apart. One of these tanagers laid her first egg on April 17 and her second on April 18, but by April 22 both had vanished. The other bird laid her first egg on April 21, but by the following dawn her nest was empty like her neighbor's. I do not believe that these tanagers were responsible for the disappearance of each other's eggs; more likely a toucan or a snake pillaged both nests. In May of the same year, one tanager built and began to incubate in this calabash tree while another pair fed nestlings close by. At about

the same time, two female tanagers successfully hatched their eggs and fledged their young, the first a week earlier than the second, in nests situated six feet apart in a mandarin tree. In April, 1946, one Song Tanager built her nest a bare four inches away from another in which the owner was incubating two eggs; this was in a small orange tree in my yard.

The female Song Tanager builds the nest without help from the male. Her nest is composed of a diversity of materials, not all to be found in one place, and she must often fly far afield to gather them. Perhaps an epiphyte-covered tree beside the river will provide sprays of a slender creeping polypody fern and fibrous rootlets for the foundation; or she may pluck long, shiny, black fungal filaments from a decaying trunk or branch at the edge of the forest. For the thick middle layer of her open cup, she requires many broad strips of monocotyledonous leaves, which she may tear from the dry foliage of the banana plants in a neighboring plantation or from the great-leafed wild plantains (*Heliconia*) and shell-flowers (*Calathea*) about the plantation's edge; or coarse grasses in a nearby pasture may supply what she needs. For the lining she again seeks fine fibrous material, either slender rootlets or more fungal strands. One year we had in the yard a plot of bare ground from which pineapple plants had recently been removed. Many of their fine wiry rootlets had been left in the earth and were a boon to the Song Tanagers building in the neighboring trees. At times four would be on the bare ground together, all laboriously pulling up the pineapple roots.

A female Song Tanager which I watched build on April 18, 1936, brought material to her nest 30 times in the 1½ hours between 6:38 and 8:08 a.m. Another came to her nest 11 times in the 35 minutes between 9:10 and 9:45 on March 14, 1944, but after this she remained away so long that I grew tired of waiting for her return. The Song Tanagers by no means restrict their building activity to the cool of the morning, for one female worked steadily in the hot sunshine between 1 and 2 o'clock in the afternoon. One of her neighbors was also working and pilfered material from her nest while she was away. Although I have made few systematic records of the rate at which Song Tanagers bring material to their nests, I have so often watched them build, either while sitting in a blind before the nest of some other bird, or through the dining room window as I ate breakfast or lunch, that I feel quite certain that the male normally takes no part in the work.

Yet the male tanager is by no means neglectful of his building mate. He follows her as she flies off in search of material and escorts her as she returns to the nest with laden bill. While she sits in the growing structure, shaping it with vigorous movements of her entire body, he perches in some neighboring bush, voicing from time to time his squeaky notes, or perhaps singing. But he shows no jealousy when other Song Tanagers come close, whether of his own or the other sex. One female, who in 1937 built in an orange tree just outside my window, received very slight attention from a male. Later she fed her nestlings with almost no assistance from a mate. I believe that she was not regularly mated.

In 1946 I was stimulated to renew observations on nest building by the discovery of a female Song Tanager constructing her nest only four inches away from another in which two eggs were being incubated. She worked industriously, visiting her nest 87 times in the first six hours of the morning. On most if not all of these visits she brought material, chiefly strips or fragments of dead leaves, some very large. Once she clung to the trunk of a nearby cashew tree where the horses rubbed themselves, evidently pulling from the bark lengths of horse hair which she took to the nest. When she came with nothing that I could see in her bill, she probably brought similarly fine material. Her visits to the nest were distributed as follows: 5:45-6:00, 1 time; 6:00-7:00, 19 times;

7:00-8:00, 11; 8:00-9:00, 15; 9:00-10:00, 24; 10:00-11:00, 14; 11:00-11:45, 3; totals, 5:45-11:45, 87 times.

As already mentioned, on March 14, 1944, I found two female Song Tanagers building a single nest. This was situated about twenty feet above the ground in an orange tree, amid clustering foliage that made watching difficult. I repeatedly saw one of the birds come with fibrous material or leaves in her bill while the other sat in the nest shaping it. The newcomer would remain perching or clinging close beside the nest until the first departed. Then she in turn would place her billful on the structure and sit in it to give it shape. During two hours of watching, while both worked actively, I saw no actual fighting between these two builders. But sometimes they would remain motionless for a minute or two, close together and facing each other, one on the nest and the other beside it, in what appeared to be tense, angry attitudes.

Sometimes one of the building birds would go beneath the nest, grasp the dangling end of a fiber in her bill and pull it free. If the fiber proved refractory, she would tug vigorously, sometimes even closing her wings and hanging from it with all her weight, reminding me of a Montezuma Oropéndola stealing fibers from a neighbor's nest. But after the tanager had torn away the loose strand, she went to sit in the incipient nest with it and wrapped it carefully around one of the supporting twigs. This tearing away of dangling ends made it clear why the Song Tanager's nest is usually so neatly finished on the outside. Although the nest was barely begun, the builders brought alternately fibrous materials, broad dead leaves and downy stuffs, including seed plumes.

While these two Song Tanagers added to the same nest, a third female of the kind, building in another orange tree on the opposite side of the house, stole material from their nest and carried it off to her own. She tore away loose strands in much the same fashion as the builders, but having secured them flew away with her booty. The similarity in the conduct of the builders and the thief was most confusing at first, especially since the foliage permitted only a partial and disjointed picture of their activities. Even when the purloiner carried off materials from beneath the very bills of the building females, they did not attack her.

Each of these three female tanagers was faithfully followed by a mate on her journeys back and forth. The three males never attacked or threatened each other but watched these extraordinary proceedings with perfect calm. They did not sing during the two hours between seven and nine o'clock.

By 9 a.m. of the following day, March 15, one of these two Song Tanagers had begun a nest slightly over a yard away from that which both had been building the preceding day. The site of the new nest was an upright crotch well inside the crown of the tree. The structure was barely begun and consisted of only a few strands and tufts of material. Meanwhile, the other tanager continued to work at the nest which both had been building. Unfortunately, I could not distinguish these two females by their appearance. The one who continued in possession of the nest first begun I called "A," the builder of the newer and slightly lower nest "B."

While I watched, B went to A's nest, which twenty-four hours earlier she had been helping to build, pulled away a billful of material and took it to her own, where she carefully worked it into place. She did this repeatedly, tearing away liberal billfuls, while her mate looked on. Presently Tanager A returned with material, added it to her nest, then went to B's little accumulation and removed material to carry back to her own. After her departure, B returned and recovered these stolen goods, taking them back to her nest. This happened over and over again in the next hour. The same piece of material travelled repeatedly back and forth between the two nests. A large, fluffy tuft of spider's silk was especially attractive to both birds, and I saw it pass from one nest to the other perhaps half a dozen times.

So far as I saw, B took things from A's nest only in the present owner's absence; but A repeatedly tore strands from B's little pile while B was close by. Yet there was never any fighting. At most B would dart toward A; then the two would rest facing each other, almost touching, tense, immobile and silent, for a good part of a minute. They seemed to be trying to outstare each other! The tanagers would face each other, thus motionless, in the most diverse attitudes, sometimes while one hung head downward, sometimes while clinging sideways to a twig. Then, after glaring for many seconds, the two would separate and each go about her own business, A to carry off her booty, B to gather up and arrange the disordered materials of her nest's foundation. The attitudes struck by the two female Song Tanagers when they met reminded me of the posturing of a bird jostled by a neighbor on my feeding shelf, when the aggrieved party would lower its head and open its bill, maintaining a rigid attitude for some seconds. These female tanagers, however, would open their bills only when they began to posture, then they gradually closed them while each continued to point her own at her rival.

As before, the two males were spectators only, following their mates closely, perching close beside or even upon the nests, but taking no active part either in the building or in the disputes.

During the next two days the situation continued unchanged, each bird still trying to build up her own nest by tearing material from her rival's, with the result that neither got very far. In the hour between 6:50 and 7:50 a.m. on March 17, A brought material from a distance 12 times and took it from B's nest 8 times. In the same period, B brought material from a distance 5 times and stole from A's nest 14 times. Once B stole material from her neighbor's nest 5 times in quick succession, and twice she carried away 3 billfuls in succession. But I did not see A steal from B more than twice without flying away to fetch material from some more distant source. One of these sources was a nest which a Gray-capped Flycatcher was building in a neighboring cashew tree; but she filched from this only in the flycatcher's absence. Both tanagers also frequently descended among the lower branches of their orange tree to retrieve fallen pieces of building material, and once B dropped to the ground for this purpose.

Despite all the material, stolen or otherwise, which B brought to her nest, late in the morning I found the crotch nearly bare. This was in large measure because the things she stole from A were principally pieces of leaf, which promptly slipped out of the fork, where there was not enough fibrous material to hold them in place, A having carried away practically all of this. Because A's nest was so much farther advanced than B's, she was bringing materials which were of no present use to B, yet the latter continued to appropriate them, with no significant results.

Probably because of the extraordinary nature of these proceedings, the male tanagers seemed to be more interested than is usual while the female builds, going frequently to visit the nests. Once one of them, I know not whether A's mate or B's, seized a piece of material dangling below B's nest but released his hold on it without pulling it away.

By March 18, both A and B had practically bare crotches to show for five days' labor, but each continued to bring material only to have it promptly stolen by her rival and end up on the ground. The male tanagers were becoming less attentive, as though tiring of the farce. After this, B, the less forceful character, abandoned her attempt to complete a nest in this orange tree, leaving A to work actively on her structure in its original position. But although relieved of her rival's immediate presence, A's troubles were by no means at an end. Her nest had through this long-drawn dispute received unfortunate publicity and was being used as a public quarry by some of the many birds of various kinds now building in the yard. One or more Song Tanagers continued to pilfer from her nest and carry their stolen goods to more distant sites. A Chipsacheery

Flycatcher, too, bore away plunder for her bulky domed nests built in a neighboring tree; and even a tiny Bananaquit came for its share of the spoils. To make matters worse, Tanager A stole again and again from the Gray-capped Flycatcher in the cashew tree. She continued to build in her orange tree for about ten days, or until March 23, but after this became discouraged and doubtless went to try her fortunes in some fresh site. By the end of the month, there was no trace of a nest in this orange tree.

Mutual stealing of nest materials is of very common occurrence among nearly all colonial nesting birds, from terns and penguins to rooks and oropéndolas. But the tightly woven fabrics of the oropéndolas and other social Icteridae discourage robbery, the female birds usually finding it easier to fly far off and gather fresh material than to detach a strong fiber from a neighbor's nest. The looser construction of the Song Tanagers' nests made it easier to pull them apart; and moreover, the tanagers themselves, impromptu colonists, stole to an excessive degree, hence the negative results of their activity.

But the two Song Tanagers whose fortunes we have been following were altogether exceptional individuals of their kind. Usually the female tanagers work with so much industry that they complete their bulky nests within four working days. Those who labor even harder may build the nest in three days; others who proceed in a more leisurely fashion may consume five or possibly even more.

The completed nest of the Song Tanager is a substantial open cup, measuring from 4 to 5 inches in external diameter by  $2\frac{1}{2}$  or 3 in height. The interior cavity measures about 3 inches in diameter by  $1\frac{3}{4}$  or 2 in depth. The bulk of the nest usually consists of dry leaves, often strips of giant monocotyledonous leaves, such as those of the banana, wild plantain, shell-flower, canna, or other members of the order Scitamineae. Some of these pieces may be two or even three inches in breadth. In the absence of these, the narrower blades of grasses are used. This flat material is held together by an outer network of cordlike or fibrous material, much of which is also incorporated between the layers of leaves. For this binding material a great variety of sources may be employed, including slender dry herbaceous vines, weedstems, fungal hyphae, wiry roots, bast fibers, horse hairs, and the like. The often thin inner lining of the nest is composed of fibrous material of the same nature, among which may be found rootlets, tendrils, fine grass stems, and black fungal filaments. Often but by no means invariably the outside is ornamented with a spray or two of living fern, as of a wiry-stemmed, small-leaved polypody (*Polypodium ciliatum*) that creeps over trunks and branches, or with portions of the larger fronds of a *Nephrolepis* or some other fern. Similar ornamentation is, in my experience, more frequently found in the nests of the Caribbean race of the Song Tanager. The Pacific coast race does not often employ down in her nest; but one female, building in the vicinity of a balsa tree that was shedding great fluffs of the softest seed down, found this material irresistibly attractive, and brought many billfulls of it to her nest.

#### THE EGGS

The female occasionally lays her first egg on the morning following the day on which she finishes her nest. More often she allows one or two whole days to pass, laying on the second or third morning following the day when the nest is completed. Since the bird normally takes from 3 to 5 days to build her nest, she lays the first egg 5 or 6 days after beginning the structure. My earliest dates for eggs in the valley of El General, from 2000 to 3000 feet above sea level, are April 15, 1936; March 11, 1937; April 10, 1939; April 17, 1940; March 5, 1943; March 17, 1944; April 3, 1945; and March 9, 1946.

The two eggs which normally make the full set are always, in my experience, laid on consecutive days, an interval of very nearly 24 hours separating the laying of the



first and second. They seem invariably to be laid early in the morning, from before sunrise to a half hour after sunrise. Fifteen eggs of which I timed the laying appeared between 5:15 and 6:30 a.m. One of the earliest was laid between 5:20 and 5:50, one of the latest between 6:08 and 6:25. It is not practicable to determine the exact minute at which an egg is laid. The female Song Tanager usually goes on the nest before sunrise, or more rarely a few minutes after sunrise, sits quietly for from 20 to 40 minutes, then flies away leaving the newly laid egg in the nest. Sometimes the male tanager escorts his mate to the nest when she comes to lay the egg.

Although I have looked into nearly two hundred nests of the Song Tanager, only four of them contained more than two eggs. One of these unusual sets consisted of three eggs laid by two female tanagers, one of which captured the nest from the other, as told elsewhere (p. 144ff.). The eggs in another set of three were fairly uniform in size and pigmentation and hatched all on the same morning, so that I have no doubt that they were all the product of the same bird. Moreover, several hours' watching of this nest failed to reveal that a second tanager took an interest in it; it seemed perfectly normal except for the unusual size of the set. The following year there was another nest with three eggs 80 feet from the site of the last, in all probability belonging to the same individual. The fourth unusually large set contained four eggs, which could be separated into two contrasting pairs. In one the eggs were long and tapering, measuring 26.2 by 15.9 and 25.4 by 15.9 millimeters; in the other they were short-ovate, measuring 22.6 by 17.1 and 22.6 by 16.7 millimeters. These eggs were most probably laid by two birds; although after I found the nest with all four eggs already present, only one female was seen to take an interest in it.

There is considerable variation among the eggs of the Song Tanager, both as to ground color and markings. The ground color varies from pale blue to blue-gray, pale gray, or more rarely whitish, with no trace of blue. The markings consist of heavy and light blotches, fine dots and scrawls of black, varying shades of brown, and pale lilac. These marks are often of very irregular shape and usually heaviest and most crowded in a wreath about the large end of the egg, with a lighter scattering over the remaining surface. On some eggs the brown spots predominate, on others the black, with at times no brown markings present. Fifty eggs measured at the nest averaged 23.7 by 17.0 millimeters. The eggs showing the four extremes measured 27.8 by 16.7, 21.4 by 16.3, 23.8 by 18.3 and 21.4 by 15.9 millimeters.

The distribution according to the month of laying of 188 nests in the valley of El General, between 2000 and 3000 feet above sea level, is as follows: March, 38; April, 70; May, 47; June, 17; July, 11; August, 4; September, 1.

#### INCUBATION

On the day on which she lays her first egg, the female Song Tanager sits upon it for brief periods. During the following night, she may either sleep upon the egg or leave it exposed while she goes to roost in a thicket with her companions. (My records contain two instances of sleeping on the single egg and two of leaving it exposed.) Returning early next morning, the tanager lays the second egg, then begins to incubate with fair constancy. During the day when the second egg is laid, she may incubate with almost the same assiduity she will display during the following days, or she may sit less patiently, only gradually working up to full constancy in incubation. These individual, or perhaps seasonal, differences in the way incubation begins are reflected later in the hatching of the eggs. Sometimes the two eggs of a set hatch almost simultaneously; again, there may be an interval of twelve hours or more between the hatching of the

first and the second. In the latter case, it seems likely that the first egg was incubated during the night before the second was laid.

The owner of nest 65, one of the earliest of the season in 1944, was a good example of a bird who gradually warmed up to the task of incubation. I watched this nest from 8 to 10 a.m. and again from 2 to 4 p.m. on the day the first egg was laid, during the same hours on the day the second egg was laid, and again the following day. I also watched during all the afternoon of the fifth day after the set was complete and all the next morning. From this longer record, it was possible to extract two-hour periods to correspond with the records made at the beginning of incubation. Table 5 shows how this tanager gradually increased her time upon the eggs. When she first began to incubate, she often came to the nest in company with the other Song Tanagers of both sexes who visited the feeding shelf close by. After eating banana, she would go to sit on the nest, while her companions flew away. Often she would leave the nest when after an interval she heard them returning to the feeding shelf.

Table 5  
Incubation by a Female Song Tanager (Nest 65)

Date in 1944	Stage	Number of sessions 8 to 10 a.m. and 2 to 4 p.m.	Total time on nest in minutes	Per cent time on nest
March 17	First egg laid	5	27	11.3
March 18	Second egg laid	5	72	30.0
March 19		6	131	54.6
March 23 and 24		6	160	66.7

At nest 71A the first egg was laid before 6:00 a.m. on April 6, 1944. That same morning I watched the nest from 6 to 8 a.m. This tanager sat for brief, widely separated periods, like the bird at nest 65. Her three sessions lasted for 3+, 11 and 5 minutes, making a total of 19 minutes in the two hours. The second egg was laid while the tanager sat continuously from 5:53 to 6:14 a.m. the following morning. Between 8:01 and 10:02 o'clock that morning the tanager incubated for three periods of 31, 30 and 16 minutes, respectively. When I resumed my watch at 2:01 p.m. I found her sitting and she remained for 13 minutes. She took three additional sessions, the third continuing until 4:06, making in all four sessions of 13+, 17, 21 and 20 minutes. This made a total of 148 minutes of incubation in a period of 246 minutes. Thus, if we may consider our sample as representative, on the day her second egg was laid this tanager incubated 60 per cent of the time—slightly over twice as much as her neighbor at nest 65 on the corresponding day and almost normal incubation for the species.

At nest 89 the second egg was laid while the tanager sat continuously from 5:47 to 6:22 on the morning of May 15, 1945. That same day I watched the nest from 8:32 to 10:32 a.m. and from 2:32 to 4:32 p.m. In the four hours I timed 7 completed sessions which ranged from 10 to 28 minutes and averaged 18.4 minutes. In the same period the tanager's 8 recesses ranged from 5 to 23 minutes, averaging 12.75 minutes. She incubated 59.1 per cent of the time. In the middle of the incubation period I watched this nest for 16 hours and found that the tanager covered the eggs for 74.3 per cent of the daylight hours. Thus this bird, like the owner of nest 71A, approached but did not equal full constancy in incubation on the day her second egg was laid; but the tanager at nest 65 fell far short of full constancy in incubation.

The female Song Tanager incubates the eggs with no assistance from the male, in

this agreeing with eleven other species of tanagers which I have studied during this period. As with nearly all other small terrestrial birds that carry on incubation without help from the mate, her day is taken up with a number of shorter or longer sessions on the eggs alternating with generally shorter recesses during which the eggs are left uncovered. Although there is a good deal of variation in the lengths of successive sessions and recesses of the same individual and still greater variation between these periods as measured for different individuals of the same or of different species, yet there is a rather surprising uniformity in the percentage of the day which the birds spend on the nest. This is true not only in a single species, but even in whole avian families, provided always that the records cover significant periods, preferably of six hours or more. In addition to the studies of the beginning of incubation already recorded, I devoted a total of 44 hours to watching 4 nests in which incubation had been going on for a number of days and the birds had "struck their stride." The results of the watches at four of these nests are summarized in table 6, where also are given, for comparison, similar records for other species of tanagers. The first three Song Tanagers kept their eggs covered between 70 and 75 per cent of the day, which appears to be about average constancy for tanagers as a family.

Table 6  
Incubation Patterns of Tanagers  
(Incubation by Females Only)

Species	Hours of record	Sessions in minutes		Recesses in minutes		Total time on eggs %
		Range	Average	Range	Average	
Song Tanager, nest 65	12	8-102+	29.3	5-32	11.8	71.2
nest 89	16	12-104+	33.6	7-19	11.6	74.3
nest 103	5	17-46	34.5	8-16	11.3	75.3
nest 119B	6	6-71	28.3	1-11	5.2	*84.5
Crimson-backed Tanager	10	16-89	39.0	11-36	21.9	64.1
Gray-headed Tanager	6	66-97	76.3	25-66	45.5	62.6
Blue Tanager, nest 6	6	2-36	14.1	4-12	7.2	66.2
nest 15	3	11-28	18.4	2-8	5.4	77.3
Golden-masked Tanager	5.8	10-64	29.3	6-29	16.0	64.6
	7	6-51	18.9	2-17	7.9	70.5
	10	2-47	22.6	2-11	7.3	75.6
Yellow-browed Tanager	12.5	30-53	39.7	2-27	10.1	79.8
Silver-throated Tanager	6	8-48	21.1	5-12	8.3	71.8
	5.1	17-33	24.1	4-14	7.2	77.0
Blue-rumped Green Tanager	6.25	63-93	80.0	25-48	33.5	70.5
	4.2	95+-134		22		
Yellow-crowned Euphonia	4	12-42	28.8	5-12	8.6	77.0
Tawny-bellied Euphonia	4.25	55-78	66.5	27-38	31.7	67.7
Bonaparte Euphonia	6.1	32-83	59.5	8-44	27.0	68.8
Turquoise-naped Chlorophonia	5	24-34	29.2	15-44	22.6	56.6

\*Abnormally lengthened, see text below.

But the fourth tanager (nest 119B), who incubated while another of her kind built a nest only four inches from her own, spent considerably more time on her eggs than those females who had no neighbors close enough to bother them. During six hours of the morning of April 18, 1946, she took 10 sessions on the eggs, ranging from 6 to 71 minutes, and an equal number of recesses, varying from 1 to 11 minutes in length. She spent 84.5 per cent of the morning on her eggs—nearly 10 per cent more than the most assiduous of the other three Song Tanagers that I watched. Her sessions were, on the average, slightly shorter than those of any of the other three, but her absences were

somewhat less than half as long (see table 6). She seemed afraid to leave her nest unattended, lest the other tanager building so close by damage it, possibly by pulling out material for incorporation into her own structure. The incubating tanager appeared to reduce the length of her recesses to the very minimum necessary to satisfy her appetite. Once she was absent from her nest for only a minute, during which she paid a hurried visit to the neighboring feeding shelf and ate banana. Eight of her 11 returns to the nest that I witnessed were made while the building tanager was approaching the new nest or working at it. The incubating bird appeared to be keeping a close, uneasy watch over the interloper.

Yet there was little active hostility between these two female Song Tanagers. Once, when the builder followed the incubating bird to her nest and hopped close around it while she sat, the latter jumped from her eggs and clutched the other. The two fell to the ground and remained there for a minute or two, hidden from my view by the tall grass. Again, as the builder approached carrying a big dead leaf, the other left her eggs and went to meet her. The two hung back downward side by side from a branch of the orange tree, clutching each other, I think; but soon they separated and went about their respective occupations. Late in the morning, the builder clung motionless above her own nest and close beside her incubating neighbor, striking an attitude which is one of the Song Tanager's methods of displaying hostility, and maintaining it for about three minutes. But aside from these three minor incidents in the course of six hours, the two female tanagers got along well together. The incubating bird sat quietly on her eggs while the other built close below her, and if she disapproved of the new nest, she did nothing to show it. Colonial-nesting oropéndolas and grackles often quarrel more frequently as they build close together.

The female Song Tanagers' sessions on the nest tend to be somewhat longer in the afternoon than in the forenoon, but the difference is not pronounced so long as the day is rainless. If rain falls in the afternoon, as it does on so many afternoons during the season when Song Tanagers nest, she sits on the eggs for somewhat longer periods and takes brief recesses to search for food during breaks in the showers. At both the nests to which I devoted most attention while the bird incubated, the female was in the habit of taking unusually long sessions in the middle of the day. Those turns on the eggs which began at or a little before noon were the only ones in the entire day that exceeded an hour in length. At nest 65, the female was sitting when I began to make a record at 12:33 p.m. on March 23 and continued uninterruptedly in the nest until 2:15, giving a session of more than 102 minutes. On March 25, I found this female tanager on the nest at noon and began to watch. She sat continuously until 1:13 p.m., more than 73 minutes. Aside from these, this tanager's longest turn on the nest in twelve hours of watching which covered all hours of the day, was 42 minutes; this was the session which followed the noon session on March 23. Her next longest session, 39 minutes, followed her first recess of the day and began before sunrise.

At nest 89, the female tanager returned to her eggs at 11:31 a.m. on May 24 and sat continuously until 12:38—67 minutes. The following day she was sitting when I began to watch at noon and remained on the nest until 1:44 p.m. During her long session of more than 104 minutes a drizzle began and soon increased to a hard rain. Rain was still falling when at 1:44 she left the nest for a brief 8-minute recess. Aside from these long midday sessions, this tanager's longest turns on the eggs in 16 hours of watching covering all hours of the day, were 55 and 52 minutes, both taken on a dark, wet afternoon, and one of 47 minutes made on an afternoon with intermittent sunshine.

My attempt to study incubation at nest 107 on May 12, 1945, was not very successful. But I did succeed in timing the midday session, which lasted 50 minutes, from 11:34 a.m. to 12:24 p.m. and ended with the tanager's spontaneous departure. Although

not as long as the midday session timed at other nests, it was the longest recorded at this nest in five hours of watching; the next longest, 44 minutes, was taken in the middle of the morning.

Hence it appears that female Song Tanagers habitually take a "siesta" on the nest in the middle of the day, sitting then for a longer period than at any other time during the hours of daylight. So far as I saw, they did not actually sleep. During the long session of the tanager on nest 65 in the first hours of the afternoon on March 23 and 25, the Song Tanagers which are nearly always to be seen flying about the yard did not appear at all, and none came to the feeding shelf which they were in the habit of visiting frequently through most of the day. It seemed that while the incubating bird rested on her nest, all her neighbors of both sexes had settled down for a period of quiet repose amid the foliage. But this midday pause in the day's activities is not invariable with Song Tanagers. While feeding their nestlings, for example, they bring food at least at a moderate rate through every hour in the day, including that between noon and 1 p.m.; and we have already given an example of a Song Tanager who built actively in the hot sunshine between 1 and 2 p.m.

With most birds of other species that I have watched incubate, the midday session has not been significantly longer than others.

At most nests, the male is more or less attentive to his mate during the course of incubation, but the degree of interest taken in the nest varies greatly with individuals. From time to time he escorts his mate to the nest tree as she returns to her eggs; but he is by no means so constant an attendant as the males of many less gregarious species of tanagers which fly always in pairs; and on the majority of her returns to the nest the female Song Tanager comes alone. Less frequently still, the male Song Tanager comes to look into the nest, and on very rare occasions he brings food in his bill and appears to be offering it to the eggs, "anticipating the nestlings," as I have called this rather infrequent behavior of male birds. Even if the female is at hand, she takes no interest in food brought by her mate until after the eggs hatch. I have never seen the male Song Tanager feed the female, although such feeding is frequent enough in numerous other species of tanagers.

At nest 65, the male tanager was somewhat more attentive to his mate and the nest on the day she laid her first egg than after incubation had been in progress for a few days. In the four hours when I watched the nest on March 17, the day the first egg was laid, he thrice escorted his mate when she came to cover the single egg and twice more came to visit her while she sat. On one of these visits he uttered low notes while resting close above the female. When he flew off, she left the egg and followed. Early in my two-hour watch on the following day, the male came to the nest with his mate and remained perching close by during all of the 11 minutes she spent on the eggs, then followed her when she flew away. Returning eight minutes later, again with the male, she incubated for 13 minutes, while he rested below the nest, repeating a thin *zzzt*, the *pet churry* call, and other queer, nasal notes. When the female ended her session he again flew away with her. But during two hours in the afternoon of this same day, when the female sat on the nest only once, the male did not appear.

During my twelve-hour watch covering the afternoon of March 23 and the following morning, the male Song Tanager escorted his mate on only 5 of her 18 returns to her eggs and came once more to visit her while she sat. When he came with his mate at 10:07 a.m. he brought food in his bill. Slowly approaching the nest in advance of her, he at length stood upon the rim and lowered his head into the cup, as though offering food to a nestling. He maintained this position for about a minute. Then the female proceeded to the nest; and as she reached it he flew away, still bearing the morsel.

At nest 89, I twice saw the male bring food to the nest while it contained eggs, once

during a total of 20 hours of formal watching, and once again at a time when I was not making a continuous record. On the first occasion, the male alighted beside his mate while she rested in a tree near the nest, apparently about to return to it. He bore a bit of food in his bill. Without offering it to her, he preceded her to the nest, where he rested upon the rim, looking intently in, and working the food between his mandibles. After about a minute in this attitude he carried the food away. This was in the middle of the afternoon of the eleventh day of incubation. At noon the following day, while sitting in the dining room at lunch, I saw the male and female tanagers come together to the nest tree. The male went first to the nest, stood on the rim, bent down his head and worked his bill. I could not distinguish food in it, but think it most probable that he had brought a small morsel. In a minute he flew off, and the female settled down to incubate. Next morning the eggs hatched in this nest.

Nest 103 was built in this same orange tree the following year. Watching for five hours on the last two days of incubation, I failed to see the male bring food to it. Once as the female returned to the nest he escorted her as far as the next tree, and once while she sat he alighted below her in the orange tree and repeated over and over a low, weak note. After an interval he hopped higher and continued the same utterance. So, by successive short advances, he approached within two feet of the nest, where he delayed several minutes, all the while repeating the same note. After about ten minutes in the nest tree he flew off, without having gone to the nest. I could detect no food in his bill. About 24 hours later the first egg hatched.

To a nest of the Crimson-backed Tanager which I watched in Panamá in 1935, the male thrice brought insects in the course of ten hours of observation on the seventh and eighth days of incubation. On two of these visits the female was absent and he lowered his head into the nest, uttering low, soft notes, as though coaxing newly hatched nestlings to take food. On the male's third visit to the nest with food, he found his mate sitting and gave it to her with evident reluctance. Like the Song Tanagers which I watched in later years, he had come to see whether the nestlings had hatched, not to feed his mate. Similar anticipatory food-bringing has been observed at the nests of several species of warblers, finches and other birds. When the male forms the habit of bringing food to the nest before the nestlings escape from the shells, he is likely to minister to their needs very soon after they hatch. We shall see later how promptly the Song Tanager brings food to his newly hatched offspring.

#### DEFENSE OF THE NEST

While incubating, the Song Tanagers do not often resent the presence of other individuals of their own species in the vicinity of their nest, unless they come very close. Then such intrusions will occasionally arouse the mild and often ineffectual protests of the nesting birds. One afternoon, while I watched nest 89, two females clashed in a guava tree growing close beside the orange tree that held the nest. They actually struck each other, an extremely rare occurrence among Song Tanagers. But before the fight was well begun it had ended. Meanwhile one male chased another in the cashew tree on the other side of the nest tree; but after a few seconds one of them flew away. The only interpretation I could place on this episode was that it sprang from the trace of an instinct to defend a territory. At another nest, two females followed the owner as she approached with food for her newly hatched nestling. She flew toward them and they promptly retired. Meanwhile her mate chased another male Song Tanager which had come close to the nest. At a third nest I saw the female tanager try to drive away another female of her kind, but in a very mild fashion. When the intruder failed to move, the owner left her alone.

Small and harmless birds of other species are not as a rule chased from the vicinity of the nest unless they come within a few feet of it or try to pilfer from it. When many birds of a number of species breed in a small area, they often attempt to build their own nests with materials stolen from the nests of their neighbors, instead of making longer journeys to search for these materials at their primary sources. Few building birds are able to resist the temptation of carrying away a straw, a rootlet, or a strong fiber from a neighbor's unguarded nest. In my yard, which in April, May and June is usually crowded with nesting birds, such larceny is rife. While watching the Song Tanagers' nest 65, I saw the female chase Blue Tanagers, Golden-masked Tanagers, a Blue Honeycreeper and a Chipsacheery Flycatcher from her nest tree. One of the Golden-masked Tanagers pulled material from the nest once, and a female Blue Honeycreeper pilfered from it repeatedly in the absence of the owner, but without harming the eggs. The Chipsacheery Flycatcher was also building and seemed to be on the point of becoming a thief, when the pair of Song Tanagers dashed at her together, making her flee with a little frightened squeal. Once the female Song Tanager was on the feeding shelf, twenty feet from her nest, with a pair of Blue Tanagers and a male Blue Honeycreeper. After satisfying itself with banana, one of the Blue Tanagers flew to the orange tree that held the nest. Whereupon the Song Tanager at once interrupted her eating and went to drive the intruder away. The Blue Tanager retreated unresistingly, then the Song Tanager returned to finish her meal of banana. But the male Song Tanager of this pair paid no attention to a Buff-throated Saltator nor to a Yellow-bellied Elaenia that perched close beside him while he rested in the orange tree near his incubating mate.

Some of these intruding species were slightly larger than the Song Tanager, others considerably smaller, but all innocuous to eggs and nestlings. Twice while this Song Tanager was incubating, a Frantzius Aracaris flew into her orange tree, and each time the tanager fled precipitately. On another occasion, she stole from her nest upon hearing aracaris call in the distance. These big birds with huge red bills are inveterate nest-robbers and would probably have eaten the eggs if I had not promptly driven them away. But I could not watch the nest all the time; and a few days later the eggs vanished, taken, no doubt, by these toucans.

Another nesting Song Tanager was continually annoyed by a female Variable Seed-eater, a bird far smaller than herself. Once the little bird impudently pulled a fiber from the bottom of the nest while the tanager sat in it upon her newly laid eggs. Aroused by the tugging, she jumped from the nest and drove the thief away.

Although in the face of huge-billed toucans Song Tanagers act as though intimidated, when their nest is threatened by snakes, they are often surprisingly bold in its defense. One afternoon my attention was arrested by a sudden commotion on the bank of a stream where a Song Tanager had her nest among bushes overhanging the water. A slender green snake, about two feet in length, had discovered the nest and was swallowing the eggs. The female tanager, crying loudly in her querulous nasal voice, was fluttering above the snake, trying to drive it off. If she did not actually touch the reptile, she certainly came within an inch of doing so. The fact that she did not turn away the serpent is not proof that she did not hurt it; for in Panamá I watched a mica, mortally wounded by two or three revolver shots, continue to gorge itself with the contents of the nests in a colony of Yellow-rumped Caciques. As I arrived below the tanager's nest, the green snake lifted its head from the interior, its mouth greatly distended with the egg it was swallowing. I gave it a blow with a stick that brought it down into the river. The tanager's nest was empty, the second egg, I believe, having fallen into the water during the scuffle.

At a low nest built only three feet above the ground in a young orange tree in my

yard, the parents were often annoyed by the domestic chickens passing close beneath. After the nestlings hatched, both male and female tanagers became greatly excited whenever the chickens came near, fluttered close above their heads, and uttered harsh, nasal cries. They made the speckled rooster flee; but a hen passing close beneath the nest with a brood of chicks took no heed of the parent tanagers.

#### A NEST WITH TWO CLAIMANTS

As already recorded, one of the rare sets containing three eggs was the product of two birds. The history of this nest is one of the strangest that has come to my attention in the course of my studies of the Song Tanager. In April and May, 1939, among the numerous birds' nests in a shady pasture in the neighborhood of San Isidro del General, I found this nest situated eight feet above the ground in a small orange tree. It was a loosely made structure, well hidden amid the foliage. On visiting it on May 4, I found a brightly colored female sitting on two eggs. Both her breast and her rump were as bright an orange as I have ever seen on a female Song Tanager. But as I approached the nest on the following morning, a female Song Tanager of no more than average brilliance of plumage flew from it. This discovery of two birds sitting by turns on the same nest stimulated me to undertake a continuous watch. It was then nine o'clock in the morning. After ten minutes the duller female, D, returned and settled on the nest. After she had been incubating for 25 minutes, the brighter female, B, arrived and rested on the rim while D continued to sit. After five minutes B flew away. D remained until 9:56, when she ended her long session of 46 minutes and went off for an 8-minute recess. Returning at 10:04, she resumed incubation. Three minutes later B returned and stood beside the nest for 9 minutes, went off for 8 minutes, then returned once more. D, still sitting, now threatened her with open bill; but soon they came to terms and B rested peacefully on the nest's rim. After three minutes B flew away, and a minute later D followed. B saw her go, but instead of returning herself to sit on the eggs, she flew away with a male tanager.

Ten minutes later B returned, found the nest unoccupied and sat in it. After she had been sitting there for 6 minutes, D returned to the orange tree and called a great deal, whereupon B left the nest, but not the tree. Two minutes later B returned to the nest, while D still lingered in the orange tree, calling in a typically thin, whining voice. B, apparently responding to this, twice jumped from the nest, but each time promptly returned to it. After 14 minutes in the orange tree, D flew away, leaving B on the nest. She sat very restlessly, constantly turning around and making movements as though shaping an unfinished nest. I feared that she might break the eggs, but she did not.

At eleven o'clock a male tanager visited the nest, and as he flew away, B followed. She settled on a log lying near the foot of the tree and her posture invited him to mount her, for the second time that morning. Soon D returned to the eggs and again B came to stand on the rim beside her. B was far less voluble than D. The male tanager again approaching, B once more flew down to the log to invite him to sexual union. Then again she went to the nest, but soon departed. Once more she came to perch beside the nest, while D sat on steadily. Finally both flew away together. Throughout by vigil, D came and went in the rhythmic manner of an incubating bird, and never sought the male's attentions. B often failed to sit even when she had the opportunity to do so, and when on the nest, she behaved more like a nest-building than an incubating female. This conduct and her invitations to the male convinced me that she had not yet laid and that the nest and two eggs were the property of D.

Two days later this nest held three eggs, the third, I had little doubt, laid by B. It was she who was sitting when I began to watch at nine o'clock, and during the next two



hours she sat and took recesses with the regularity of an incubating bird. D rarely had an opportunity to enter the nest and was clearly losing out. Twice she came to the orange tree, and finding B covering the eggs, hopped restlessly back and forth through the surrounding branches, calling from time to time, and in the end grew tired of waiting and flew away—once after she had watched her rival occupy her nest for ten minutes. She came a third time to the orange tree just as B was leaving the nest. Seeing the other approach it, B returned, and for two minutes the pair stood motionless above the nest, staring at each other. Then B grasped D's bill in her own and forced her backward, after which she returned to sit on the eggs. D clung for a minute below the branch from which her rival had pushed her, then hopped about in the orange tree as before. After sitting for a few minutes, B left the eggs and came to perch quietly beside D, less than a yard from the nest. Thereupon D started toward the nest; but B hurried ahead of her and took possession of it once more. She was evidently becoming hungry now, for in a few minutes she flew away to search for food. Then D, who had lingered near by, found an opportunity to incubate at last.

But D had not occupied the nest for two minutes before B returned and stood on the rim beside her. After a minute D tried to bite her, forcing her from the rim but leaving the nest herself to accomplish this. For a moment they perched quietly near each other, a yard from the nest. Then B promptly went to sit in the nest, leaving D outside once more. D flew away, but after a few minutes returned only to find B still in possession of the nest. All that she could do was to hop through the orange tree, repeating her whining call and after five minutes she flew away. The single male who frequented the vicinity and seemed to be the mate of both females was neutral during this quarrel. He perched in a neighboring ceiba tree and sang.

The following morning I again watched this nest for three hours. B had obtained complete possession and was incubating regularly, but neither D nor the male appeared. I believe that I had witnessed representative acts in a change in ownership of the nest. B had won out by persistence and the weaker or less self-confident D yielded to her without the necessity of a physical conflict which tested to the limit the strength of each. The nearest approach to a fight which I witnessed occurred when B grasped D's bill in her own and forced her backward from the nest; but this was a relatively gentle struggle.

I had expected that B would lay a second egg on the morning of May 8 and incubate a nestful of four. But at no time did I see more than three eggs in the nest. Thenceforth B continued to incubate three eggs. Only one egg hatched, at a date which made it clear that it had been laid by the second rather than the original owner of the nest, and was accordingly B's. Her single nestling was reared with no help from the male.

#### THE INCUBATION PERIOD

The first sign of the approaching hatching of the egg is a minute fracture of the shell at a single point on the circumference where the egg is thickest. This fracture can often be detected from 18 to 29 hours before the egg hatches. Most of this period is occupied by the embryo in piercing the shell at the point where the fracture was first evident; this it accomplishes by rhythmically tapping and scraping against the inner surface of the shell with the hard white egg tooth near the end of its upper mandible. Once the shell is actually perforated, the bird rapidly enlarges the gap and effects its escape by pushing off the blunter end as a neat lid.

The incubation period of the Song Tanager, as determined by daily visits to the nest made during the later part of the day, is sometimes 12 and sometimes 13 days. In 1945, I published records of 15 eggs which hatched in 12 days, and of 6 eggs which hatched in 13 days. Subsequent to preparation of the paper, in the nesting season of 1944, an

attempt was made to determine more accurately the incubation period. I have already explained why it is impossible to time to the minute the laying of an egg. Similarly, it is not practicable to learn exactly when an egg hatches. The emergence of the young from the shell is a somewhat gradual process. If from concealment one keeps continuous watch over the nest, he will see the female bird carry off or eat the empty shell, and he may be sure that the egg has quite recently hatched; but the exact interval between the emergence of the chick and the disposal of the shell cannot be determined by this method, for the nestling usually escapes while the parent covers the nest. Too frequent approaches to the nest will keep the parent away, reduce the amount of heat the egg receives, and thus retard the process of hatching, resulting in an artificially lengthened incubation period. Hence the best we can do is to indicate the period within more or less narrow time limits. Obviously, for the purpose of determining the incubation period in terms of hours, we can use only the second egg; for we have already seen that the first egg receives a certain amount of incubation, varying from nest to nest, before the second is laid. Without a great expenditure of time, we cannot learn the total amount of this sporadic incubation; nor, knowing the total number of hours, could we evaluate the effect of such incubation on the development of the embryo.

In table 7 are presented data on the laying and hatching of the second egg in six nests of the Song Tanager. By computing the interval between the latest possible minute at which the egg might have been laid (as taken from the records in column II) and the earliest possible minute at which the egg hatched (supposing it to have hatched immediately after the observer's visit at the earlier of the two limiting hours as recorded in column III) we arrive at the minimum possible incubation period given in column IV. Similarly, taking the earlier of the limiting hours in column II and the later of those in column III, we obtain a maximum possible incubation period, as given in column V. The true incubation period must lie somewhere between these two figures.

Table 7  
Length of the Incubation Period of the Song Tanager

I	II	III	IV	V
Nest	Interval in which second egg was laid a.m.	Interval in which second egg hatched	Incubation period Minimum possible	Maximum possible
86	April 29, 5:15-6:08	May 11, 12:00-5:15 p.m.	12d, 6h	12d, 12h
89	May 15, 5:47-6:22	May 27, 8:40-9:55 a.m.	12d, 2¼h	12d, 4¼h
90	May 16, 5:25-6:10	May 28, 11:30-12:50 p.m.	12d, 5¼h	12d, 7½h
103	April 21, before 6:25	May 3, at 7:25 a.m.	12d, 1h	12d, 2h
115	June 19, 6:08-6:25	July 1, 7:00-12:00	12d, ½h	12d, 6h
118	July 13, 6:05-6:25	July 25, 10:30-12:00	12d, 4h	12d, 6h

Examination of the last two columns shows that most of the second eggs in these six nests hatched between 12 days (288 hours) and 12¼ days (294 hours) after they were laid. The most rapid hatching, between 12 days, 1 hour and 12 days, 2 hours, was recorded at nest 103. The hour given for hatching, 7:25 a.m., is that at which the female tanager was seen to eat the shell while the nest was continuously watched. The longest incubation period, between 12 days, 6 hours, and 12 days, 12 hours, recorded in this table is that for nest 86, which was situated close beside a path where the female tanager was from time to time frightened from her eggs by people passing by. It is certainly not impossible that at other nests incubation is still slower, but it seems likely that most of my published records of "13 days" were made at nests such as this, where the second egg had not hatched when the nest was inspected at about noon on the twelfth day after incubation began, and therefore the nestling was not seen until the thirteenth day. If we average the 15 records of 12 days' incubation and the 6 records of 13 days' incubation,

we get an incubation period of 12.3 days, or 12 days, 7 hours, which is a closer approximation to the true incubation period, although in the light of the data in table 7 it is still slightly too long.

With some birds, there appears to be a diurnal periodicity in the hatching of the eggs. Schrantz (1943:377) found that of 119 eggs of the Yellow Warbler, only 9 hatched in the afternoon; the other 110 hatched in the night or early morning. Of 24 eggs of the Chipsacheery and Gray-capped flycatchers in 10 nests, 11 hatched in the night, 10 in the first half of the forenoon, 3 between 9 a.m. and noon, none in the afternoon. The restriction of hatching to certain parts of the day is less marked in the Song Tan-



Fig. 21. View of Rivas in the valley of the Río Buena Vista, El General, Costa Rica, in 1936. The bottom of the valley lies at about 3000 feet in the Tropical Zone. The summits in the background are lateral spurs of the Cordillera de Talamanca and rise about 1000 feet higher; they are still covered with primary forest. Buff-throated Saltators, Streaked Saltators, Song Tanagers, Blue-rumped Green Tanagers, and many other birds were studied in this area.

ager. Of 18 eggs of which I know the approximate time of hatching, 3 hatched in the night, 11 in the forenoon (at least 6 of these before 9 a.m.), and 4 in the afternoon. If the hour of hatching were perfectly random, we should expect, in the tropics where day and night are of nearly equal length, that half of the eggs would hatch in the night, a quarter of them in the forenoon, and a quarter in the afternoon. We do not know why in some species eggs so rarely hatch in the afternoon. In the Song Tanager the eggs may usually hatch in the forenoon simply because they are laid in the neighborhood of 6 a.m. and their incubation period is normally between 12 and  $12\frac{1}{4}$  days, which would cause them to hatch between 6 a.m. and noon on the twelfth day after laying. This explanation bears greater weight as applied to the second egg of a set than to the first, which receives a variable amount of warming before the second is laid; and in the case of flycatchers of the genus *Myiozetetes*, with sets of usually 3 eggs laid at variable intervals of from 1 to 3 days and receiving a certain amount of incubation in the interval, it would hardly apply at all. This is a point in avian physiology which deserves greater study.

The eggs of the Song Tanager are surprisingly resistant to exposure, as I learned through certain unpremeditated experiments. When I began to study the Song Tanagers

in the valley of the Río Buena Vista in 1936 and 1937, I found them so extraordinarily shy that it was difficult to study their behavior at the nest even from a blind. On the afternoon of April 20, 1936, I set up a small brown wigwam of cloth in front of a nest containing two well incubated eggs. Entering the blind next morning at dawn to begin my study, I found that the tanager had not covered the nest during the night, which had been cold and rainy. The eggs were wet and thoroughly chilled as a result of their night's exposure. Yet one was pipped on April 22. Unfortunately, when I returned next day to learn whether the eggs had hatched, I found the nest empty. I had a similar experience at a neighboring nest. Although the empty blind had been left in place before this nest all day, the Song Tanager neglected her eggs during the cool, rainy night that followed, and they were wet and cold when I came next morning to begin my vigil. Yet they hatched in the next two days. In both instances, of course, the tanagers had resumed incubation after I removed the blind.

Even after they had nestlings, these Song Tanagers were amazingly shy. I set the blind in view of a nest fourteen feet above the ground in the midst of a cane-brake and entering at once, waited to see the tanagers come with food for the two nestlings. Although both parents flitted about in the background with food in their bills, they would not approach the nest even at the end of an hour and a half, after which I deemed it prudent to remove the offending object. The following year, I set the blind forty feet away from a nest containing a single three-day-old nestling. The vegetation surrounding the modest brown wigwam was disturbed as little as possible, so that it might partly screen it from view of the nest. After the blind had been in position for most of the day and the following night, I entered it to watch, but found that the mother tanager was not attending her nestling. I then removed the blind for six hours to allow her to come to her nest, after which I replaced it. But the tanager was still so distrustful that she allowed her nestling to die of starvation and exposure rather than approach it in the presence of the strange brown tent.

#### THE NESTLINGS

Seated before the open window of the dining room in the dim gray light of dawn on May 27, 1944, I began to watch Song Tanagers' nest 89 in an orange tree in the yard. On the preceding day, I detected on the shell of the egg first laid the slight roughness which gives notice of hatching. Placing the egg against my ear, I could hear the faint, rhythmic tappings of the bird within. Late in the afternoon of that day the second egg was pipped, but the shell of the first was still unpierced.

At 5:33, while the light was still dim, the female tanager flew from the nest for breakfast. Taking advantage of her absence, I hurried out and raised a mirror above the nest, and saw that the eggs were still unhatched. After a 9-minute recess, the female tanager returned alone, incubated for 28 minutes, then went off for more food. Returning to the nest at 6:22, she stood on the rim and looked attentively in, several times lowering her head into the bowl. Evidently something out of the ordinary was taking place there, but from my position at the window I could not see inside the nest. The tanager resumed incubation, but sat restlessly, and after six minutes rose up, picked a piece of empty shell from beneath her, crushed it in her thick blue bill and swallowed it. The other half of the neatly divided shell promptly followed the first. Now there could be no doubt that the egg had hatched. At other nests, too, I have found the eating of the shell the first unequivocal sign that the egg has hatched, although the female bird's restless sitting while the chick is escaping the shell beneath her sometimes informs the attentive watcher what is taking place. The female Song Tanager, so far as I have seen, always eats the empty shell rather than carry it away, as many birds do.

Twenty-six minutes after eating the shell, the mother tanager again flew from the

orange tree. Now I could look at the newly hatched tanager. The tiny bird of course had its eyes tightly closed. The sparse gray down on back and head, which at hatching must have been tightly stuck against its pink skin in thick curly strands, had already begun to loosen; within an hour of the escape from the shell, the tufts of down, completely dry, spread apart to form clustered loose filaments of gossamer fineness. The nestling lay in the bottom of the nest, head bent under, and seemed almost too weak and frail to be capable of movement; but of a sudden it trembled, struggled as though trying to lift a crushing weight, straightened its neck, raising its sightless head into the air, and quivering with the effort, opened wide its mouth, revealing a bright red interior. Thus it advised its parent of its early need of food.

After a twelve-minute absence, the mother tanager returned to nest 89 with her mate, each bringing food. The male stood aside while the female offered her morsel repeatedly to the nestling, still less than an hour old. Each time, after presenting it to the chick, she pressed it between her mandibles before offering it again. Soon the food disappeared, doubtless down the youngster's throat; and the mother settled once more into the nest to brood.

But now the male tanager advanced and stood over his mate with his offering. After about a minute, she flew from the nest, leaving him free to deliver the food. But it was too large for the newly hatched bird and was not immediately swallowed. The father uttered a sharp note, repeating this over and over, and continued to offer the food until his mate returned, after an absence of six minutes. She entered the nest without feeding the nestling; and while she sat the male bird hopped around her still holding his morsel and voicing the same sharp note. Apparently he wished to give the insect to the female, but she made no move to receive it. Finally he carried it away.

An hour and eleven minutes passed between the nestling's first and second meals. Again both parents came to the nest together with food. This time the male advanced first to feed the nestling, but while he was offering the food, the female came and he stood aside for her. She delivered the food and flew away. Then the male returned, and uttering the same sharp monosyllables as before, successfully delivered what he had brought. He always displayed the utmost patience in feeding the nestling. Once when he brought a fairly large item, he continued to present it for five minutes, uttering squeaky notes the while, before it finally vanished. At another time he took four minutes to deliver the food, and while he was intent upon this occupation a little Variable Seedeater, building her slight cup near by, plucked loose fibers from the underside of the tanager's nest. But when the male tanager brought smaller particles, they disappeared down the nestling's throat in about ten seconds. The female tanager usually succeeded in disposing of her offerings more rapidly, but once when she brought a biggish item she continued to place it in the nestling's mouth for three minutes before it went down. She never took food from her mate for delivery to the nestlings. If covering the nest when he arrived with a morsel, she flew off to leave the way clear for him to feed the young himself. In the middle of the morning the second egg hatched and this shell was also eaten by the female. By 11:30 that morning the mother tanager had brought food 11 times and the father 7 times.

The following morning I watched another nest (no. 90 in my records) situated in an annatto bush in front of the house. The female tanager ate the shell of the first egg at 6:58 a.m., gave the nestling its first meal at 7:34, and fed it once more before the male arrived with food. On his first visit to the nest that morning, at 8:30, he brought a morsel in his bill. Unlike her neighbor in the orange tree on the other side of the house, this female tanager took the food from her mate and rose in the nest to feed the nestling, which its father then saw for the first time. During the remainder of the morning, some-

times the male would feed the nestling on his own account, sometimes pass the food to his mate for delivery. Neither parent found it necessary to coax the nestling to take food for so long a time as at the nest in the orange tree; no feeding took much over a minute. Once the male and female came to the nest together, the former with food in his bill, the latter with nothing that I could detect. The male tried for a minute to give the food to the nestling, but was not successful. Then the female, who had watched these proceedings from a perch close beside the nest, advanced to the rim. The male thereupon relinquished the food to her, and in about half a minute she succeeded in making the nestling swallow it. In the course of the morning (until 11:15) the mother brought food to the single newly hatched nestling 4 times, the father 5 times. The second nestling did not hatch until about noon.

The following year, 1945, there was again a nest (no. 103 in my records) in the orange tree north of the house. At 4:30 p.m. on May 2, as a hard rain was coming to an end, I found that the first egg had hatched on the eleventh day after incubation began. The empty shell had already been removed, and the second egg was barely pipped. I at once began to watch. In the next 1½ hours the mother fed the newly hatched nestling four or five times. The male did not go directly to the nest, but once, as it was growing dark, he perched in the orange tree, about a yard from the nest and on a level with it, while his mate gave the nestling its last meal of the day. Then he lingered in this position while the female settled down to brood for the night. After two minutes he flew off to roost in the hedge, without having gone to look into the nest.

The next morning I resumed my watch of this nest at 5:20, as it was growing light. In the first hour the mother tanager fed the nestling four or five times; it was not always easy to see whether she brought anything in her bill. The father did not come to the nest until 6:20, when he brought a large insect and gave it to the nestling, the mother being absent. Twenty-six minutes later he came with a second item and this time found his partner sitting. She crouched down in the nest, opening and closing her bill, and after some hesitation the male passed the food to her. Then she rose up and fed the nestling. By the time the second egg hatched, at about 7:25, the first nestling had already received about 12 meals that morning, 8 or 9 from its mother, 3 from its father.

A little later I followed the events attending the hatching of the eggs at a nest (no. 107 in my records) situated in a privet hedge in front of the house. The female tanager ate the shell of the first egg at 7:05 a.m. on May 11, and gave the nestling its first meal at 8:09. By 11:48, when the second nestling was just pushing off the cap of its eggshell, she had already brought food to the first twelve times. The male often followed her as far as a neighboring tree, but never went up to the nest. During much of that afternoon it rained; but I watched from 5:04 to 5:44 without seeing the male tanager at all. At 6:45 next morning I resumed my vigil. At 7:15 the male tanager approached for the first time, following his mate, and rested in the hedge about a yard from the nest while she fed the nestlings. At 7:42 he came back with food in his bill and delivered it to his mate on the nest. After passing it to the nestlings she flew off, leaving him standing on the rim, apparently offering the nestlings another morsel which he had retained in his mouth. At 7:56 he brought food again and gave it to his mate while she brooded.

My final observations on the beginning of feeding were made at one of the unusual nests with three eggs. All three were slightly pipped at 7:15 a.m. on May 4, 1946, but none had hatched by nightfall. At dawn on May 5, I entered the blind and began to watch. When the female tanager left the nest I went up and saw that all three eggs were strongly fractured, but none was yet pierced. At 6:44 the tanager ate a piece of shell, and five minutes later another piece. At 7:08 she left the nest, and returning five min-

utes later she gave the nestling its first meal, then brooded it. At 8:35, she swallowed the shell of the second egg. By 11:00 she had fed the two nestlings twelve times. At 11:08 the male tanager visited the nest for the first time that morning. The fact that on this and several subsequent visits he went first to an empty Song Tanager's nest four inches away, suggested that he had not been in the habit of making frequent visits of inspection to the three eggs. He had brought nothing in his bill and spent about two minutes standing beside the occupied nest, looking down into it, the while voicing low notes of song. Then he flew off, and 23 minutes elapsed before he returned with a morsel and spent about two minutes giving it to the nestlings. A minute after flying off he was back with more food, which this time he delivered in about one minute. In the half hour following his first delivery of food (11:33 to 12:03) he fed the nestlings five times, often singing in an undertone as he came and went. This male tanager differed from the preceding four in not having food in his bill when first he saw the nestlings and in his far more rapid rate of feeding at the outset.

The foregoing paragraphs may be summarized: At the first nest in the orange tree the mother fed the first nestling 38 minutes after she ate the shell from which it emerged; at the nest in the annatto bush, the female gave the nestling its first meal 36 minutes after she ate the shell; at the nest in the privet hedge the nestling did not receive food until 64 minutes after its mother had eaten the shell; at the nest with three eggs, the mother brought food 29 minutes after eating the shell. At the first nest in the orange tree, the male came with food about 38 minutes after the first egg hatched; at the nest in the annatto bush he came with food about 92 minutes after the first egg hatched; at the second nest in the orange tree he did not bring food until 14 hours or more had passed, but 11 of these were hours of darkness and inactivity; at the nest in the privet hedge, slightly more than 24 hours passed before the male began to feed the nestling, but again 11 of these were hours of night; at the nest with three eggs, the male brought the first morsel 4 hours and 49 minutes after his mate ate the shell from which the first nestling emerged. More casual watching at several other nests revealed that the male Song Tanager usually begins to feed the nestlings on the day they hatch, except at certain nests where the female appears to have no regular mate.

How does the male Song Tanager learn that the nestlings have hatched and require food? I think it unlikely that his mate makes him acquainted with this event by means of some special call or note. At the nests that I watched continuously while the eggs were hatching, I detected no sound which I could interpret as a communication to this effect. Of course, I could not follow all that went on between the mated pair while they were together during the female's absences from the nest. But if the female bird can indeed communicate to her mate the fact that her eggs have hatched, why does he at times delay so long in bringing food? From studies made at nests of numerous other species and reported elsewhere, I concluded that the female bird does not make known to the male by means of voice that the eggs have hatched, but on the contrary he must discover this for himself. Usually he seems not to learn of the existence of the nestlings until he has visited the nest and seen them. But at four of the five nests of the Song Tanager which I watched most carefully, the male bird brought food *before* he had seen the nestling.

We have already seen that in the course of incubation the male Song Tanager brings food to the nest, "anticipating the nestlings," but at long and irregular intervals, probably not more than once or twice in a day. His first arrival with food after the nestlings have hatched may be just another of these "anticipatory" visits, which now at last fulfills its purpose. We need seek no more recondite explanation of the fact that the male Song Tanager usually begins to feed his offspring within 24 hours or so after they hatch.

When he begins to bring food within an hour or two, as at the first two nests, it may be merely a fortunate coincidence that his "anticipatory" visit follows so promptly on the birth of the nestling. But I hold it not unlikely that in these instances he brings food promptly because he has seen his mate carrying food in her bill. The proof of this theory would, of course, be difficult.

The nest in the orange tree which I could watch from the dining room window received more of my attention than any other. During the nestlings' fifth, sixth and seventh days after hatching, I devoted a total of nearly 13 hours to watching this nest, my vigils so arranged that taken conjointly they covered all hours of the day, from the beginning of the birds' activity in the morning to its cessation in the evening. The information gathered during these watches is summarized in table 8.

Table 8  
Care of Two Nestling Song Tanagers (Nest 89) on 5th, 6th and 7th Days after Hatching

Hour	Male	Feedings Female	Both	Broodings by female in minutes
5:15-5:30 a.m.	0	0	0	Left nest at 5:26
5:30-6:00	3	4	7	6, 8
6:00-7:00	7	8	15	1, 11, 10
7:00-8:00	3	4	7	5, 4, 4
8:00-9:00	7	9	16	3, 2
9:00-10:00	5	16	21	
10:00-11:00	6	8	14	
11:00-12:00	3	7	10	
12:00-1:00 p.m.	3	4	7	4
1:00-2:00	3	10	13	
2:00-3:00	2	5	7	17, 18
3:00-4:00	6	4	10	3, 7, 2, 23
4:00-5:00	7	12	19	1, 5
5:00-5:26	1	2	3	4, 5
5:26-6:00	0	(1?)		Settled for night at 5:38
Totals	56	93	149	21 times, 143 minutes

Watches: 5:15 to 9:00 a.m. and 12:00 to 1:00 p.m. on 5th day; 11:00 to 12:00 a.m. and 1:00 to 6:00 p.m. on 6th day; 9:00 to 11:00 a.m. on 7th day.

Weather: 5:15 to 8:00 a.m., drizzly after rainy night; 8:00 to 9:00, sunny; 9:00 to 11:00, lightly clouded; 11:00 to 12:00, sunny; 12:00 to 1:00, partly clouded; 1:00 to 4:00, gathering clouds, hard rain from 2:23 to 3:50; 4:00 to 6:00, darkly overclouded.

Feeding continued throughout the day. Although there was considerable variation in the hourly rate, from 7 to 21 times per hour, there was no hour during which the nestlings were not fed at least seven times. The variations in the rate from hour to hour do not appear to be indicative of a significant diurnal periodicity in the activity of the parents so much as of variations in the degree of satiety or hunger of the nestlings, as determined by the amount of food they received in the preceding hour. At least, it would require a far more extended series of observations to make out a case for diurnal periodicity in the rate of food bringing.

The female brought food 93 times to 56 times by the male. She was consistent in her greater activity in feeding the nestlings, bringing food more often than he in every single hour save that between 3 and 4 p.m., during which she devoted 35 minutes to covering the nestlings while rain fell hard. I could not convince myself that the male regularly brought larger portions than the female to compensate for his less frequent feedings. Because much of the food was carried within the mouth or throat, it was difficult to estimate the amount brought on each visit to the nest.

The first meal was brought by the male tanager to the nestlings in the orange tree



at 5:30 a.m. on June 1. On June 2, the last definitely recognized meal was delivered to the nestlings by their father at 5:26 p.m. Thus the period of food-bringing extended over very nearly twelve hours each day. For the twelve hours of activity, the two nestlings together received an average of 12.4 feedings per hour, or 6.2 feedings per nestling per hour.

The food of the nestling Song Tanagers consisted largely of insects. Some were of considerable size, well mangled by the bill of the parent bird before being brought to the nest. Small green grasshoppers were delivered a number of times; often I saw the tanagers fly down to the lawn to catch them. Several times they came with bits of banana from the feeding-shelf on the opposite side of the house. Often several morsels were brought at one time, one held prominently in the bill, one or more additional pieces in the mouth or throat. Or else all the food might be concealed in the mouth or throat as the parent approached the nest. The female, if she happened to be brooding the nestlings, would always fly off as the male approached with food, even if she had settled on the nest less than a minute earlier. I did not once see her take food from the male and pass it to the nestlings, as did the female Song Tanager in the annatto bush on the other side of the house. Even while rain fell hard, the female would leave the nestlings exposed when the male came to feed them, flying off out of sight, but then returning in a minute or two to shield them from the downpour until the father arrived with another meal for them.

Whenever the nestlings were sluggish in rising to take the food he had brought them, the male tanager would utter one or two sharp monosyllables, which usually had the desired effect. He would as a rule deliver the food he had brought, remove a dropping if need be, then promptly fly away. The female, on the other hand, would often linger on the rim of the nest, looking down at the nestlings even if she did not brood them, sometimes bending down her head as though arranging the lining of the nest. Each parent had its own particular position from which to feed the nestlings, the male invariably on the west side of the nest, the female on the north, toward the center of the tree.

The droppings of the nestlings were either swallowed by the parent while it stood on the rim of the nest or carried off to a distance and dropped. Both parents employed both methods of disposal, in no consistent fashion, save that small droppings tended to be eaten. Several times a parent started to carry off a big dropping, only to have it break; then it would pick the pieces from the nest and eat them. If a dropping fell on the foliage below the nest, they would fly down to remove it.

Twice on the morning of June 1 a female Variable Seedeater plucked at strands of material on the underside of the tanagers' nest, hoping to procure them for the nest she was building near by. Once her tugging shook the nest, causing the nestlings to lift up their open mouths in anticipation of food. On each occasion the would-be thief was driven off by the arrival of a parent tanager bringing food.

Again on the eleventh day after the nestlings hatched, when they were well feathered, I devoted the entire afternoon to watching them. The record made during this watch is summarized in table 9. It is of interest that from noon to nightfall the male fed 22 times, the female 38, as compared with 22 and 37 feedings, respectively, in the same hours on June 1 and 2. But although the total number of feedings was very nearly the same for the eleven-day-old nestlings as for the five- and six-day-old nestlings, the hourly distribution of feedings was rather different, as may be seen by a comparison of the tables. On June 7 the last meal was given the nestlings at 5:06, and the mother settled on the nest for the night at 5:08. On June 2, the last meal was delivered at 5:26 and the female settled down at 5:38 to brood through the night—half an hour later, although her nestlings were five days younger.

Table 9

Care of Two Nestling Song Tanagers (nest 89) on Afternoon of Eleventh Day after Hatching

Hour	Male	Feedings		Broodings by female in minutes
		Female	Both	
12:00-1:00	5	9	14	
1:00-2:00	7	9	16	
2:00-3:00	4	9	13	
3:00-4:00	4	6	10	16
4:00-5:00	2	4	6	12, 4
5:00-5:06	0	1	1	Settled for night at 5:08
Totals	22	38	60	

Weather: Cloudy from noon to nightfall, with rain from 3:24 to 3:30, 4:05 to 4:15, and at 5:08.

Thus there was at this nest a considerable increase in the rate of feeding the nestlings in their first five or six days of life, but little if any increase in their last five days in the nest. They departed early in the morning of their twelfth day after hatching.

In May, 1946, when I had the unusual nest with three nestlings, I thought it would be of interest to learn whether the rate of feeding varied with the size of the brood. During the morning when the three nestlings were 11 days old, I watched them continuously from 5:30 to 10:30 a.m. The male tanager brought food 40 times, the female 46, making a total of 86 feedings in 5 hours. Hence food was brought to the nest at the rate of 17.2 times per hour, or 5.7 times per hour for each nestling. On the other side of the house I had at the same time a nest with a single nestling. When this lone nestling was 10 days old, I watched from 5:30 to 10:30 a.m. and saw the mother feed it a total of 42 times, or at the rate of 8.4 times per hour. Although a male Song Tanager from time to time came into the vicinity of the nest, he took no interest in it. It is regrettable that these two nests differed not only in the number of occupants, but also in the number of attendants. If we draw into this comparison the observations made two years earlier at nest 89, on the afternoon when the two nestlings it held were 11 days old (table 9, period from 12:00 to 5:00 p.m.) we find that the solitary nestling was fed at the rate of 8.4 times per hour, each of the brood of two received food at the rate of 5.9

Table 10

Rates of Feeding Nestlings in the Genus *Ramphocelus*

Species	No. of nestlings	Age of nestlings in days	Hours watched	Number of feedings			Feedings per hour per nestling
				Male	Female	Total	
Song Tanager							
<i>R. p. costaricensis</i>							
nest 4	2	4-5	2	6	12	18	4.5
4	2	10-11	1.5	6	11	17	5.7
19	2	10	2	10	16	26	6.5
30	2	about 7	2	8	15	23	5.8
37	1	6-7	2	0	9	9	4.5
37	1	11-12	1	0	13	13	13.0
49	2	about 9	3	14	17	31	5.2
52	2	about 6	2	16	17	33	8.3
53	2	10-11	2	7	20	27	6.8
89	2	5-7	12	56	93	149	6.2
89	2	11	5	22	37	59	5.9
121	1	10	5	0	42	42	8.4
124	3	11	5	40	46	86	5.7
<i>R. p. passerinii</i>	2	9-12	4	3	25	28	3.5
Crimson-backed Tanager							
	2	6	3	6	13	19	3.2
	2	3	3	10	4	14	2.3
<i>R. dimidiatus</i>	2	9-10	4	10	10	20	2.5

times per hour, and each of the brood of three at the rate of 5.7 times per hour. Moreau (1939:125; 1940:243; 1941:168) in studies of several species of African swallows and swifts, found that for a lone nestling food was brought more frequently than for each member of a larger brood.

At seven other nests of the Song Tanager, I have watched the parents attend nestlings for shorter periods. The results of all my studies of the rate of feeding of nestling Song Tanagers are assembled in table 10. At all of these nests, the males brought food less often than the females, from less than half as often to 16/17 times as often. At nest 37, which is the one that changed ownership as already told, the male did not once bring food in the two hours of my vigil. At another nest, which I watched a good deal at odd times from the window of the cabin I occupied in 1937, I saw a male bring food only once, on the eve of the departure of the single nestling. These two females, as well as the attendant of nest 121, apparently had no regular mates. Also in table 10, brief records are given for nests of two other kinds of *Ramphocelus*. The male of the race *R. p. passerinii* was as neglectful of his offspring as some male Song Tanagers of the race *R. p. costaricensis*, but the male Crimson-backed Tanager (*R. dimidiatus*) brought food to older nestlings as often as his mate.

My purpose in watching briefly so many nests of the Song Tanager was to learn whether these birds have "helpers at the nest"—unmated individuals who assist the mated pair in attending the nestlings. Since Song Tanagers do not attempt to keep others of their kind at a good distance from their nests, in the fashion of territorial birds, but on the contrary are surrounded by other Song Tanagers while they rear their families, the situation appears to be favorable for the development of this form of mutual helpfulness. The great variation in the brightness of the rump and breast of the females would facilitate the recognition of individuals, should more than one attend a nest. But I have never to my knowledge seen more than one individual of each sex bring food to any one nest of the Song Tanager. Once, however, I saw two females feed a sick young bird that was fully grown, as recounted elsewhere. But other species of tanagers do have helpers. At two nests of the Golden-masked Tanager, I have watched three birds in adult plumage feed the nestlings, and at three other nests I have seen a youngster in juvenal or transitional plumage help the parents feed the nestlings. A nest of the Plain-colored Tanager on Barro Colorado Island was attended by four grown birds. Each of these nests contained merely the normal family of two nestlings.

Sometimes the male Song Tanager, approaching the nest with food in his bill, sings in an undertone. After emptying his mouth by feeding the nestlings, he may perch on a neighboring bough and sing more freely. But more often he is songless while attending the nest.

#### BROODING

In the hours immediately following the hatching of her eggs, the female Song Tanager may alter the rhythm of brooding, coming and going more frequently, but she makes little or no reduction in the total time she spends covering the nest. On the morning her first egg hatched, the female in the orange tree (nest 89) brooded 60.3 per cent of the time; the bird in the annatto bush (nest 90), 72.1 per cent; the tanager in the privet hedge (nest 107), 71.3 per cent; the mother of the three nestlings (nest 124), 61.6 per cent. At the first and fourth of these nests, the female tanager sat somewhat less constantly than while she incubated: at the second and third, the percentage of time on the nest was essentially the same as that found for incubating birds. Possibly the difference in the constancy of brooding among these tanagers was due, in part at least, to the fact that at the nest in the orange tree, and also at the nest with three eggs, the second egg hatched in the middle of the morning, while in the other two nests the

second egg did not hatch until the end of the morning. But the habit of the bird in the orange tree of always leaving the nest when her mate came with food, instead of remaining and taking it from him, was also responsible for her less constant brooding.

An instructive comparison of the behavior of the female before and immediately after the hatching of her eggs may be made from the records available for the tanager in the orange tree (nest 89). In the period from 5:35 to 11:31 a.m. on the morning of May 24, three days before her eggs hatched, this bird took 10 sessions in the nest which ranged from 12 to 38 minutes in length and averaged 23 minutes. Her 11 recesses fluctuated between 7 and 19 minutes, averaging 11.5 minutes. She spent 66.7 per cent of the time on the eggs. From 5:33 to 11:23 on the morning her nestlings hatched, she sat in the nest 14 times, for periods ranging from 3 to 33 minutes, averaging 15.1 minutes. Her 14 recesses varied from 4 to 21 minutes, averaging 9.9 minutes. She was on the nest for 60.3 per cent of the 6 hours. Thus there was a reduction in the average length of her sessions from 23 to 15.1 minutes, in the length of her recesses from 11.5 to 9.9 minutes, and in her total time on the nest from 66.7 to 60.3 per cent. After her eggs hatched, she came and went more frequently and with less regularity, as reflected in the greater variability in the lengths of her sessions and recesses. At nests of other species, I have found this increase in the frequency of coming and going even when, as often happens, the female increases her total time on the nest after her eggs hatch.

A still further analysis may be made of this female tanager's behavior during the early and late forenoon. Before 9:32, which was about the time her second egg hatched, she brooded for long periods: 28, 32, 32, 17, 17, 5 and 33 minutes. After 9:32 her periods of brooding were much shorter: 3, 7, 5, 9, 11, 8 and 4 minutes. Feedings now became more frequent. Her recesses showed no orderly variation through the morning.

At nests 90 and 107, the female tanagers sat for unusually long periods while the first egg was hatching beneath them. At the former she sat continuously for 50 minutes, at the latter for 55 minutes. These are the longest sessions I have recorded for the Song Tanager, with the exception of the midday "siesta," sessions during rain, and a single session of the tanager who incubated with unusual constancy while a second built a nest close beside her. But at nest 89 the female sat for only 32 minutes while her first egg hatched, and at nest 124 for 35 minutes. After the hatching of her first nestling, the tanager at nest 107 abruptly reduced the length of her sessions, then abruptly lengthened them again, as shown by the following sequence: 36, 55 (hatching), 10, 7, 3, 3, 2, 7, 5, 20, 23, 38, 19 and 30 minutes. Again the recesses showed no significant fluctuation, but they tended to be shorter than during the course of incubation, her 14 recesses ranging from 4 to 17 minutes and averaging 7.4 minutes.

As the nestlings grow older, the amount of brooding that they receive in fair weather, during the day, rapidly decreases. By their fifth day, when they bear long pin feathers but no expanded plumage, they are brooded for only brief periods, rarely as long as ten minutes (see table 8). By the sixth day, they are no longer brooded in fair, warm weather. But at this age their mother still keeps them almost continuously covered while it rains. During the afternoon of June 2, rain fell much of the time while I was watching nest 89 in the orange tree, which then contained six-day-old nestlings in long pin feathers. From 2:23 to 3:50 a very heavy shower came down. Within a minute after the deluge began, the female arrived to shield her nestlings from its impact, and then brooded almost without interruption for the next hour and a half until the rain stopped. In this period she was absent from the nest six times, but her departures were caused by the arrival of her mate with food for the youngsters, and her absences were very brief. Four lasted only a minute or so, one for two minutes, and one for ten minutes, this last during a lull in the rain, of which she took advantage to bring food twice to

the nestlings and remove a dropping. One of her spells of brooding lasted for 23 minutes, one for 18, one for 17, one for 7, one for 3, one for 2 minutes. Her brooding would have been more continuous if her faithful mate had not persisted in bringing food during the heavy rain, or if she had learned to take it from him and rise to feed the nestlings beneath her. This almost continuous brooding during rain is the more noteworthy because in all the remaining 10½ hours during which I watched these nestlings on their fifth, sixth and seventh days, their mother covered them only a total of 73 minutes. Of these, 11 minutes were accounted for by a single session early on the dark and misty morning of June 1; all the other periods of brooding were shorter. In the middle of the day, whole hours passed without the female's sitting in the nest.

Even when the nestlings were eleven days old and well feathered, their mother brooded them during showers. The last afternoon which they passed in their nest in the orange tree was wet, as most afternoons are at this season. Rain began to fall at 3:24, but did not become hard until 3:26, when the female tanager at once went to the nest to brood, remaining for 16 minutes although the brief shower had ceased at the end of 4 minutes. Again, when another shower came down at 4:05, she hurried up at once to cover the nestlings and sat for 12 minutes, not flying away until 2 minutes after the rain had stopped.

The female tanager broods the nestlings during their next-to-last and at times even during their final night in the nest. The mother of the three nestlings brooded the third during the night after the other two had departed.

When seven days old the nestlings still bristle with the long, dark feather sheaths. The horny coverings now ravel off very rapidly, with the result that when eight days old the young tanagers are beginning to acquire a covering of feathers. These now quickly expand, so that by their tenth day the young are fairly well clothed. As soon as their wing feathers have developed sufficiently to sustain them on short flights, the youngsters are ready to leave the nest.

#### DEPARTURE OF THE NESTLINGS

On June 8, I watched the departure of the two nestlings from the nest in the orange tree (no. 89). In the dim light at 5:31 a.m. the mother flew from the nest where she had brooded through the night. Two minutes later the father arrived with food, and he needed to give two sharp calls to arouse the two drowsy youngsters for their breakfast. After another two minutes the mother was back with food. Feedings now followed in rapid succession; in the first half hour of the morning the male tanager brought food four times, the female eight. By 6:12 the nestlings were becoming active and restless. At 6:18 one hopped upon the rim of the nest. Four minutes later one was on the rim and the other on a twig beside the nest. The latter hopped back to the rim, but from here promptly jumped up to a higher twig. When the mother next came with food, she found the young surfeited, but continued to offer the food first to one and then to the other, until the one above the nest at last swallowed it. Then this young tanager lost its hold on the twig and fluttered downward through the spiny branches of the orange tree, appearing to be in danger of impaling itself upon one of those needle-sharp, two-inch-long thorns. But at length, suffering no injury, it managed to catch hold of a lower branch and stop its fall. After two minutes here it again lost its footing and struck out with its wings, covering several yards before it landed on the grass. A moment later the other youngster also flew from the orange tree. Both promptly vanished into the hedge at the back of the yard. In the 57 minutes which elapsed between their first meal of the morning and their disappearance, they received food 20 times, 7 from the male and 13 from the female parent.

The departure of these young tanagers was entirely spontaneous; the parents had

made not the slightest effort to entice them from the nest. The older was 12 days old within less than an hour. The younger was between 11 days and 20 hours and 11 days and 22 hours of age. That same afternoon the two nestlings left the nest (no. 90) in the annatto bush in front of the house. I had expected that they would not depart before the following morning and had set up the blind on the lawn with the intention of watching their exit. Perhaps the disturbance occasioned by placing the blind hastened their departure. The first was between 11 days 6 hours and 11 days 12 hours of age, the second between 11 days and 11 days 6 hours. Usually the young Song Tanagers leave the nest on the twelfth day following that on which they hatch, more rarely on the eleventh or thirteenth day.

A very curious thing happened to a nestling in 1937. About two yards away from the tanager's nest in the orange tree beside my thatched cabin was a nest of big, black wasps. One day during my absence, some children attempted to destroy the wasps' nest. Whether they paid for their efforts I did not discover, but the twelve-day-old tanager did. When I left the cabin in the morning the young bird was in the nest, but when I returned in the afternoon it was perching low among the weeds in front of my window in a pitiful state. One or possibly more of the wasps had stung it upon the head or neck. The latter was swollen to several times its normal size, the crown of its head was greatly raised, and the skin was drawn backward from the eyes by the pressure of the swelling. The tightly stretched skin was translucent and, I thought, turgid with a subcutaneous accumulation of watery liquid. Hoping to afford the unfortunate bird some relief, I punctured its skin with a needle. The head and neck rapidly returned to their normal size, but without the escape of a single drop of liquid. The enormous swelling had been caused by gases alone! It would be interesting to know the chemistry of this phenomenon.

I kept this young tanager in my room over night. At dawn, when I returned it to the bushes whence it had been taken, it seemed to be recovering. After daybreak the mother resumed feeding, but no male tanager brought it food. During the preceding afternoon, while the young bird's neck was greatly swollen, the mother fed it many times, while for several minutes a male flew around bearing food which in the end he swallowed. It was interesting to see the mother tanager look for the fledgling's droppings after giving it food. Once she carried a dropping away, although, since the young bird was no longer in the nest, there was no point in doing so. I have seen birds of other kinds, including a Yellow-bellied Elaenia and a Rufous-breasted Castle-builder, carry away the droppings of fledglings that had left the nest.

#### THE YOUNG AFTER LEAVING THE NEST

After quitting the nest, the stubby-tailed fledglings are led to a low dense thicket where they remain well hidden for about three weeks. Those reared about my lawn were led to the thick hedge of *Stachytarpheta* at the back, and here the parents brought them bits of banana from the feeding shelf. They never followed their parents over the lawn and through the scattered shrubbery, in the manner of young American Robins, but remained in close concealment, like fledgling Song Sparrows. Both parents carried food to the hidden youngsters, but the female more than the male.

When the young Song Tanagers emerged from hiding and began to follow their parents about, they were hardly inferior to them in size and length of wing and tail, and they could fly with ease. Often they would accompany their parents to the feeding table and perch on a branch above it, with quivering wings and calling shrilly, while the adults carried up food and placed it in their mouths. Later, becoming bolder, they would stand on the board and be fed there. Usually it was the mother alone who attended these full grown youngsters, but sometimes the male also fed them. As a rule, he seems to lose

interest in the young birds sooner than the female. At this stage the young tanagers joined the flocks of grown birds.

The full grown young Song Tanagers resemble the adult females, and like the latter show considerable individual variation in the brightness of chest and rump. Some at least of the young males are fairly bright orange in these regions whereas some of the young females are merely yellowish-olive, as dull as the female of the race *R. p. passerinii*. Sometimes a young bird with bright rump and one with dull rump lie side by side in the same nest.

Young male Song Tanagers acquire the scarlet-and-black plumage of the adults by means of the postjuvinal molt, which begins a few weeks after they leave the nest and effects a complete change of feathers. The first indication of the approaching change in the appearance of the young males is the presence of scattered flecks of black among the olive plumage of head, neck, back, breast and wing-coverts. In 1936 I saw young males in this condition as early as May 11, but in other years I have not noticed them until later: June 17, 1940; June 13, 1942; June 14, 1943; June 4, 1945; May 31, 1946. The black rapidly increases in the plumage and then scarlet feathers begin to appear on the rump. When the change in the contour feathers is already far advanced the molt of the remiges begins. The first of the remiges to be replaced lie about in the center of the wing; but whether these are outer secondaries or inner primaries, I have not been able to learn from inspection of free birds.

Some notion of the rapidity of the molt may be gained from records of the appearance of young males who came to the feeding shelf in 1945. On June 4 I first noticed a bird flecked with black. By June 17 the entire upper rump was scarlet, but the feathers of the lower rump and upper tail coverts had not been changed. By July 2 the regions black on the adults were about half black on the young birds, and the molt of the remiges had begun. By July 16 the most advanced of the young birds had the rump entirely scarlet and the remaining contour plumage nearly everywhere black, with only small patches and flecks of paler juvenal plumage, especially on the head and breast; but the rectrices were wholly juvenal, and most of the remiges were also dusky instead of black only a few at the center of the wing having been changed. By July 24 some of the young males bore only a few spots of juvenal plumage to break the continuity of their jet black and were difficult to distinguish from the adults. By August 5, some had completed the molt of the contour plumage and were everywhere black or scarlet. But they still bore a number of juvenal remiges and were just beginning to molt the juvenal rectrices. From these observations the complete renewal of the contour plumage would appear to require about two months; but the entire molt, including that of the flight feathers, covers a considerably longer period.

Usually by the time they begin to become flecked with black the young male tanagers have become independent of their parents. At times, however, they still beg for food. On the rainy afternoon of June 10, a young male beginning to molt perched in the guava tree above the feeding shelf beside another young bird which was apparently a female. When the mother of the latter flew up to the branch beside the black-flecked young male with plantain in her bill, he tried to take it from her, as no adult male has ever been seen to do. But the female disregarded his entreaties and gave the food to the other young bird in dull female plumage.

In the early months of the year, I have occasionally seen Song Tanagers in female plumage with more or less conspicuous flecks or patches of black on the breast and neck and at times even on the head. I at first supposed such individuals to be young males acquiring the adult plumage in the prenuptial molt. But one year, when one such bird visited the feeding shelf, I kept her under observation for several weeks in March, and she became no blacker, nor ever showed any scarlet on the rump. Such black-flecked birds seem to be abnormal females rather than young males.

The change in coloration of the young male Song Tanager is a definitely seasonal process and so conspicuous a phenomenon that scarcely anyone who pays attention to this species could overlook it. During the early months of the year, and until the young begin to hatch, all the males in the entire population are so much alike in appearance that I could never detect any difference between the oldest and the youngest. But with the females the situation is quite different. Even in March and April, some females are a very much brighter orange on breast and rump than others. Probably the females become brighter as they grow older, but if so this is so gradual and imperceptible a process that I have never been able to detect how it comes about. In an earlier section of this life history we told how a bright female captured the nest of a far duller one. Apparently the captor was an older and more forceful bird. The variability in the coloration of the females within this race is interesting when considered in relation to the heterogynism or geographic color variation of the females in the species as a whole, as compared with the uniformity of the males.

#### THE BREEDING SEASON AND SECOND BROODS

The earliest eggs of the Song Tanager are laid, as we have seen, in March or April in the basin of El General, earlier in a wet than in a dry year. The latest nests of which I have records were two found at the end of September, 1936. One of these contained two nestlings which were on the point of leaving when the nest was shown to me on September 24; the other was found on the following day and contained two nestlings about ten days old. These are my only September records of nests. Even in late July and August nests are rare, the great majority of the birds breeding between March and June. From early March to mid-May, 1944, the Song Tanagers built and laid at least one egg in 18 nests in the immediate neighborhood of my house; but with the possible exception of one too high and well concealed in an orange tree to be examined, all 18 of these nestings failed to produce a single offspring. Then in June, four pairs succeeded in fledging young. After this, I found only a single nest, from which the young departed on July 31. There was no nest in August or September.

Much has been written about the long breeding season of tropical birds. In the lowlands, some few kinds do indeed nest, *as species*, throughout the year, but for most the nesting season is no longer than that of many a bird that breeds 35 degrees or more from the Equator. The nesting season of the Song Tanager can be matched, for example, by that of the Bluebird, which in Tennessee Laskey (1940:189) found breeding from February into September. The Song Sparrow nests in Ohio from early April into September (Nice, 1937:98). Even as far north as England, the House Sparrow may lay in December and attend nestlings in late August (Coward, 1928:55).

How many broods does the Song Tanager rear in a year? From experience with the birds about my house, I doubt if they often rear more than one. Yet I have a certain amount of evidence that they do at times attempt to produce a second brood, meaning by this a second nesting after a *successful* first nesting. At the end of May, 1937, I watched a pair which while feeding nestlings were followed by full grown young birds, who at times begged for the food in their bills, but so far as I saw received nothing. Probably these were the young tanagers which hatched in a neighboring nest on March 24 and left on April 4. If this inference is correct, the interval between the departure from the nest of the young of the first brood and the laying of the first egg of the second brood was about 34 days. In late May, 1942, a pair of Song Tanagers were attending nestlings in a lemon tree in front of my house. On most of his visits to the nest, the father of these half-grown nestlings was followed by a full grown youngster, who clamorously begged for the food intended for the little birds in the nest, and with such success that



it intercepted half of it. But the mother of the nestlings was not so easily persuaded; and although the full grown youngster often begged of her, it received nothing from this source, so far as I saw. This young tanager did not follow the mother as it did the father. Again, in 1942, on July 17 I found an egg in a nest from which the first brood had departed at the end of May. The female tanager continued to incubate the single egg. In April, 1946, a tanager laid two eggs in an orange tree behind my study but hatched only a single nestling which disappeared before it was feathered. By the end of the month there were again two eggs in this nest, and this time a single nestling was fledged, leaving on May 21. A month later, I was surprised to find the female tanager incubating two more eggs in this old nest, for among Song Tanagers the re-use of nests is unusual. This is the extent of my evidence for the second brood.

#### THE QUESTION OF POLYGAMY

Belt (1888:7) surmised that *Ramphocelus passerinii* is polygamous, basing his opinion on the fact that in eastern Nicaragua he so frequently saw several females with a single male. The numerical preponderance of females appears to be no greater in the eastern than in the western race of this species, so that it is likely that if one is polygamous the other is likewise. Except for the absence of all but the weakest instinct to guard a territory, the behavior of the male during the nesting cycle—his attention to the female while she builds and incubates and his subsequent care of the young—is, as we have seen, essentially that of a monogamous bird. In other genera of tanagers, as for example *Tangara*, the impulse to defend a territory is likewise weak, yet these little tanagers fly in pairs at all seasons and there can be no doubt of their essential monogamy. The laxity of territorial defense sometimes permits three or even four adults to feed the young in a single nest, but the presence of one or two birds in addition to the true parents does not necessarily signify a departure from strict monogamy. In many but by no means all species of tanagers the male helps to build the nest; so far as known he never incubates; but he almost invariably feeds the nestlings.

Birds with well developed polygamy usually nest in colonies, as oropéndolas, grackles and other Icteridae, or they possess highly specialized methods of courtship, as manakins and birds of paradise. Such situations are unknown in the tanager family. When I first found two or more nests of the Song Tanager built close together, I thought they might belong to females who possessed the same mate. Attempts to make a simultaneous study of two closely neighboring nests came to naught because of the premature loss of one or both of them. But later, when I watched two females trying to build a nest together, each was attended by her own mate; hence we may conclude that the proximity of two nests is no proof of bigamy. The fact that at nearly every nest the female, at least after she ceases to devote much time to brooding by day, brings food more often than the male, at times twice as often, suggests that the male might be attending two nests at once. But I have never been able to prove that this is so; and the very prevalence of a slower rate of food-bringing by the male should lead us to doubt that this springs from a division of loyalties; for the loss of nests is so high that, granting that he had two mates, it is unlikely that both of them would nearly always have nestlings at the same time. The male tanager's slower rate of food-bringing seems rather to spring from an innate rhythm. But at certain nests, of which we have given three instances, the male does not attend the nestlings at all or feeds them only rarely. I believe that these nests belonged to female tanagers not regularly mated. I am sure that monogamy is the prevalent condition among Song Tanagers; but a certain proportion of the females apparently form temporary attachments to mated males, because there are not enough males for every female to have a separate mate. In other species of passerine birds in

which monogamy is the usual state, a local or seasonal excess of females may give rise to a similar situation.

#### NESTING SUCCESS

It is difficult to form a true estimate of the reproductive success of a bird such as the Song Tanager. Some nests are so well hidden among the dense foliage of orange trees that it is difficult to reach them with a ladder or to see what they contain by raising a mirror above them. Either of these modes of examination may open the surrounding foliage and so leave the nests more exposed to the view of predators than they originally were. As the nestlings grow older, a visit to such a nest, no matter how carefully made, may drive them prematurely from its shelter and so decrease their chances of reaching maturity. If we disregard these nests most likely to be successful because they are so excellently concealed, we obtain too low a figure for reproductive success because we base our study only on lower or more exposed and presumably more vulnerable nests. If we visit and include in our reckonings the high, well screened nests, we also get too low a value for reproductive success because we ourselves have been responsible for decreasing the chances of survival of these nests.

In 1944 I made an effort to find all the nests in an area of 3.75 acres (1.5 hectares), which included the yard surrounding the house with its shade trees and shrubbery and the pasture in front of the house with its shade trees and the fringe of trees, bushes and vines along the bank of the creek that bounds the area on the north and east. Along the western side of the area was the hedge of *Stachytarpheta* where the Song Tanagers roosted, beyond which was a hillside pasture that offered few good sites for nests. On the south the area was bounded by tall second-growth woodland and forest where the shade was too deep for the tanagers. In these 3.75 acres, I discovered, between March and July, 23 nests of the Song Tanager, counting only those in which at least one egg was laid. From an analysis of the dates when these nests were built and occupied, it appeared that 5 or possibly 6 females were nesting in the area. This figure agrees well with that of the number of males that sang about the edges of the yard at dawn. Five or 6 nests were successful and produced at least one fledgling, whence it appears that each female built nest after nest until she at last reared a brood, then suspended her reproductive activities until the following year. Taking the more liberal figure of 6 successful nests, we obtain a reproductive success of 6 out of 23 or 26 per cent, which is by no means unusually low for birds which breed at lower elevations between the tropics.

The chief enemies of nesting Song Tanagers in this area were toucans and snakes. Swainson Toucans and Frantzius Aracaris, but chiefly the latter, periodically came out of the neighboring forest and searched through the trees in the yard for birds' nests. Although not actually caught molesting nests, so far as the Song Tanagers were concerned, they were surprised in the act of eating the eggs or nestlings of other birds among the same trees; and I have little doubt that they were responsible for most of the losses from at least the higher nests of the Song Tanagers. It was only after the toucans ceased to visit the yard so frequently, possibly because they were now finding more food in the forest, that the tanagers began to have success with their nests. An effort was made to keep the yard free of snakes and no actual case of predation by them was discovered in the area under study, although doubtless such losses occurred; we have already given an instance of the loss of a Song Tanager's nest by a snake.

#### SUPPLEMENTARY NOTES ON

#### **Ramphocelus passerinii passerinii**

When Thomas Belt reached Greytown, Nicaragua, in 1868, one of the first land birds which came to his attention, and the first to which he devoted a paragraph in his

classic "Naturalist in Nicaragua" (1888:6-7), was the Scarlet-rumped Black Tanager (race *Ramphocelus passerinii passerinii*). Had he landed at almost any other point along the Caribbean coast of Central America between southern México and western Panamá, he would have found this species almost equally prominent, for everywhere in the humid lowlands on the eastern side of Central America this is one of the most abundant and conspicuous members of its family.

*Ramphocelus passerinii passerinii* ranges upward on the more humid mountain slopes of the Caribbean drainage to at least 5500 feet above sea level. At this altitude I sometimes met wandering flocks on the northern slope of the Cordillera Central of Costa Rica, although during a year's residence in this region I found no indication that they nested so high. In Guatemala this form seems not to extend half so far above sea level.

On rare occasions, especially at dawn, I have heard the male of this race of Scarlet-rumped Black Tanager sing a simple little song. I had already passed two nesting seasons among these tanagers before I discovered that they had any song. But at break of an April day I surprised a male in the Motagua Valley of Guatemala singing his dawn-song. Perching high in a tree that stood in a bushy pasture, he repeated over and over a phrase consisting of two short, squeaky notes followed by a low whistle, continuing this for about five minutes. Years later, on the Caribbean slope of Costa Rica, I heard males singing sweet-voiced but very simple refrains, one of which sounded like *viree chip viree chip viree chip* . . . , indefinitely continued. Thus, the song of the Caribbean race of this species is as a rule less forceful than that of the subspecies which inhabits the Pacific side of Costa Rica, and is far less often heard.

In the Caribbean lowlands the nesting season of the Scarlet-rumped Black Tanager extends from early March through much of July. My earliest nest was found near Almirante in western Panamá on March 9, 1929, when it contained two freshly laid eggs; my latest, near Tela, Honduras, held eggs on July 18, 1930. The site chosen for the nest is a bush, tangle of vines, tall tussock of coarse grass, clump of ferns, or low tree, in an overgrown pasture, maize field, marsh, or edge of a plantation. Nearer human dwellings the nest may be placed in a lemon or orange tree or in a dense hedge of hibiscus. Those which I have seen ranged in height from 2½ to 6 feet above the ground.

The full set of this race of the Scarlet-rumped Black Tanager appears invariably to consist of two eggs. These are pale blue, marked with coarse irregular blotches and finer spots of black, or of brown, or of both together. The color and density of the markings varies greatly from set to set, and even on the two eggs of the same set. The measurements of eight eggs averaged 24.3 by 17.0 millimeters. Those showing the four extremes are 25.8 by 16.7, 23.8 by 17.5, 23.0 by 17.1 and 24.6 by 16.7 millimeters.

At one nest the two nestlings, already feathered, were fed 25 times by the mother in the course of four hours whereas they were fed only 3 times by the male. Of six nestlings, five left the nest at the age of 11 days and one when 12 days old. I have seen young males molting into the black-and-scarlet plumage of the adults as early as April 20 in Costa Rica and May 2 in Guatemala.

#### SUMMARY

Of the two subspecies of the Scarlet-rumped Black Tanager, one (*Ramphocelus p. passerinii*) occurs on the Caribbean side of Central America from western Panamá to southern México; the other (*R. p. costaricensis*) is confined to the Pacific side, in the region of high rainfall in southern Costa Rica and neighboring parts of Panamá. Although the males of these two subspecies are scarcely distinguishable, some of the females of the Pacific form are much brighter than any of those of the Caribbean form.

At all seasons these tanagers live in loose flocks in dooryards, plantations, lush

second-growth thickets, and similar habitats, but they avoid woodland with a nearly closed canopy. They breed up to 4000 feet above sea level on the Pacific side, and are met as stragglers up to 5500 feet on the Caribbean slope of Costa Rica.

Females are always considerably more abundant than males. No territory is defended and real fighting by either sex has never been seen. They are most excitable birds, often raising a great outcry over a large, moribund moth or some other harmless thing.

The food consists of a great variety of hard and soft fruits, with a preference shown for bananas where available, and it also includes many insects, spiders, and the like.

These tanagers roost gregariously in low, dense vegetation, more rarely in trees with thick foliage.

The males, especially of the Pacific race, are so much more songful than most tanagers that they merit the name "Song Tanager." Their songs are long-continued rather than brilliant. At dawn they sing near their roost, each bird at a particular post, which bears no definite relation to his mate's nest site. Even later in the day the males sing without much regard to territory or nest. These tanagers begin to sing freely when the first rain falls in March or sometimes late February, earlier in wet than in dry years, and they continue until July or August. The females are songless.

The females begin to build at about the same time that the males start to sing, sometimes in late February but more often in March. The nests are situated in bushes or scattered trees at heights of 1 to 20 feet, but rarely above 12 feet unless in a tree whose dense foliage offers exceptionally good concealment. Although usually scattered through suitable territory, occupied nests are sometimes close together, exceptionally only four inches apart. The males take no part in building but often follow their mates.

Once two females were found building a single nest. Later one of them began a new nest a yard away. Then each of the two continued for several days to tear material from the other's nest and carry it to her own, with the result that neither structure was completed.

The open, cup-shaped nests are built in three to five days, rarely more.

Eggs are laid at about sunrise on consecutive days. Only four of nearly 200 nests contained more than the usual two eggs. In two consecutive years a female laid a set of three in the same dooryard. Another set of three eggs and one of four were the product of two females.

Incubation is performed by the female alone. She sits sporadically during the day on the first egg before the second is laid, and she sometimes sleeps on it. After laying the second egg she may begin promptly to incubate with normal assiduity or she may gradually work up to full constancy. Diurnal sessions on the eggs range from a few minutes to nearly two hours in length, but they are rarely over an hour long except just after mid-day, when the females seem to take a "siesta" on their eggs. In normal incubation the females cover their eggs for 70 to 75 per cent of the period of diurnal activity, rarely more. One female kept her eggs covered with unusual constancy while another built only four inches away.

The male often escorts his mate to near the nest and at long intervals he may bring food and present it to the unhatched eggs, but he has not been seen to feed the female.

A dull female incubating two eggs had her nest wrested from her by a much brighter female, who laid in it and continued to incubate all the eggs. The change in ownership was effected without actual fighting.

The last egg of a set usually hatches from 12 to 12¼ days after it is laid. The first minute fracture of the shell may be detected 18 to 29 hours before the occupant emerges. Eggs hatched even after a night's exposure to the rain when incubation was well advanced. So far as seen, the empty shells were always eaten by the female.

At four nests the female first brought food from 29 to 64 minutes after she ate the shell from which the first nestling escaped. The males first brought food from 38 minutes to 24 hours after the shell was eaten. The probability that the male will begin promptly to feed the nestlings is increased by his habit of coming to the nest with food from time to time before the eggs hatch; but at some nests he began feeding so soon after the first egg hatched that it seemed that he was led to do so by some special cue, possibly by seeing his mate carry food.

The nestlings are fed throughout the day, with hourly fluctuations which appear to depend chiefly on their hunger or satiety. After the first few days, the hourly rate of feeding varied chiefly within the range of 4.5 to 8.3 times per nestling, with an extreme of 13 times. Females nearly always feed the nestlings more actively than males, sometimes bringing food twice as often, or even more. At some nests no male was found in attendance. Food was brought for a lone nestling more often than for each member of a larger brood.

On the morning when her eggs hatch, the female makes little or no reduction in the total time she spends on the nest, although she usually comes and goes more frequently. On succeeding days the time devoted to brooding is rapidly decreased, and when six days old the nestlings receive scarcely any brooding in fair weather. But even on their last full day in the nest they are covered by their mother while rain falls. She broods the nestlings through their next-to-last and often also through their final night in the nest.

The nestlings' plumage begins to expand when they are eight days old, and two days later they are fairly well clothed. They usually leave the nest on the twelfth day following hatching, less often on the eleventh or thirteenth day. If undisturbed, they leave spontaneously, without parental urging, and they are promptly led to dense sheltering vegetation, where they remain in close concealment for about three weeks. Then, at the age of about one month, when practically full grown, they begin to fly about in the flocks with their parents. The female as a rule continues to feed the young after the male has lost interest in them.

Fledglings of both sexes resemble the adult females and show about the same range of color on breast and rump. Young males begin to acquire the black and scarlet plumage of the adults a few weeks after leaving the nest. After the molt of the contour feathers is well advanced, that of the remiges begins.

In El General occupied nests are found from March to September, but there are few after July. Although some pairs with well grown fledglings attempt to produce a second brood, apparently the majority are satisfied if, after repeated trials, they rear a single brood.

Except for their failure to defend a territory, the pattern of nesting behavior of the Song Tanagers is essentially that of a monogamous bird; but because of the excess of females, those which cannot find a mate form irregular attachments to males already paired.

In a small area that was intensively studied, 5 or 6 of 23 nests produced at least one fledgling. The chief predators on Song Tanagers' nests appear to be snakes and toucans.

## CRIMSON-BACKED TANAGER

### *Ramphocelus dimidiatus*

The Crimson-backed Tanager ranges from Colombia through eastern and central Panamá, on the Pacific side of this Republic reaching as far west as the province of Chiriquí. Like other members of its genus, it is a bird of the lowlands, and of the clearings and more open country rather than the heavy forest. My own experience with this beautiful tanager is limited to the Canal Zone and the Cauca Valley in Colombia. In the former region it is abundant among the low, lush, bushy growth that covers large areas of abandoned clearings, and in plantations, orchards, dooryard shrubbery, and along the roadsides. In the Cauca Valley, it is not rare in the moister areas of bushy growth on the outskirts of the city of Cali, at an altitude of 3000 feet above sea level. In the Santa Marta region of northern Colombia, it has been reported to occur as high as 5000 feet above sea level.

When, in February, 1935, I arrived on Barro Colorado Island in Gatún Lake in the Canal Zone, I found that a pair of Crimson-backed Tanagers (*Ramphocelus dimidiatus isthmicus*) had established their home in the narrow clearing about the laboratory buildings. Here they roamed over about two acres of hilly land diversified by shade and fruit trees, ornamental shrubbery, a small banana plantation, and the tangled growth of bushes, vines and great-leaved herbs, such as heliconias and shell-flowers, about its neglected margins and corners. They were isolated from others of their kind, on three sides by the lofty wall of forest, into whose shady depths they never ventured far; while in front stretched a mile or so of open water, over which they were never seen to fly. Yet this pair or their ancestors probably reached this island by venturing across one of the narrower straits that separate it from the opposite mainland and then working along the wooded shores.

The male Crimson-backed Tanager was the most brilliant bird of the clearing. His predominant color was blood red, which he wore on his lower back and rump and most of the under parts of his body. This vivid hue shaded off to a more subdued dark crimson-maroon on his head, back and chest; yet in full sunlight these regions appeared as bright as the remainder of his body—a peculiar color-effect which is developed in even higher degree in the Silver-billed Tanager of South America. His upper mandible was black; the lower, white, tipped with black, very conspicuous with its swollen white base. The female was dressed in the same general pattern as her mate, but her colors were paler and more subdued. The two were inseparable and always darted across the clearing in close company, like vivid streaks of flame.

Dr. Frank M. Chapman had made a feeding table for the birds of the clearing on Barro Colorado Island. A pair of wires strung between his cottage and a tree at the edge of the forest supported a tray, which could be pulled in to the porch to receive the food and then drawn out until it hung several yards above the ground and midway between the supports. At this point it would be difficult for any four-footed creature to pounce upon the birds while they feasted. But a coati-mundi learned to climb laboriously out along the wires to the swinging table, lured by the ripe bananas placed upon it. This quadruped and the pair of Crimson-backed Tanagers were the only warm-blooded diurnal creatures which had at that time formed the habit of eating Dr. Chapman's bananas. Tanagers of the genus *Ramphocelus* are extremely fond of this fruit and readily attracted by it.



Fig. 22. Male Crimson-backed Tanager.

#### THE FIRST NEST

One day in mid-February, I noticed that the Crimson-backed Tanagers, after eating freely of the ripe bananas on the swinging tray, flew off with additional pieces in their bills, apparently intended for their offspring. Although I followed in the direction of their flight, it was not easy to discover where their young were hidden. Finally, I concealed myself in the upper end of the clearing, where the tanagers were usually to be found, and saw the male, with food in his bill, fly down into a hedge beside one of the walks. Following his movements, I promptly found the nest. It was so well concealed amid the compact foliage of the hedge of *Polyscias guilfoylei*, 5½ feet above the ground, that we had all passed close beside it many times without suspecting its presence. It was a shallow, open cup, composed of fibers and partly decayed leaves, bound together with cobweb. Although it bore considerable resemblance to the nests of the Scarlet-rumped Black Tanager, it was of frailer construction and lacked the green spray of trailing polypody fern which nearly always embellishes the exterior of the latter. There were two nestlings, already nearly feathered, which bore a general resemblance to their mother. While I examined their young, both parents protested in loud monosyllables with a nasal twang.

These nestling tanagers left their nest on February 22, when they could scarcely fly. The parents led them into the close-set bushes and vine tangles on the western border of the clearing and there continued to feed them. Both the father and mother tanagers still visited Dr. Chapman's feeding table on the opposite side of the clearing and carried billfuls of banana across the open space to their young, who remained well hidden in the

dense vegetation. So well did they keep under cover that I did not even glimpse them until the nineteenth day after their exit from the nest. Two days later, grown bolder, they ventured out as far as some fruit trees just within the edge of the clearing. Now, three weeks after their departure from the nest, when they were about 32 days of age, they were not noticeably smaller than their parents and so closely resembled their mother that the yellow corners of their mouths were the readiest means of distinguishing them from her. Yet careful scrutiny revealed that they were a trifle duller in coloration.

Even now they did not accompany their parents to the feeding tray but waited on the opposite side of the clearing for their return and took their food with fluttering wings. I thought it strange that the youngsters, who could fly very well, did not follow their elders to the source of supply. But the old birds themselves never remained long out of concealment and darted rapidly across open spaces, as though realizing full well how conspicuous they were. In this respect the Crimson-backed Tanagers differed in a notable manner from the Song Tanagers in southern Costa Rica; for the males of this species often rest for considerable periods on high, exposed perches, where their intensely brilliant scarlet rumps attract the eye at a distance of several hundred feet.

#### BUILDING THE SECOND NEST

On March 13, nineteen days after the young of the first brood flew from the nest, I discovered that the Crimson-backed Tanagers had recently begun a second nest, situated in the same hedge which had so well concealed their first one, but at the opposite end, forty feet away. Watching on two mornings from concealment, I saw the female alone bring material to the growing structure. She was exceedingly wary, as the sequel proved she had good reason to be, and approached through the dense thicket at the edge of the clearing, which came quite close to the end of the hedge where the nest was being built. The narrow intervening open space was crossed by a rapid dart, close to the ground. Entering the hedge-plants near their roots, she rose through their close-set branches to her nest. A small tool house stood close beside this part of the hedge; and sometimes the female tanager circled this, passing between the building and the forest just behind it, choosing the more protected route of approach rather than the shorter way across the clear space. Despite her desire not to expose herself to the eye, she was very noisy and constantly repeated a full nasal note, which gave warning of her approach through the thicket and betrayed her presence as she arranged the materials at the nest.

The male tanager frequently accompanied his mate to the nest, and while she worked there perched in a neighboring tree to sing his appealingly simple little song: *Sweet, you do; sweet, you do, you do*. At dawn he would sing so for many minutes continuously. Now that the young tanagers were bigger, and probably found a portion of their own food, he sang more often than while they were a greater care. In the first two days of building, I failed to see them near the nest; but early on the third morning they approached it with their parents.

The male also failed to give material aid to his mate in building her third nest in the following month. In this he agreed with his near relative, the Song Tanager or Scarlet-rumped Black Tanager. But male tanagers in numerous other species of diverse genera (*Tanagra*, *Chlorophonia*, *Tangara*, *Thraupis*, *Eucometis*) take an important share in building the nest.

#### INCUBATION

On March 17, four days after I found it, the second nest in the hedge was completed. Since it was already well started when it first came to my attention, probably five or six days were occupied in its construction. The first egg was laid before 9:00 a.m. on



March 18, the second on the following day. The eggs were light blue, thickly sprinkled with irregular black spots of various sizes, a few spots of pale lilac, and some black scrawls. These eggs measured 23.0 by 17.5 and 21.4 by 16.7 millimeters; two more eggs laid later by the same female measured 23.8 by 17.5 and 21.4 by 16.7 millimeters. Incubation began with the laying of the second egg.

At 12:30 p.m. on March 26, the seventh day of incubation, I entered my brown wigwam blind set close beside the hedge to make a record of the events at the nest. I watched until 5:15 that evening, then from daybreak until 11:37 the following morning. As with all other tanagers that I have watched in similar fashion, the female Crimson-backed Tanager alone covered the eggs. Her periods of sitting ranged from 16 to 89 minutes, with an average, for 10 sessions, of 39 minutes. Her recesses ranged from 11 to 36 minutes, with an average, for 9 recesses, of 21.9 minutes. Her three sessions before 8:35 in the morning ranged from 16 to 30 minutes, while her periods of sitting later in the day were generally longer, with the longest 89 minutes in the late afternoon. Aside from this, there was little regularity in her comings and goings. In the ten hours of my record, she covered the eggs a total of 390 minutes and was absent 197 minutes. Making allowance for the fact that the record included one more session than recess, she covered the eggs 64.1 per cent of the time. Once she climbed slowly out of the nest to capture some insect she spied on the foliage a few inches away, swallowed it, and returned at once to her eggs. I did not include this momentary absence in the record.

As the female tanager returned to the nest at the end of a recess, she voiced fairly loud, nasal notes, which would seem to nullify all her caution in making the approach, unless the enemies she chiefly feared possessed far keener sight than hearing. Usually she alighted low in the hedge, then climbed up through the branches to the nest. Her mate, and sometimes also one of the young birds of the first brood, often accompanied her part of the way to the nest. Usually they paused in a neighboring tree, where the male sang while she settled down on the eggs. Once, however, he followed her almost to the nest. He was more attentive in the morning than in the afternoon.

Ten minutes after I began my watch on the afternoon of March 26, while the female was absent from the nest, the male came to it with an insect in his bill, perched on the rim, and uttered continuous, low, cheeping notes, as though coaxing very young nestlings to receive food. He bent his head down into the nest, as if to feed the nestlings, but they were still in the shells. He then flew away, still bearing the insect in his bill.

At 10 o'clock the following morning, 4 days before the eggs were to hatch, the male tanager again brought food to the nest, this time a green insect. Upon reaching the rim he found his mate sitting and hesitated, not seeming to want to give the food to her, while she on her part evinced no eagerness to receive it. Finally he passed it to her; then she returned it to him. I believe it passed back and forth once again; but since the female sat with her tail toward me, I could not see very well. Finally she swallowed the offering, which appeared not to have been intended for her. An hour and a half later, the male tanager again appeared with food in his bill. The female flew from the nest as he approached, and he undoubtedly saw her depart; yet he continued to the rim of the nest and looked in, the while murmuring a low, pleasant twitter. Again he found that the eggs were unhatched and he was obliged to carry the food away.

The behavior of both the male and his mate left no doubt in my mind that these three morsels of food were not intended for her. Courtship feeding is not infrequent in other genera of tanagers, including *Tanagra*, *Chlorophonia*, *Tangara* and *Thraupis*; but I have never witnessed it in any species of *Ramphocelus*. The male was in fact bringing food for the nestlings. I have witnessed such anticipatory food-bringing by male birds of several other kinds, but this behavior seems far more rare among female birds

than among males. Such conduct gives us tantalizing glimpses into the mind of a bird and furnishes strong grounds for doubting the dicta of those who affirm with confident authority that non-human beings live only in the present. If the male Crimson-backed Tanager did not anticipate the future, what was he doing? The "releaser" for food-bringing—a gaping nestling mouth—certainly was not present to him, except perhaps as he remembered it from his previous brood. The same impatience to begin to feed the nestlings, which causes some male birds to offer food with great earnestness to unhatched



Fig. 23. Female Crimson-backed Tanager on nest at Barro Colorado Island, Panamá Canal Zone, March 30, 1935.

eggs, leads others to attend nestlings in neighboring nests of their own or other species, until their mates hatch out their own offspring.

Most of the time while the female tanager incubated, the male remained with the young birds of the previous brood. Now about 45 days old, they attempted to feed themselves; but on two of the three occasions when I saw them pluck berries, they dropped them from their bills. Once, after clumsily losing a big berry, one of the young tanagers quivered its wings and called, as though begging to be fed. It reminded me much of a little child who, having attempted to accomplish a task beyond its strength or skill, petulantly cries out for its mother's help. I saw some indications that the father tanager still fed the young birds; but, except when they followed their mother to the vicinity of the nest, they lurked in such close seclusion amid the foliage that it was difficult to make sure of this. Dr. Chapman told me that the male still carried bits of banana from the feeding tray; and it was not banana that he took to the nest. The call of the young tanagers was now a slightly squeaky whistle, which in tone-quality reminded me much

of the song of the Crimson-collared Tanager. By night, the male and at least one of the young birds roosted among the dense foliage of the hedge, very near the first nest. Peering in among the leaves at dusk, I could see the youngster perching in the top of the hedge; and although it must have seen my head only a foot away from its own, it did not budge.

Both of the eggs hatched on March 31, twelve days after the last was laid and incubation begun. Twelve days was also the period of incubation at the third nest of this pair. Young *Ramphocelus* tanagers are all very much alike, with pink skin in no wise concealed by the sparse but rather long, gray natal down of the usual passerine distribution. The inside of the mouth is red, as in all the nestling tanagers I have seen.

#### CARE AND FATE OF THE NESTLINGS

When the two nestlings were six days old and covered only with short pin feathers, I spent three hours watching their nest from the blind. Between 6:25 and 9:25 in the morning, the mother brought food thirteen times, the father, who had been so eager to begin feeding, only six times. The male Song Tanager also usually feeds the nestlings less often than the female, at times only half as much. While the female Crimson-backed Tanager brought only insects to her six-day-olds, their father often gave them the flesh of the pitangua berries (*Eugenia uniflora*) from a bush with ripe fruit growing near the nest. The nestlings were so well supplied that they soon became surfeited; and by means of low, clucking notes, such as the male had used when he brought food to the eggs, their parents urged them to stretch up their mouths and take more. Although the little birds responded by raising their gaping bills, they were so stuffed that they could scarcely swallow more and the parent transferred the morsel back and forth from one to the other, until at length one gulped it down with the requisite promptitude. But sometimes the mother herself was obliged to eat the last particles of what she had brought.

In the early morning, the mother brooded the nestlings for six short periods, ranging from two to nine minutes in length. But after eight o'clock, the day becoming quite warm, she no longer sat on the nest. If she happened to be covering it when her mate arrived with food, she flew off to leave him a clear field rather than take it to pass it on to the nestlings. As was to be expected from the fact that he neither helped build the nest or to incubate, the male tanager never brooded.

The young tanagers of the first brood still foraged with their parents and sometimes followed them to the vicinity of the nest. I had hoped that I might see them feed their younger brothers and sisters, as young Groove-billed Anis, Barn Swallows, Neotropical House Wrens and other birds sometimes do. But the two-month-old tanagers were apparently having a difficult time in finding enough food to satisfy their own hunger, for they still begged of their parents. Once a juvenile of the first brood followed its mother almost to the nest, perched in the hedge a few feet away, and begged for food with pleading calls and quivering wings. So far as I could see, after the second brood hatched not even the father heeded these importunities.

When eight days old, the nestling Crimson-backed Tanagers were fairly well feathered, and they now crouched down in the nest in fear when I went to visit them. They were still brooded by their mother the following night. Early in the afternoon of the next day, while writing in the library, I heard the parents call repeatedly in full, nasal tones. Hurrying out to learn what the trouble might be, I found the young birds drowsing snugly in their nest and could discover no cause for alarm. I started off down the hillside; but before I had gone many paces the tanagers' cries re-commenced, and I paused to watch. In addition to the parent tanagers and their two grown young, other birds began to gather around the scene of excitement. There were a pair of Streaked Flycatchers, a pair of Green Honeycreepers, a female Variable Seedeater, a House Wren, and others that I

could not recall when the commotion was over. Suspecting a snake, I ran back quickly to the nest and saw a big serpent with one of the nestlings in its distended mouth. Its nest-mate had meanwhile jumped from the nest and started to hop away across the path. When I had attended to the snake, a yellow-spotted, gray mica (*Spilotes pullatus*) four feet long, I tied up the damaged nest and replaced the surviving young tanager.

Next morning at dawn I found the surviving nestling sleeping alone. It was now too well feathered to require brooding. Returning to my room, I heard the tanagers calling excitedly as they had done the previous afternoon. Knowing now what to expect, I found another snake, smaller and of a different kind, at the nest; and a bulge a few inches behind its head betrayed where the second nestling had gone. Now I understood why the female tanager had always been so cautious in her approach to the nest. Since snakes have imperfect organs of hearing, perhaps her oft-repeated calls did not make any difference.

#### THE THIRD NESTING

After the loss of their nestlings, both the parent tanagers roosted in the *Polyscias* hedge, along with their two grown offspring of the first brood. But less than ten days after their loss, the female began to build once more. This time she moved to a greater distance, choosing as her site a red-leafed cordyline bush down the slope in front of the main building. Here she built four feet above the ground. The new nest was finished on or about April 21. On the twenty-third, the first egg was laid, the second on the following day. Both hatched on May 6, after twelve days of incubation.

The two young tanagers hatched in February continued to keep close company with their parents while the latter reared their May brood. Both still resembled the female in plumage—possibly both were females, for young male Song Tanagers of this age begin to acquire the more intense colors of the adults. Being older now, I thought they might help to feed the nestlings, but I watched in vain for this. Social bonds are strong within species of *Ramphocelus*. They flock during the breeding season and have no real territories; and the scarlet-rumped species, in which females conspicuously outnumber the males, are sometimes polygamous. But their sociability apparently seldom leads them to feed nestlings other than their own.

During three hours on the nestlings' third morning, the male brought them food ten times, the female four. She, however, brooded them half the time, once for 55 minutes continuously, while rain fell hard. The brilliant crimson of the male tanager's plumage contrasted prettily with the light red of the foliage among which he stood to feed his nestlings, coaxing them with a queer, low note, produced without opening his bill, whenever they were sluggish about opening their mouths for food.

The eyes of the nestlings opened when they were three days old. When nine days of age, they were well covered with plumage, which they preened much as they sat in the nest. Sometimes they exercised their wings, flapping them above their backs. The rainy season now prevailed; but the parents brought food through the showers, taking little account of them. Yet when a harder downpour came, the female brooded the feathered nestlings for ten minutes, although she had otherwise ceased to cover them by day. They were already so big that they more than filled the nest, and she was obliged to sit on top. Rain often causes parent birds to brood after they have ceased to do so in fair weather. Now both parent tanagers took about equal shares in bringing food, each feeding the nestlings ten times in four hours on their ninth and tenth days. When a Yellow-rumped Tanager, attracted by the calls of the nestlings, went to look into the nest, the two older juvenal Crimson-backed Tanagers joined their parents in driving the inquisitive visitor away.

The female brooded the nestlings for the last time on the night of May 15 to 16. Early in the afternoon of May 16, when the nestlings were ten days old, the parent tanagers again began to call in alarm, as on the day when the snake attacked their second nest. Their nasal complaints drew quite a crowd of their neighbors, among other birds several Plain-colored Tanagers, a pair of Blue Honeycreepers, some Bananaquits and the Streaked Flycatchers. Suspecting that a snake was lurking near the nest, I searched carefully through the surrounding grass and bushes, but could discover no



Fig. 24. The biological station on Barro Colorado Island in Gatún Lake, Panamá Canal Zone. Crimson-backed Tanagers, Blue Tanagers, Golden-masked Tanagers, Plain-colored Tanagers, Buff-throated Saltators and Bananaquits nested in the clearing about the buildings.

cause for their disquiet. At length leaving the birds, I went inside to write; but the continued cries of distress of the parent tanagers, reaching me through the screened windows, drew my thoughts away from my notebook. Several times in the next two hours I returned to their nest, but always looked in vain for the cause of their continued anxiety. Finally I decided to watch from the blind, which was still in position on the slope above the cordyline bush. Thence I saw that the tanagers perched often upon a low branch of a rosebush growing near the nest, cocked their heads to one side, and peered down into the weeds growing two feet below, at the same time reiterating their full, nasal cries. Emerging then from my concealment, I beat through the herbage beneath the rosebush, driving out a large, yellow-spotted mica. This big snake preys insatiably upon eggs and nestlings and is one of the most destructive enemies of nesting birds in all Central America.

Then I returned to my hiding place to learn what the tanagers would do next. They had fled while I killed the snake, but they returned as soon as I had concealed myself. Their first concern was to perch upon the branch of the rosebush above the spot where their enemy had lurked for so many hours. They peered down into the weeds to see whether it still lay in ambush there. They had been so agitated by their long period of tension and fear that they did not completely quiet down during the next hour. They continued to call far more than was customary with them, and they returned again and again to look down at the spot where the serpent had lain. During this period, 4 to 5 p.m.,

they entirely neglected to feed their nestlings, who had crouched down motionless in the nest while in danger, but who now began to move about and call for food.

That night a single nestling slept alone in the nest. Its nest-mate had hopped out in the evening. Next morning I found it among the weeds beneath the cordyline bush and returned it to the nest. But the eleven-day-old youngsters were restless, preening much, flapping their wings, and moving about a great deal. The nest had become strongly tilted toward the side on which the parents always alighted; and presently one of the active younglings fell out. It slid over the flat, glossy surfaces of the big cordyline leaves, and despite valiant efforts to hold on, went slipping and tumbling from leaf to leaf until it

Table 11

Chronology of Leading Events in the Lives of a Pair of Crimson-backed Tanagers  
on Barro Colorado Island

February 19—First nest found in hedge, with two nestlings.	10—Another snake swallows the other nestling.
February 22—Two nestlings leave the nest.	21—Female completes her third nest.
March 13—Second nest in hedge well started.	23—First egg laid.
17—Second nest completed.	24—Second egg laid.
18—First egg laid before 9 a.m.	May 6—Both eggs hatch.
19—Second egg laid; incubation begun.	9—Nestlings' eyes begin to open.
31—Both eggs hatch.	15—Nestlings are well feathered.
April 8-9—Nestlings brooded during night for last time.	15-16—Female broods at night for last time.
9—A snake kills a nestling.	16—Nestlings narrowly escape a snake.
	17—Nestlings leave nest.

came to a halt on the ground. Since it appeared unable to fly, I decided to return it to the nest; but as I did so the other young tanager took fright and discovered how to use its wings. It flew about twenty feet and came to rest in an orange tree growing down the slope, whither the parents hurried. As seems usually to be the way, the little bird who had just left the nest for a while received most of its parents' attention and nearly all the food they brought; the stay-at-home was temporarily neglected. But after the appetite of the fledgling in the orange tree had been satisfied, they took the food to the other in the nest, until it, too, ceased to call for more. In the course of the morning this young bird also sallied forth from the nest. Returning at noon, I found the tilted nest empty.

To complete our study of the Crimson-backed Tanager, it may be well to repeat here the records of a few additional nests found by others. Stone (1918) mentions two nests found by Jewel, one on March 3 and the second on June 11, each containing two eggs. Hallinan (1924) discovered a nest on May 10 with four eggs, and one on May 24 with two eggs. All these records are from the Canal Zone. It is likely that the four eggs in the same nest were laid by more than one bird, for species of *Ramphocelus* have sets of more than two only with extreme rarity.

## SUMMARY

Crimson-backed Tanagers dwell in bushy second-growth, plantations, and dooryard shrubbery, from sea level up to about 5000 feet. The present study was made of a single pair which in 1935 occupied the small clearing in the forest on Barro Colorado Island, Canal Zone.

The open nest was built by the female alone while the male followed when she went for material and sang as she shaped the structure.

Two eggs, the usual number, were laid on consecutive days. A set of four, reported by Hallinan, was probably produced by two females.

Only the female incubated. In the course of ten hours her sessions ranged from 16 to 89 minutes and averaged 39 minutes; her recesses ranged from 11 to 36 minutes and

averaged 21.9 minutes, and she spent 64 per cent of the time on the eggs. At two nests the incubation period was 12 days.

Four days before the young hatched, the male presented food to the eggs, the while uttering low notes as though coaxing nestlings to open their mouths. Once when he came with food and found the female sitting, she reluctantly took it from him.

Both parents fed the nestlings, the female somewhat more frequently than the male. From one nest they left at the age of 11 days.

After leaving the nest, the young of one brood kept out of sight in dense vegetation for the next 19 days, or until about a month old, after which they came into the edge of the clearing. Even when 45 days old they were clumsy in taking food, dropped berries from their bills, begged from their parents, and were probably fed at least occasionally by their father while their mother incubated the next set of eggs. They continued to beg even after the second brood hatched, but apparently they were no longer fed.

The female resumed laying 24 days after the young of the first brood left the nest. The two nestlings of the second brood were killed by two snakes within a period of less than 24 hours. Thirteen days later the female, having completed a third nest, began to lay her third set of eggs.

The young of the first brood, when three months old, continued to accompany their parents while they attended their third nest. They helped to drive away trespassing birds, but they took no part in feeding the nestlings.

## RED ANT TANAGER

### *Habia rubica*

The dim underwood of the tropical rain-forest is not an environment which favors the production of intense colors in either the vegetable or animal kingdoms. The bright red flowers of some acanthaceous shrubs, the scarlet of the great vine-leafed passion-flower, the intense azure of the morpho's wings, the flashing green and violet of the wood-nymph hummingbirds, the vivid bill of the Orange-billed Sparrow—these are outstanding exceptions in a habitat where blossoms tend to be small and dull, and birds are clad in shades of brown or olive. The bright colors of the tropical forest are concentrated in the sunbathed upper levels, where trees and creepers and epiphytes display lavish masses of bright flowers and where the brilliant parrots, toucans, hummingbirds, trogons, cotingas and honeycreepers occur. Here in the woodland tree tops, or in the clearings that admit the sunlight, dwell a great variety of tanagers, that most colorful avian family of the western hemisphere. Few of these birds are at home in the undergrowth of the heavy forest; and here they tend to lose the brilliant hues of their family, to become more like the dull antbirds, ovenbirds and flycatchers with which they mingle. One of these exceptional genera of tanagers which pass their lives in the underwood of heavy forest is *Habia* or *Phoenicotheraupis*, which is widespread throughout tropical America.

The Red Ant Tanager (*Habia rubica*) is one of the larger members of its family, about seven inches in length. The male is deep, dull, subdued red on the upper plumage, paler on the more posterior under parts. From time to time one catches a glimpse of vivid scarlet in the middle of the black stripe that runs over the top of his head. This vivid color belongs to an erectile crest of elongated, narrow feathers that is seldom fully displayed, and then but briefly, although it is not infrequently partly revealed. The female's plumage is olive, with a greenish tinge in full sunshine; her throat is more yellowish; and over the top of her head there is a median dark stripe which at times parts to reveal a hidden patch of dull orange or ochre, corresponding to the scarlet crest of the male. In both sexes the thick bills are dusky and the eyes brown. From the confusingly similar Rosy-throated Ant Tanager, with which the Red Ant Tanager comes in contact in many parts of its great range, it can be distinguished by the dark stripe which forms a border on either side of the expanded bright crest; the Rosy-throated Ant Tanager lacks this contrasting margin.

The Red Ant Tanager extends across the tropical American mainland from southern México to northern Argentina, Bolivia and western Ecuador. The Panamanian form, *H. r. vinacea*, which will chiefly occupy our attention, is restricted to Panamá and Costa Rica. In the latter country it ranges upward, according to Carriker (1910:843) to at least 4000 feet above sea level; and in the basin of El General I found it fairly abundant up to 3300 feet. Here it is a bird of the heavy primary forest, beyond whose vine-tangled borders it scarcely ever wanders. Although my dooryard borders the woodland where it roams, and from which at times its notes are heard, I have not once in a dozen years seen it among my shade trees; and it has never come to sample bananas on the feeding shelf that attracts so many other kinds of tanagers. In this it resembles a great many other birds of the understory of the rain-forest; although some, like the Orange-billed Sparrow and the Bicolored Antbird, occasionally wander into the open, and others, like the Blue-black Grosbeak and Salvin Manakin, habitually do so.

Although the Red Ant Tanager constantly proclaims its presence in the underwood of the forest by its incessant chatter, it is not for that reason easy to observe; for it is



skillful in keeping itself screened by the dense foliage and exceedingly restless. It so constantly shifts its position and flutters from bush to bush that even if one succeeds in seeing it, he as a rule enjoys but a fleeting glimpse. These birds usually remain near the ground, rarely rising to the upper levels of the forest, and they travel about in company with other small birds of the underwood, such as the Slaty Antwren, Chestnut-tailed Automolus, and, at higher altitudes, the Stripe-crowned Warbler. Although it is difficult to count birds so retiring and restless as these tanagers, what I have seen of them leads me to believe that they remain in pairs through most or all of the year, and like most birds of the mixed forest flocks, they avoid other individuals of their kind beyond their own immediate family. As with other forms of *Habia* that I know, they are not often found with army ants; were the application of the name "ant tanager" to this genus not sanctioned by long usage, it might be better to give it to the Gray-headed Tanager; for *Eucometis* is a far more regular follower of the myrmecine hordes, at least in Central America.

#### VOICE

It is perhaps not wholly without significance that the two tanagers that dwell in the undergrowth of the heavy forests of the valley of El General are less brilliant in plumage than most of the local representatives of their family and are here its most notable songsters. Probably where striking coloration serves to attract a partner, song is reduced to a minor role in the advertisement of territory and the formation of pairs and tends

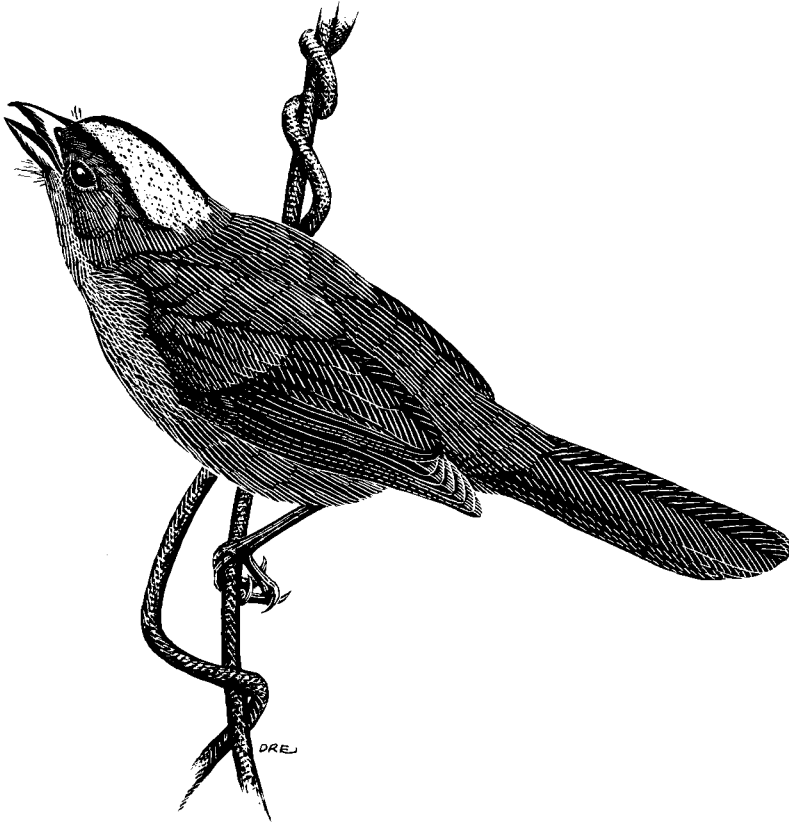


Fig. 25. Male Red Ant Tanager.

to become poor and weak. Of the two forest-dwelling tanagers to which we here refer, the Gray-headed is the more appealing songster, but the Red Ant Tanager has the more varied repertoire. He is, in fact, a vocalist with an amazing range of tones and moods, the most versatile that I know in the whole tanager family. Most of the ornithologists who have written briefly of the habits of the several species of *Habia* have commented on their loud, harsh voices. The loudest of the notes uttered by the Red Ant Tanager when surprised by man as it roams through the woodland are less harsh than those of some related forms, the Rosy-throated Ant Tanager, for example, and are mixed in incongruous fashion with softer and more pleasant calls. On rare occasions the male pours forth a softly warbled refrain of singular beauty, seldom long continued. A male whose nest I watched uttered low, sweet warblings as he came with food in his bill.

Different again from all the other utterances of the ant tanager is his dawn-song, which I came to know soon after my arrival in El General. From late January until well into June this is one of the notable sounds of the waking forest. His voice at this time is loud and clear, but scarcely liquid. Different individuals adopt slight variations of the same theme. One version of the dawn-song sounded to me like *peter, peter, peter . . .* continued indefinitely at a uniform rate, with no separation into phrases to relieve the monotony of the insistent chant. Another ant tanager repeated interminably a phrase which called to my mind the word *intervene*. A third, as though to introduce a small measure of variety into his performance, sang *intervene* from 4 to 6 times without a pause, then rested momentarily before beginning a new sequence. Yet another sang *peter-bird* from 6 to 15 times continuously, with pauses of 8 to 10 seconds between series. In 1942 and 1943 an ant tanager sang each morning in the low, dense vegetation at the forest's edge 50 yards from my house. In a bright, crisp voice, and in a continuous flow without break or pause between phrases, he would sometimes seem to sing *intervene, intervene, intervene . . .*, while on other mornings I would hear *peter-bird, peter-bird, peter-bird . . .*

The monotonous song starts in the dim first light when the forest birds begin to waken and is continued tirelessly for many minutes, until finally silenced by the growing daylight. This ant tanager, unlike some of his close relations, does not mount to a high and conspicuous perch to deliver his dawn-song but remains as always well concealed amid thick undergrowth, often near the forest's edge. Accordingly, I have never enjoyed a really satisfactory view of him as he sang at dawn. The dawn-song is so different in form and tone both from the usual chatter of the ant tanager as he roams through the forest and from his sweet warbled song that, until I heard it later in the day, I could not believe that it was an utterance of the same bird. Like the dawn-songs of the flycatchers, which it resembles in the endless repetition of a single simple phrase, this song is rarely heard at a later hour, and then as a rule only when the birds are excited by rivalry or perhaps by an escape from sudden danger. When I overheard the notes of the dawn-song while the sun was high, there were usually several ant tanagers in the vicinity; and their sharp, excited calls left no doubt of their identity even when foliage screened them from view. Once I heard a song intermediate between the dawn-song and the sweet warbling, that in phrasing was like the former but in its soft tone approached the latter. While one male ant tanager gave the warbling song as he came to the nest with food in his bill, another voiced a subdued version of the dawn-song in the same circumstances.

Very different in form and in the position chosen for delivery, and far more melodious, was the dawn-singing of the ant tanagers that I heard in the neighborhood of Colomba in the Department of Quezaltenango in western Guatemala in July, 1935. Here, in the coffee plantation of San Diego, about 3000 feet above sea level, the backs and sides of

the long, steep ridges of volcanic soil were occupied by coffee groves; these were largely under the shade of tall trees left standing when the original forest was thinned to receive the coffee seedlings. In the bottoms of the deep, narrow valleys were remnants of unspoiled forest, with much dense, impenetrable second-growth on the precipitous intervening slopes. In the lush vegetation of these humid ravines was a considerable population of both the Red and the Rosy-throated ant tanagers; and in the remnant of forest at the confluence of two rushing mountain streams, nine feet up in a sapling, I found the slight, open nest of the latter, containing two eggs. With these two rather similar species present, the identification of the males who sang so profusely, generally well above my head, was a matter of considerable difficulty; but so far as I could tell these were all Red Ant Tanagers, probably of the race *salvadorensis*.

All through the day the ant tanagers at the plantation lurked in the dense vegetation of the valley bottoms and lower slopes, where I sometimes heard their harsh chatter and more rarely saw them. But at dawn the males rose to the edges of the coffee plantations to sing, from an exposed perch some 40 or 50 feet up in a tall shade tree, or even from the topmost boughs. Now in July the Gray's Thrushes were falling silent at day-break; and the ant tanagers had the air almost to themselves, singing generously in a manner one would hardly expect from the musically deficient family of tanagers. Their song, lovely in its simplicity, consisted of from seven to nine loud, clear notes, with considerable pauses between the well marked phrases; it was repeated at the rate of about eight times per minute. While I listened near one, from both slopes of the valley I would hear the answering songs of other ant tanagers, all delivered in the same clear, far-carrying voice. There were considerable differences in the tone and phrasing of the several individuals. The total effect was not that of a chorus so much as of a kind of responsive singing. While performing, the birds often spread their scarlet crown-patches, which shone out brightly even in the half-light of dawn.

The full tide of music lasted about three-quarters of an hour, but the more persistent songsters continued for nearly an hour, usually staying on the same perch throughout this long period. Toward the end of the protracted performance their songs became more widely spaced; and by preening, scratching, and stretching wings and tail, they revealed that zeal was waning. Then, of a sudden, each would dive straight downward, almost seeming to fall, from the high tree top down the steep slope to the denser vegetation in the ravine while their mates remained unseen. From far below a few scattered verses of the same song might then float up to me. By a quarter to six all had ceased their morning singing, and I rarely heard it again until the following dawn. The ant tanagers began to sing somewhat later than the thrushes, orioles, ground-chats and sparrows, possibly because they ate a little before embarking on such a long vocal performance, more probably because in the dense vegetation in the deep, narrow valleys where they lived, daylight came a little later to awaken them.

Chapman (1929:270) has given high praise to the song of the Dusky-tailed Ant Tanager, now considered to be the Isthmian race of the Rosy-throated Ant Tanager. He wrote that "it was composed of sixteen highly musical, flute-like notes so exactly separated by the intervals of our scale that, judged even by human standards, they formed a true song." But I recall that he used to paraphrase this song as *glad to meet you*; and so it sounded to me as I heard it at dawn. Probably the longer song mentioned by Chapman was formed by running together four of the basic phrases. We heard a Rosy-throated Ant Tanager deliver this same song in the evening, which suggests that, unlike the Red Ant Tanager and most other birds with typical dawn-songs, but like the Streaked Flycatcher and the Wood Pewee, this tanager sings in both the morning and the evening twilight.

## THE NEST

In the valley of El General the breeding season of the Red Ant Tanager extends from February until at least June. Here I have found eight nests, all in the primary forest, although sometimes in a bushy opening between the trees. All were situated in saplings or slender bushes, often such as were entwined by vines or climbing ferns, and at heights ranging from  $5\frac{1}{2}$  to 18 feet above the ground. But the highest nest was exceptional, and 6 of the 8 were between 6 and 12 feet up. The structure is a broad and usually shallow cup, composed of rootlets and fibers, those on the exterior coarse, those in the lining finer, all together forming a fabric so thin and open that the eggs are visible through the meshes of the bottom. Coarse strands of spider's silk are used to bind the nest to its support, which is sometimes the trifurcation of a slender stem. A typical nest measured 3 inches in internal diameter by  $1\frac{1}{2}$  in depth.

Once I found a female ant tanager with fibrous material in her bill and saw her go to a nest she had newly begun. Later I set up a blind and spent  $3\frac{1}{2}$  hours watching, but I saw her bring material only four times more. On each occasion her loud, harsh notes announced her approach through the undergrowth before she could be seen. But she was silent while actually at work arranging the strands in her nest. Her mate did not appear. This nest was never completed, probably because the site chosen for it failed to provide adequate support.

## THE EGGS

From two nests the single egg was lost before the set was complete, and another contained a single nestling. Of complete sets, there were three of two eggs and one of three eggs. Alvarez del Toro (1952: 18) described and figured a nest of the race *rubicoides* from Chiapas, México, that contained two eggs on May 26. The eggs are dull white or have a faint bluish tinge and are marked with speckles and blotches of pale brown or cinnamon, sometimes also with chocolate spots, which are gathered in a wreath around the large end and sparingly scattered over the remaining surface. One had instead of definite spots a smoky brown band around the thick end, where also were some faint grayish mottlings and a few very fine brown dots, with still fainter dots toward the sharp end. The measurements of 5 eggs average 24.3 by 17.7 millimeters. Those showing the 4 extremes were 25.0 by 17.5, 24.6 by 18.3, 23.0 by 17.5 and 24.6 by 16.7 millimeters.

The distribution according to the month of laying of 7 nests in the valley of El General, 2200 to 3200 feet above sea level, is as follows: February, 1; March, 1; April, 1; May, 3; June, 1.

## INCUBATION

Incubation is performed by the female only. On June 9, 1949, I found my eighth nest of the Red Ant Tanager in the forest on the ridge behind my house. It contained two eggs well advanced in incubation. Two days later the female was sitting when I came to set the blind on the steep slope above the nest. She flew off at my approach, but soon returned to cover her eggs while I worked 20 feet away. An abrupt movement by me sent her again from her nest, but she promptly came back to it in my presence. On June 12 I watched her incubate from daybreak until at 1:23 p.m. I was driven from the blind by rain and hunger. In the  $7\frac{1}{2}$  hours of my vigil she took only 3 sessions on the eggs, lasting 88, 121 and 142+ minutes (the third not completed when I left), and 3 recesses of 21, 26 and 51 minutes. Thus she incubated for more than 78 per cent of the time, a good record for a tanager. After each excursion she chattered loudly as she settled on the eggs but thereafter she incubated in silence, sometimes preening as she sat. At times a thin stripe of dull orange, narrowly bordered on each side by black, was visible along the center of her crown; but at other times these brighter feathers were

all folded down and invisible, leaving only a narrow median line of black over her head. Once early in the morning I heard her mate in the distance, but otherwise he stayed out of sight and hearing.

At two nests found before the set was complete I attempted to learn the length of the incubation period but was defeated by the premature loss of the eggs.

#### THE NESTLINGS

The newly hatched nestlings have pink skin sparsely shaded by long, dark-gray down, and their eyes are tightly closed. The interior of the mouth is red.

At 6:30 on April 12, 1940, I began to watch a nest containing two nestlings that had hatched in the preceding night. In the next 4 hours their mother brought food to them 5 times. She brooded 6 times for periods ranging from 8 to 34 minutes and was absent for 6 periods ranging from 6 to 40 minutes. She covered the nestlings for a total of 119 minutes. Although the male sometimes accompanied his mate on her return to the nest, especially early in the morning, he always stopped short several yards from it and did not once go to look into it. The pair would approach voicing loud notes in sharply contrasting tones, many of them harsh. The female exercised much patience in delivering food to her newly hatched nestlings, which seemed to experience difficulty in swallowing even the small larvae that were well crushed in her bill. Sometimes after trying for several minutes in vain to make the nestlings eat, she was obliged to swallow the food herself.

The following morning at 6:45 I resumed my watch at this nest. At 7:07 the mother returned with a small larva, gave it to a nestling, then brooded. Her mate followed her, bearing a large green caterpillar and uttering low, sweet warbling notes interrupted by loud, harsh calls. He approached to a point about three yards from the nest, hesitated there, then went off with his caterpillar. The female brooded until 7:23, flew away, and seven minutes later returned to feed and brood, again followed by her mate. He then went off, but while the female sat he returned with a morsel and went to the nest. The mother flew away, and standing by the nest he coaxed the nestlings to receive his offering. Since they would not take it he swallowed it himself, ate a dropping, and flew away. In the 3 hours of my watch the female brought food 5 times. The male came thrice with food, but only on his second and third visits went all the way to the nest with it, and both of these times he failed to deliver it because it was too big for the nestlings. Since my earlier watch had shown that his visits to the nest were at best infrequent, how did he discover that the nestlings had hatched? Possibly he made a visit of inspection in the interval between my two vigils, possibly also he brought food because he had seen his mate do so. The fact that when he first appeared with something in his bill he did not go up to the nest with it lends weight to the second supposition. He did not, like his mate, adjust the size of his offerings to the nestlings' capacity; had she been as blundering as he, they might have starved because offered items that were too large. While at the nest, the only point where I could see him well, he kept his bright scarlet crown patch quite folded under; or at most I caught a glimpse of brilliant color in the middle of the black median line. In these 3 hours, the mother brooded the nestlings for 5 periods ranging from 9 to 35 minutes and totalling 89 minutes, with 4 completed absences ranging from 6 to 38 minutes.

On June 23, 1949, when the two nestlings in the nest where I had studied incubation were 8 days old and studded with pin feathers, I watched them for the first 5 hours of the morning. Although quite without expanded plumage to cover them, the nestlings were brooded only once, for 14 minutes, by their mother. She brought food 17 times, the male 12 times, and there was one more feeding early in the morning when the light

was so dim beneath the high forest trees that I could not see the parent's color and determine its sex, making a total of 30 feedings, or 3 per nestling per hour. So far as I could see, the food consisted wholly of larvae and mature insects. Many of the offerings were so big that the youngsters gulped them down with difficulty. One especially large insect was swallowed only after ten minutes of valiant efforts by the youngsters and their mother. Each time that one failed to swallow it, she took it again into her own bill and mashed it flatter, and the flatter it became the more its width exceeded that of the nestlings' throats. Dozens of times it was given to a youngster only to be taken again into the mother's bill for further treatment. At last one succeeded in laboriously gulping it down. Then it voided a dropping, which the mother carried away. With such substantial meals, the babies required few feedings; and the parents did not need to make many visits which might betray the nest's position to predators.

In approaching the nest, which was six feet up in a slender sapling, the parent tanagers flew low and came to rest on some support near the ground, to look carefully around before rising to its level. This mode of approach was admirably indirect and revealed great caution on the part of the tanagers; but at the same time they often, although not invariably, came, delivered the food and flew off with much sharp chatter that would certainly have betrayed their position to any predator that hunted with its ears. Other types of predators must be abundant and efficient; for all my nests of the Red Ant Tanager were prematurely destroyed by them, and I was unable to determine the length of the nestling period.

#### SUMMARY

Red Ant Tanagers occur in humid lowland forests and in Costa Rica range up to about 4000 feet above sea level. Never forming flocks of their own kind, they wander in pairs through the lower levels of the woodland, usually in company with a variety of small birds of other species. They seldom follow the army ants.

These garrulous birds have a remarkable variety of notes. Their calls, now harsh, now softer and more pleasant, are uttered almost incessantly as they wander through the forest. At times the male delivers a soft warble of singular beauty. At daybreak he sings a special song seldom used later in the day except under the stress of great excitement. This dawn-song consists of a simple phrase of two or three sharp, clear notes reiterated incessantly for the better part of an hour. This song usually is given from a low perch amid dense vegetation.

In El General nesting begins in the dry month of February, but the majority of nests are found after the rains begin in April, May, and June. The open nest is placed in the forest undergrowth, usually in a slender sapling or bush, from 5½ to 18 feet up.

The two or sometimes three eggs are incubated solely by the female. One female took very long sessions, ranging from 88 to more than 142 minutes, and she covered her eggs more than 78 per cent of an observation period of 7½ hours.

The nestlings, which bear sparse natal down, are brooded by the female and they are fed by both parents. Two nestlings eight days old were fed 30 times in five hours of the morning. The food consisted of larvae and mature insects, many so large that the youngsters swallowed them with great difficulty. In approaching the nest, the parents always flew near the ground, well below the level of the nest.

## GRAY-HEADED TANAGER

### *Eucometis penicillata*

With gray head and neck, bright olive-green upper plumage and clear saffron-yellow under parts, this fairly large tanager is conspicuous amid the dark undergrowth of the forest, and it is not easily confused with any other species with which it mingles. The sexes are alike in plumage, and both have black bills and dark eyes. The species as a whole, as delimited by Hellmayr, ranges from the Yucatán Peninsula southward through Central America to northern South America. From Caribbean Central America, north of Panamá, it has rarely been recorded, but it is abundant in the Pacific lowlands from Nicaragua to Chiriquí. The more southern forms have conspicuous light crests, but the race *Eucometis penicillata stictothorax*, which now engages our attention, is crestless. It is found on the Pacific slope of southern Costa Rica and western Panamá as far as the province of Veraguas. In the former republic it ranges upward into the foothills to at least 3500 feet above sea level, nesting up to no less than 3000 feet.

Primarily a denizen of lofty rain-forest, the Gray-headed Tanager does not hesitate to enter adjacent areas of second-growth, or even to cross bushy fields and shady pastures in search of food and sites for its nest. In the valley of the Río Buena Vista on the upper side of the basin of El General, I often met these birds in the narrow fringe of woods along the river. Here the spreading, epiphyte-laden boughs of tall and gnarled sotacaballo (*Pithecolobium*) trees cast a heavy shade over the low rocky shore, and perhaps a few trees of other kinds grew to the landward of them, and there was an undergrowth of canes, bushes and tangled vines. I saw Gray-headed Tanagers in these narrow, elongated groves even where they were separated from the nearest extensive area of forest by thousands of feet of intervening cornfields, open pastures, or low and dense second-growth thickets—types of country through which these birds might swiftly pass, but where they never lingered.

Gray-headed Tanagers are most often seen about the deployed hordes of foraging army ants, forming part of the motley band of birds which subsist upon fugitives from the ants. Shyer than many of the antbirds and other members of the mixed flock, they usually fade away through the undergrowth on the approach of the bird watcher; but like other ant followers, they appear to eat the insects and other small creatures stirred up by the myrmecine army rather than the ants themselves. At all seasons they are usually met in pairs, or in groups of three or four, which seem to be parents with full grown offspring.

#### VOICE

The Gray-headed Tanager is one of the most gifted minstrels in its family. Long-continued, complex in form, always sweet and appealing, its song is most often delivered in a modest, subdued voice. *Whichís whichís whicheery whichís whichú* is, I believe, a fair rendering of the song of a male bird I heard while he helped to build the nest. Sometimes the *whichís* was delivered thrice rather than twice at the beginning of the song; rarely a *whichí* followed the *whichú* and terminated the verse. Very often the song was abbreviated, the final syllables omitted. But one Gray-headed Tanager who sang profusely while he followed army ants on a sunny morning in June had a song far longer and more elaborate than that just described. It flowed smoothly on from verse to verse, and now and again it rose into a jubilant crescendo. It was as fine a song as I have heard from any tanager and would have done credit to a thrush. While singing, the male Gray-headed Tanager often rises well above the lower levels of the forest where he dwells,

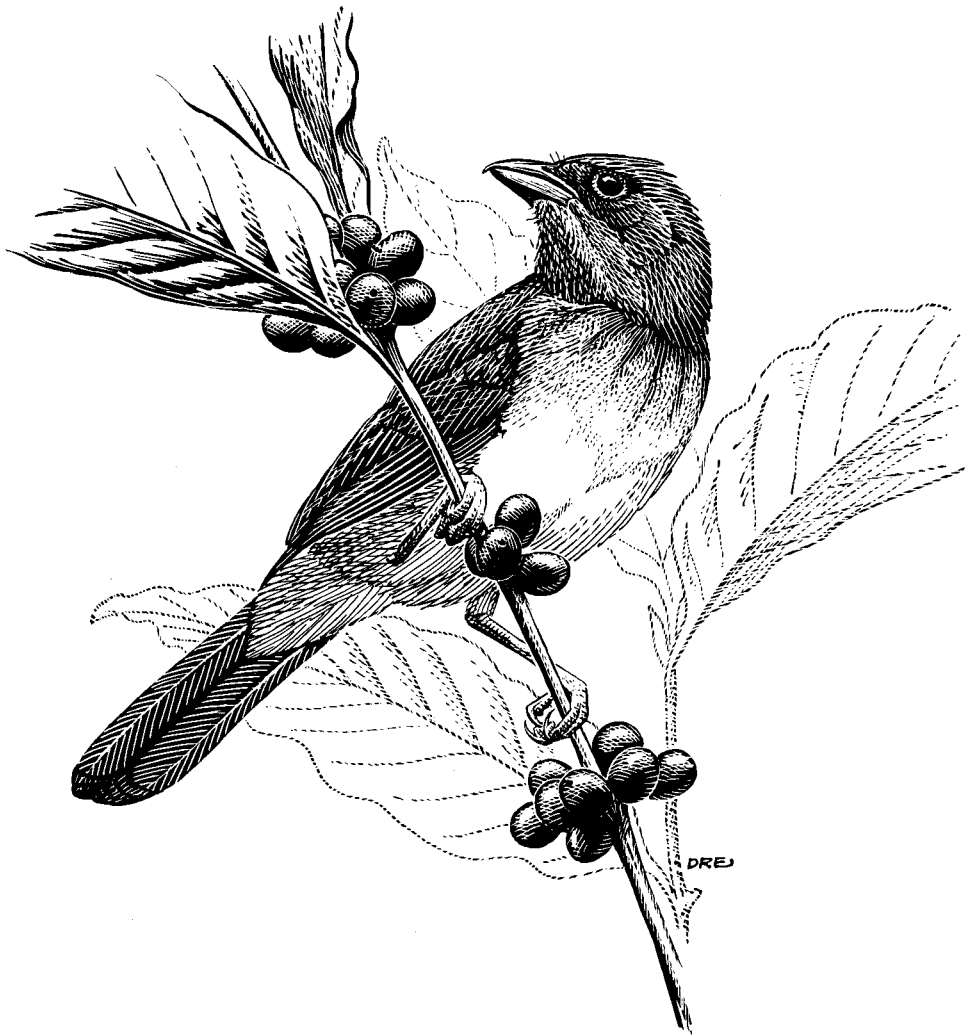


Fig. 26. Gray-headed Tanager.

sometimes almost to mid-height of the taller trees, but never, so far as I have seen, to their lofty crowns.

While following army ants, Gray-headed Tanagers voice a subdued *chip*, much softer than the sharp *whic* of the race of this tanager (*E. penicillata cristata*) of Colombia. While building, one pair uttered a rather squeaky *tseet tseet tseet*, the weak note repeated rapidly from once or twice to five or six times. Both sexes, but especially the female, of another pair gave low *chips* while constructing the nest.

#### NEST BUILDING

The 15 nests of the Gray-headed Tanager that I have found showed a wide choice of sites, but all were low. Thirteen of these nests were at heights of from 26 inches to 6 feet above the ground. One on level land was 8 feet up; and one supported among vines that covered over a slender bush leaning over a low cliff was 10 feet above the



base of the cliff. Only 2 of the 15 nests were in high primary forest, and both of these were in the crowns of small palms fiercely armed with long, sharp, black spines. Seven nests were in coffee bushes in small plantations, at distances varying from about 200 to 1000 feet from the forest. One nest was supported between the close-set, coarse, upright stalks of a tussock of Job's-tears grass (*Coix Lacryma-Jobi*) growing in a neglected banana grove, about 250 feet from the forest's edge. One of the lowest of the nests, 32 inches up, was placed amid some low *Piper* bushes at the edge of a pasture, 10 feet out from the bushy margin of the high forest. Another nest, in a bush beneath the fringe of trees along the bank of the Río Buena Vista, was close beside the principal cart road that ran up the valley. The nest among the vines on the cliff was almost directly above a well worn footpath, between a wide maize field and a riverside fringe of trees and bushes, far from the woodland.

For three consecutive years a pair of Gray-headed Tanagers built in our little coffee grove, making a total of five nests, all in quite similar sites in coffee bushes within a few inches of five feet above the ground. This plantation is separated from the forest by about 350 feet of pasture in which grow a few scattered trees, but by making a slight detour the tanagers could pass through the enclosure surrounding the house, where trees and shrubbery stand much closer together. They preferred this more sheltered route, and while nesting in the coffee passed together back and forth by the house many times each day, usually flying swiftly, although occasionally the male would pause to sing briefly in our shade trees. Strangely enough, I have no recollection of seeing these tanagers in my dooryard or in the coffee grove except while they nested there or at least were preparing to do so. They have never come to eat bananas on the shelf close by the house that is visited by so many tanagers of other kinds. During their intermissions from building or incubation in the coffee grove, or when seeking food for their nestlings, they seemed always to make the rather long flight back to the forest 400 feet or more from their nest. I wondered whether on these occasions they always went to forage with a swarm of army ants. Once I met one of these tanagers going toward its nestlings in the coffee bush with food in its bill from a point more than 200 yards distant. Thus there is a wide separation of the nest and the foraging area, and apparently no definite territory is maintained.

Three nests which I watched carefully from concealment, and a fourth that I observed casually, were built by male and female together. Each bird brought material, placed it in the nest, and sat there to give the structure shape. At the second and third nests, the tanager of either sex, if it found the mate sitting when it arrived with a contribution, might pass its material to the other; but I did not see this at the first nest. Here, when one came with fibers and found the other occupying the cup, it was often so impatient to place its own contribution that it would almost sit on its mate, who thereupon withdrew. At the second nest, too, the tanager, instead of passing what it had brought to its partner sitting in the nest, would at times stand on the back of the latter, causing it to fly suddenly away. Its swift departure caused the bird on top to fly off, too; but soon it would return to deposit its billful. The two often came and went independently of each other, instead of flying back and forth together in the manner of so many tanagers while they build. Apparently they found most of their materials at no great distance from the nest and were never far separated. All the pairs were rather noisy while building, calling much, the males singing sweetly even while they held a billful of material or while they sat shaping the nest. The first pair finished their nest in 5 or 6 days; others completed their frail structure in 2 or 3 days.

The nest of the Gray-headed Tanager is a thin-walled, shallow cup, often so slightly built that the eggs may be seen through the meshes of the bottom. It is at times com-

posed almost wholly of blackish or brown rootlets and fungal hyphae. One was made of fibrous rootlets loosely matted and had a lining of the long, thread-like, pistillate inflorescences of the small tree *Myriocarpa*. Another was made of blackish rootlets, intermixed with which were many small, delicate living ferns, chiefly *Rhipidopteris peltata* and filmy-ferns of two species. The nest in the clump of Job's-tears was of rather different construction, loosely put together with coarse petioles, lengths of slender vines, dry flower stalks and a few dry fern pinnae. Many of the petioles stuck out far beyond the walls of the nest. The lining was of slender rachises of acacia and some black fungal filaments. The internal diameter of this nest was  $2\frac{1}{2}$  inches. Another nest was 4 inches in outside diameter by  $2\frac{1}{4}$  inches high; the cavity was  $3\frac{1}{4}$  by  $2\frac{1}{2}$  inches in diameter by  $1\frac{3}{4}$  inches deep.

A nest of the Gray-headed Tanager found on Barro Colorado Island on March 29, 1935, was situated 5 feet above the ground in the nearly vertical fork of a small sapling growing on the bank of a rivulet, which at this season was dry. It was a deep, open cup, composed externally almost entirely of the brown, dry, pistillate inflorescences of *Myriocarpa* and lined with fine brown fibers. It was attached to the supporting twigs with cobweb. The internal diameter was  $3\frac{1}{4}$  by  $2\frac{1}{2}$  inches, the depth 2 inches.

#### THE EGGS

My earliest date for eggs in El General is April 2, 1937, when I found a set of three, an exceptional number. The height of the nesting season here is in May, and I have a single record of an occupied nest in August; this contained unfeathered nestlings on the fifth of the month. The first egg may be laid promptly on the completion of the nest, or five days may elapse before its deposition. In three nests the eggs were laid on consecutive days. Four eggs were laid before 7:05 a.m. I have seen 10 nests with two eggs or nestlings, two with three eggs, and one in which, so far as I could tell, only a single egg was laid.

The eggs of the Gray-headed Tanager are pale blue-gray, heavily overlaid and mottled with shades of dark brown, which on the thick end almost masks the ground color. On most eggs the brown markings are fairly crowded over the whole surface, but on some they are few and scattered toward the sharper end. Sometimes the brown marks are in the form of scrawls, and some eggs bear a few flecks of black. The measurements of 12 eggs average 24.2 by 17.3 millimeters. Those showing the four extremes measured 25.4 by 18.3, 22.6 by 17.5, and 25.0 by 16.7 millimeters.

The nest of the Colombian race of the Gray-headed Tanager found on Barro Colorado Island contained two eggs which were laid on April 1 and 2. In coloration they were pale bluish-gray very heavily mottled all over with brown and a few irregular scrawls of black, and they measured 24.6 by 15.9 and 21.8 by 16.7 millimeters. At Gatún in the Canal Zone, Jewel (Stone, 1918) found a nest of this race which on July 9 contained two eggs.

The distribution according to the month of laying of 14 nests of the Gray-headed Tanager in the valley of El General, 2000 to 3000 feet above sea level, is as follows: March, 1; April, 2; May, 6; June, 3; July, 2.

#### INCUBATION

From a blind set beneath the banana plants of the abandoned plantation, I passed the morning of April 8, 1937, watching the Gray-headed Tanager's nest in the heavy tussock of Job's-tears grass. So far as I could learn from my vigil, the female alone incubated the three eggs. She was a patient sitter, and in 6 hours of watching took 3 sessions of 66, 97 and 66 minutes, with intervening recesses of 25 and 66 minutes, thus

keeping her eggs covered 62.6 per cent of the morning. Upon leaving her eggs she always flew up the steep bushy slope to the forest on the crest above, about 250 feet distant from the nest. This was true whether she left spontaneously or, as on other days, was frightened from her nest by my arrival. She approached from the same direction, accompanied by her mate on her first two returns of the morning, but alone on the third. Both nervously flitted their wings and voiced low monosyllables as they came to the nest. The male did not once sing within hearing of my blind and, except when he accompanied his mate on her return to the eggs, was not seen in the vicinity. After escorting his mate to her nest at the end of her first recess of the morning, he settled on a twig near the blind and remained there, silent and motionless, for a quarter of an hour.

On May 28, 1948, I studied incubation at another nest, situated in a coffee bush in our small plantation, where the eggs had been laid 6 days earlier. In 6 hours of the morning the female took 4 sessions lasting 48, 45, 53 and 97 minutes, with 4 recesses lasting 20, 20, 22 and 55 minutes, thus covering her eggs 67.5 per cent of the morning. Her mate was both more attentive and more songful than the male of the earlier nest, coming to call his partner from her eggs at midday as well as early in the morning, and escorting her on at least three of her four returns to the coffee bush. Often I heard his song and weak notes from the surrounding bushes. The pair seemed to go off to forage in the woodland 400 feet away during each of the female's absences from the nest. The female tanager, as a bird of the deep forest, panted late in the morning even in the light shade of the coffee grove.

At three nests both eggs hatched after 14 days of incubation. At one nest the single egg hatched in 14 or 15 days. At another nest one of the eggs vanished in the course of incubation, and the other hatched after 16 days, which is abnormally long.

#### THE NESTLINGS

The newly hatched Gray-headed Tanagers have dark skins, sparse gray natal down, and tightly closed eyes. The interior of the mouth is red. When I visited a nest in a coffee bush on the day the nestlings hatched, the parent performed the nearest approach to an "injury-feigning" display that I have ever seen in the tanager family. On all my previous visits to this nest, the female, if she happened to be incubating, slipped from the eggs and flew quietly away while I was still a good distance off. But on the evening when I first saw her nestlings, she continued bravely to cover them until I was only two yards or less away. Then she dropped to the ground and hopped slowly and somewhat haltingly away, as though crippled in the legs, but without beating her wings against the ground as so many birds do in similar circumstances. She vanished among the bushes, but soon returned and perched close by, uttering low notes of complaint, while I looked at the nestlings. Another parent Gray-headed Tanager dropped to the bare ground beside me when its feathered young fluttered from the nest, but it gave no demonstration of this nature.

On July 19, 1948, I spent the first four hours of the morning watching a nest with two nestlings 10 days old. Both parents fed them a total of 32 times, or at the rate of 4 feedings per nestling per hour. The most rapid feeding was during the first hour, when they brought food 12 times. Although now that brooding had ceased I could no longer distinguish the sexes except when the male sang, and save for one brief refrain he was silent this morning; it was clear that both sexes were actively attending the young, for six times they came together with food in their bills. So far as their rapid movements permitted me to see, this consisted largely of insects. The nestlings' feathers had begun to unsheath when they were seven days old, and now on their tenth day they were well clothed with plumage, which from time to time they preened. They also stood up in the

nest to flap their wings momentarily. The mother brooded these well feathered nestlings the following night. One left the next afternoon, and the other slept alone in the nest for a single night. Next morning I found it perching on the nest's rim, and it flew off while I stood watching it. When they left the nest, 11 and 12 days old, respectively, these youngsters could fly for considerable distances. At this time their upper plumage was olive and their under plumage pale yellow heavily clouded with olive on the breast. Their heads were still bristly with unopened pin feathers.

From another nest two youngsters left when 11 days old, and a nestling reared alone departed at the same age. One brood of two made their exit when only 10 days old. I was not certain that they had not been carried off by some predator, but after much searching I found one of these precocious tanagers perching quietly ten feet above the ground in a thicket beside the coffee grove where it was hatched. The parents were bringing it food from the distant forest. While I searched for their young, they flitted about not far above or ahead of me, twitching their tails and voicing low, complaining notes.

#### SUMMARY

Gray-headed Tanagers inhabit lowland rain-forests but they often enter neighboring second-growth woods or shady plantations to forage or nest. In Costa Rica they range up to at least 3500 feet above sea level. They are usually met following the army ants, but they catch small fugitive creatures rather than the ants themselves. At all seasons they are found in pairs or family groups, seldom singly and never in larger flocks.

The male sings a beautiful, long-continued song, far more elaborate than that of most tanagers.

In El General, the breeding season begins in March and continues, for belated nests, until August. The slight, open nest is placed from 2 to 8 feet above the ground, in thorny palms in the forest, or in coffee or other bushes beyond its borders. Both sexes build actively and complete the structure in from three to six days.

Each nest contains two or, more rarely, three eggs, which are laid early in the morning on consecutive days. The eggs are incubated solely by the female, who takes rather long sessions, those timed ranging from 45 to 97 minutes in length. One female kept the eggs covered for 62.6 per cent of the morning, another for 67.5 per cent. The incubation period is 14 days or, exceptionally, 16 days.

The young are hatched with sparse natal down and are fed by both parents, who when nesting in a plantation often go a good distance to forage in the forest rather than in the vicinity of their nest. Rarely a parent gives a rather poor distraction display when a man visits the nest. Such displays are unusual in the tanager family. The young remain in the nest from 10 to 12 days.

## BLUE TANAGER

### *Thraupis episcopus*

North Americans are apt to associate the color red with tanagers. But one of the most widespread and familiar of the tanagers of tropical America is blue. Its body is light blue-gray, paler on the under parts than on back and rump. Its wings and tail are bright sky-blue (see frontispiece). Its iris is brown, bill black and blue, and feet lead-color. The sexes are usually too similar in appearance to be distinguished with certainty. This fairly large tanager ranges with only slight geographical variation from southern México to Venezuela and western Perú. In South America east of the Andes it is represented by races similar in general appearance, but bearing conspicuous patches of white on the wing-coverts.

Over most of its extensive range, the Blue Tanager is one of the most common and familiar birds of the clearings. It is a creature of the tree-tops, active and restless, rarely, unless attached to a nest, remaining long in one spot. It hunts among fruit and shade trees about houses, the ornamental trees of city parks, coffee plantations with their light canopy, pastures with scattered trees, and open groves; but it rarely ventures far into heavy forest. The race *Thraupis episcopus diaconus* has a wide altitudinal range, extending from the seacoasts up to about 5000 feet in Guatemala, 4500 feet in El Salvador (Dickey and van Rossem, 1938:549), and 7500 feet in Costa Rica. It is distributed over both the Caribbean and Pacific coasts, and in both humid and arid regions, but in the drier types of country it is largely restricted to the more luxuriant vegetation along the watercourses, irrigated areas, and other spots where abundant ground water favors the growth of taller trees. I found Blue Tanagers among the palms and shade trees of the central plaza of Chiclayo, situated in an oasis amid the sandy wastes of the northern coast of Perú. In the surrounding deserts this tanager could not survive.

#### FOOD

Like most birds, the Blue Tanagers prefer a fairly varied diet. They eat many kinds of berries and other fruits and are especially fond of wild figs and bananas. For several years they have been regular visitors to my feeding shelf, coming usually in pairs to feast upon the bananas and ripe plantains displayed there. As the nesting season approaches, the male, after eating freely of the banana beside his mate, takes an additional morsel in his bill and passes it to her after they have flown to one of the upper limbs of the tree that supports the board. When more succulent fruit is scarce, Blue Tanagers eat the dry green fruits of the Cecropia tree. They find many insects on the leaves and bark of trees. Often they bend down to examine the lower side of a branch for the insects and spiders that harbor there, a habit common to many of the more arboreal tanagers. Or they hang head downward from the end of a twig to pick an insect or caterpillar from among the terminal leaves. Although they forage much in the manner of warblers, these larger and heavier birds are somewhat less spry in their movements. Often, too, they make quick aerial darts to snatch insects on the wing.

#### VOICE

The song of the Blue Tanager is animated but lacking in force. The phrasing, varied and intricate, would do credit to any songster, but the tone is weak and a trifle squeaky. The bird seems to attempt a musical feat beyond its slight vocal powers. Mrs. Sturgis (1928:416) compares the Blue Tanager's song to one of the songs of the American Red-

start. Although at no season a persistent or exuberant songster like the thrushes, the Blue Tanager sings from time to time throughout the year. The female at times delivers a song briefer and weaker than the male's. The birds' call-note is a long-drawn, somewhat squeaky monosyllable, much in the tone of the song.

#### SOCIAL HABITS

Blue Tanagers remain mated throughout the year. Usually they fly two by two at all seasons, but at times, when they are not nesting, half a dozen or so band together.



Fig. 27. A homestead at Rivas, Costa Rica, in 1937. The rounded crowns of the aguatillo trees (*Persea caerulea*) in the pasture were frequented by Blue Tanagers, Golden-masked Tanagers, Yellow-crowned Euphonias, and Blue Honeycreepers.

I have noticed this tendency to flock especially at higher altitudes during the last months of the year. Apparently two or three mated pairs had joined each other. Considering that Blue Tanagers are so rarely found in a single state, it is surprising to learn that in Costa Rica these pretty birds are almost universally known as *viudas* (widows)—a name which has never been satisfactorily explained.

#### ROOSTING

An orange or lemon tree, with its abundant sheltering foliage and sharp protecting thorn, is a favorite roosting place of the Blue Tanagers. During the wet season of 1936, a pair slept in the trees about the thatched cabin which I then occupied at Rivas in the basin of El General in southern Costa Rica. At the end of October I found them roosting in a lemon tree in the front yard. By searching in the foliage with flash-light toward the end of the night, I was able to pick out one of the sleeping pair. It perched on a branch where a cluster of the parasitic *Loranthus*, adding its foliage to that of the lemon tree, made a very compact mass of verdure. It slept with its feathers fluffed out and its

head turned back and buried among them, in the manner of other birds. I could not at first locate the mate, who must have found a position even better concealed by the leafage; but a few nights later I found the two roosting on opposite sides of the lemon tree.

For a month this lemon tree was the Blue Tanagers' roosting place. But one evening at the end of November they arrived to find that most of the branches had been pruned off in the course of the day. The few that remained did not offer them sufficient shelter and concealment for the night. Confused, the tanagers flew back and forth many times between the shorn lemon tree and the neighboring trees, voicing low, questioning notes. Finally, when the light had grown very dim, both entered a sour orange tree where they had earlier nested, and here they passed the night.

A week later, I found the pair sleeping in a smaller sweet orange tree close beside the sour orange. I sometimes stole out in the night to see them by flash-light. Each roosted upon one of the long, horizontal thorns in the center of the tree, in positions about a foot apart. They never slept pressed closely side by side, as mated birds of some kinds roost. After a fortnight, one of the pair returned to the sour orange tree to roost, leaving the other to sleep alone in the sweet orange close by, still on the same thorn. A few days later the second tanager deserted the sweet orange in favor of the taller and more densely leafy sour orange, where both were so well screened by the dark foliage that I never succeeded in seeing them while they slept. Usually they came together to their roost, but at times one bird would arrive a few minutes ahead of its mate. This was their nightly roosting place until about the middle of the following January, after which the pair shifted to another situation and I lost them.

At times a number of pairs of Blue Tanagers will gather from the surrounding countryside to roost in a particularly attractive site. At the end of 1942, when I lived in another part of the valley of El General, several pairs slept in my yard, chiefly in two big, densely umbrageous orange trees growing close together behind the house. I tried to count how many roosted here, but with slight success. In the evening the tanagers would arrive by pairs or sometimes in trios, dart swiftly from tree to tree, into their roosting trees and out again, quite confusing the watcher who attempted to keep count of them. In the dim light of dawn they would shoot out of the trees suddenly, and from all sides, and so swiftly that it was not always possible to distinguish them from birds of other kinds which roosted in the same trees. At night, with an electric torch, I could pick out a few amid the foliage, but the majority were too well screened to be glimpsed. A dozen Blue Tanagers sleeping in the two big orange trees was a conservative estimate; possibly there were twice as many. With these Blue Tanagers roosted at least six Palm Tanagers, a few Golden-masked Tanagers, a wintering Summer Tanager, wintering Baltimore Orioles, and other birds.

#### NEST SITE

In the more southern portions of its range, the Blue Tanager begins to nest very early. Neal Cali, Colombia, I found a pair feeding nestlings on January 3, 1941. On Barro Colorado Island, Canal Zone, a bird was incubating by January 18, 1931. At Puerto Limón, Costa Rica, a pair was feeding nestlings on March 5, 1934. But in the Caribbean lowlands of Guatemala, I did not find the Blue Tanager building until March 19. In the basin of El General, Costa Rica, between 2000 and 3000 feet above sea level, the Blue Tanagers nest somewhat later than at lower elevations on the more uniformly humid Caribbean slope of Central America at the same latitude. Here in some years they start to build as early as the first of March, but usually it is the second half of the month before they begin to nest.

The Blue Tanager's well built open cup is placed in an amazing variety of situations. Most often it is built in a bush or tree, at heights ranging up to one hundred feet above

the ground. Almost any kind of tree may be selected. Often the birds use trees with clustering foliage which affords good concealment, such as the orange, avocado, or calabash; but at other times they build in the guarumo (*Cecropia*), targuá (*Croton*), or guava (*Psidium*), which provide slight protection. The nest may be placed among the foliage at the ends of slender boughs or it may rest upon a thick branch against the trunk. At times the Blue Tanagers build in a palm tree. One nest in Guatemala was attached to the branches of the inflorescence of a coconut palm, among the young coconuts, in a position where it was sheltered and shaded by the hooded brown spathe. In Costa Rica, two nests were placed in neighboring cohune palms (*Attalea*). One, at a height of about seventy feet, was built among the tangled coarse fibers of the leaf-sheaths, between the bases of the heavy stalks of the huge fronds, in just such a situation as might be chosen by the Abbot Tanager or the Palm Tanager. Indeed, two pairs of this last species were nesting in quite similar sites among the bases of the fronds of the same cohune palms. The other pair of Blue Tanagers had placed its nest in a more exposed position, above the lowest persisting base of a dead and fallen frond, at the very bottom of the palm tree's leafy crown. Miller (1932:16) found a nest built in an exposed position on the frond of a royal palm in El Salvador.

A cluster of green bananas or plantains hanging in the plantation may be used to support the nest. Sometimes the structure is placed on top of the bunch, where the up-turned "fingers" of the topmost "hand" provide a safely sheltered nook. But one Costa Rican nest was hidden away in the very center of the clustered fruits. The birds entered and left between two slightly separated "fingers" of the bunch. As these fruits grew they constricted the passageway, making it increasingly difficult for the tanagers to struggle in and out. One afternoon I watched the female make six separate ineffectual attempts to squeeze between the green bananas and return to her eggs, then almost ready to hatch. Then I climbed up on a ladder and enlarged the passage by pushing apart the fruits. After this the tanagers reached their nest without difficulty and successfully reared their brood of two. For their second brood, they built above the topmost hand of the same bunch, thereby avoiding the difficulties of ingress and egress which had troubled them during their first nesting. I have three records of Blue Tanagers' nests in bunches of bananas and two in bunches of plantains. A somewhat similar situation was a compact cluster of sour mandarins, in the midst of which the nest was excellently concealed.

Again, the Blue Tanagers may place their nest beneath the roof of a shed. Not long ago a pair built in my horses' shelter, supporting their nest upon the rounded inner ridgepole, under the peak of the high-pitched roof thatched with leaves of the sugar cane and at a point about equidistant from the two ends of the shed, which is four yards long. In four successive years Blue Tanagers built in a rather similar position beneath the peak of a thatched shed used for storage in the yard of Isaías Retana at Pedregoso. When I saw the nest in May, 1939, it was situated on the inner ridgepole about two feet inward from the end of the open gable; and in an exactly corresponding position near the other end of the roof was the old nest used the previous year. All these nests in sheds were placed against upright members of the framework for additional support. They were as carefully constructed as the majority of those built in the open; some were beautifully covered with moss. In 1941, the fourth year, Don Isaías told me that two pairs were building in sheds on his farm, suggesting that this kind of nest site was becoming more popular among the local Blue Tanagers. When it is recalled that the related Palm Tanagers not infrequently build beneath the eaves of houses, although more often in cavities in trees, these nests of the Blue Tanager placed beneath roofs are not so surprising.



A low nest was situated between the densely leafy shoots springing from the top of a guava stump. Resting upon the flat top of the stump five feet above the ground, this nest enjoyed perfect concealment. In 1942, I was amazed to find a Blue Tanager's nest resting upon the ground, amid the young shoots springing from the base of a small stump of *Vismia guianensis*, in an open, close-cropped pasture, about fifty feet from the edge of a thicket. I could not insert a finger between the bottom of the nest and the ground! The following year, not far from the site of this terrestrial nest, a pair, doubtless the same, built one foot above the ground among the close-set stump sprouts of *Croton glabellus*. In 1945, a nest was found among the densely clustered leafy sprouts springing from a low guava stump in the hillside pasture behind my house. The bottom of this nest was only two inches above the ground.

#### THE USE OF STOLEN NESTS

The Blue Tanager may convert the nests of larger birds for its own use, or even capture those of smaller birds and lay its eggs in them without making alterations. At the end of April, 1939, I watched a Boat-billed Flycatcher incubating in a bulky open nest, composed of coarse rootlets and twigs, and situated in the top of a small ceiba tree growing in an open pasture. At the same time a pair of Blue Tanagers was attending a nest in the top of a tree of *Cassia spectabilis* standing close beside the silk-cotton tree. One afternoon I found the tanagers' nest on the ground and the flycatcher's nest abandoned. Both had probably been despoiled by toucans. The tanagers at once took possession of the flycatcher's empty nest; both members of the pair sat in it and went through the motions of shaping it. The following day they were carrying material into the bulky open cup. When they had reduced the cavity to the proper size, the female Blue Tanager laid her eggs in the remodelled nest and began to incubate. In 1944, a pair of Blue Tanagers remodelled the open, cup-shaped nest of the slightly larger Song Tanager and reared a family in it.

Twice I have known Blue Tanagers to capture nests built by the considerably smaller Golden-masked Tanager. In both instances the builders laid one or two eggs before relinquishing all claims to their little mossy cup. I did not actually witness the transfer of ownership in either case; but from what I know of the habits of the Golden-masked Tanagers, I feel sure that it was effected without much fighting. One of these nests was situated directly in front of my dwelling, and I saw no conflict between the two species. Probably the female Blue Tanager merely ensconced herself in the nest in the absence of the rightful owner and refused to depart upon the latter's return.

I am able to give in some detail the history of the first of these nests of the Golden-masked Tanager which were occupied by Blue Tanagers. At the end of April, 1937, a pair of Golden-masked Tanagers built a nest among the foliage densely clustered at the end of one of the thick, upright watersprouts springing from a pollarded Spanish plum (*Spondias lutea*), beside the roadway in front of my cabin at Rivas. The pair had earlier completed a nest in this same position and laid two eggs, only to abandon their nest when the lining of the bottom was pulled up by some unknown agent. After this I had removed the deserted nest for more careful examination. In order to give the Golden-masked Tanagers the best possible opportunity to rear a family, I had resolved to leave this second nest strictly alone. But when a pair of Blue Tanagers began to frequent the Spanish plum tree and the Golden-masked Tanagers were no longer seen in its vicinity, my curiosity was aroused and I climbed up to investigate. The completed nest contained one egg of the Golden-masked Tanager and two which, from their larger size, clearly belonged to the Blue Tanager, which had already begun to incubate the three eggs. This was on May 6. The Blue Tanager's eggs hatched on May 15 and 16, but the Golden-

masked Tanager's smaller egg not until May 17. Since the incubation periods of the two species are of practically the same length, it appears from the date of hatching that the Golden-masked Tanager returned to slip an egg into the nest after the Blue Tanager had captured it and begun to lay.

The Blue Tanagers fed the nestling Golden-masked Tanager along with their own offspring. The little Golden-masked Tanager developed far more rapidly than its larger nest mates and was half feathered while they were still naked. The nest, intended for two Golden-masked nestlings, was indeed crowded. The young Golden-masked Tanager, whose nestling period was shorter than that of the Blue Tanagers by three or four days, departed first. After its exit from the nest, I looked in vain for it. When the Blue Tanagers left the nest, at the age of twenty days, they rested in a guava tree across the road, where the parents brought them food; but the young Golden-masked Tanager was not with them. Probably its calls of hunger did not attract the foster parents, with the result that it starved after leaving the nest.

The second nest of changed ownership was found on March 21, 1944, in the midst of a green bunch of the small plantains known as dominicas, in the plantain grove on my farm. It then contained two eggs which the female Golden-masked Tanager was incubating. Revisiting the nest four days later, I was surprised to see three eggs in it; I had never known a Golden-masked Tanager to lay more than two. The following day there were four eggs. Subsequent watching showed that a Blue Tanager was incubating them. The Golden-masked Tanagers did not appear in the vicinity. The four eggs in this nest were so similar in appearance that on the basis of coloration alone I could not decide which had been laid by the Blue Tanager and which by the Golden-masked Tanager; but two were larger than the other two. The two large eggs and the two small eggs differed among themselves in density of markings; but placing a small egg and a large egg together, I found that I could make two sets of quite uniform appearance. Measurements showed, however, that the small eggs were smaller than any undoubtedly laid by the Blue Tanager for which I had recorded the dimensions, and the big eggs were larger than any belonging unquestionably to the Golden-masked Tanager that I had measured. Hence each of the eggs in the set laid by *Thraupis episcopus* resembled an egg originally laid in this nest by *Tangara nigro-cincta*, more closely than it resembled its own mate. Here, then, was an excellent beginning for the same sort of relationship as is found between some of the Old World cuckoos and their victims, although the Blue Tanager is still far from being a consistent parasite of any sort. A few days later, all four eggs had vanished from this nest.

#### NEST BUILDING

Nearly always the Blue Tanagers build their own nests. On March 19 and 21, 1932, I passed some pleasant hours watching a pair build in the top of an avocado tree growing beside the overseer's house on a Guatemalan banana plantation. Both shared in the construction of the nest; although the male certainly contributed a substantial amount of work, it seemed that the female performed the major part. Often both entered the tree together with material in their bills. One perched close beside the nest, still holding its burden, while the other sat in the little cup, placed its contribution, and made vigorous movements with feet, body, bill and wings to give it shape. Sometimes it was the male who entered the nest first while his mate waited close by. After carefully tucking his material into the fabric, he would fly to a neighboring bough and sing while the female went to the nest to continue the work. She also sang a little. The male no less than his mate helped to shape the nest, and while sitting in it he often spread out his pretty blue wings, which seemed to aid in keeping the rim at the proper level. At times

he went off with the female as she flew away to find material, then returned with her without bringing anything himself, merely perching close by and singing while she worked.

The male Blue Tanager usually if not invariably helps build the nest. At at least six other nests, I have seen both sexes bring material. On October 22, 1940, I watched a pair of the white-winged race building a nest in a Cecropia tree, above the main highway leading down the valley of the Río Tarma to San Ramón Chanchamayo, Perú. Here, too, both sexes shared the work. On the same Guatemalan banana plantation where I watched the Blue Tanagers build, a pair of Abbot Tanagers made a nest at about the same time, in a coconut tree on the other side of the house, both male and female taking substantial shares in the work of construction. At several nests of the Palm Tanager, I have seen both sexes bring material. Thus it appears that in the genus *Thraupis* as a whole, building by both sexes is the rule, as indeed it seems to be in the entire family of tanagers, with the exception of *Ramphocelus*, *Piranga*, and a few other genera.

Blue Tanagers are inveterate thieves. Not only do they at times pirate whole nests of other birds, but even more frequently they pull material from occupied nests of their neighbors. Years ago I lived in a house in Panamá, where a pair of Blue Tanagers was building in a pandanus tree at the same time that a Lesser Rice Grosbeak was completing construction of her frail little cup in a hibiscus bush nearby. One day as I sat on the porch I heard a great chirping and commotion among the birds, and looking through the screen saw both male and female grosbeaks attacking with spirit a Blue Tanager, which apparently had been trying to pull fibers from their nest. Some years later, I watched a pair of Blue Tanagers building a nest at the same time that a pair of Yellow-crowned Euphonias were lining their roofed home on the top of a neighboring living fence post and while a female Blue Honeycreeper was preparing the foundations of her nest in the top of a nearby aguacatillo tree. Several times, while the euphonias were away, the Blue Tanagers pilfered tufts of cobweb from the outside of their nest. Then, by their united efforts, they pulled out a long piece of white string which the euphonias had laboriously twisted into their walls, one of them carrying it off to their own nest. When the euphonias returned to find the Blue Tanagers plucking at the walls of their nest, they drove at the far larger birds, who fled. After they had been chased away from the euphonias' nest, they went to gather cobweb from the same twigs where the honeycreeper was collecting it. Here they might have obtained all that they required. But not content with stealing from the euphonias, they went to tear away the cobweb with which the honeycreeper had so laboriously covered the crotch in the top of the aguacatillo tree and carried the spoils to their own nest. The Blue Honeycreeper could not make head-against the encroachments of the Blue Tanagers.

The completed nest of the Blue Tanager is a neatly finished open cup with thick, soft, but substantial walls. The outer layer of one Guatemalan nest was composed of rootlets, fibers, tendrils, green moss, fine grass blades, slender petioles, a large splinter of wood, and other unidentified material, all closely matted together and bound with much cobweb, forming a firm, compact fabric. The middle layer was made up of broad, flat grass blades and strips from coconut fronds. The interior was sparsely lined with fine fibers. The nest was loosely attached to the fork of a bough with cobweb. A Costa Rican nest built on the ground had the outer wall composed of moss, pieces of a creeping epiphytic polypody fern with small green fronds and wiry rhizomes, and strips of dry monocotyledonous leaves. The middle layer was of finely shredded bast fibers, the lining of black fungal hyphae and fine light-colored fibers. Another nest, built near a cotton bush, contained much fluffy white cotton fiber in the outer wall. A pair of Blue Tanagers building high up in a wild fig tree was seen to pluck papery fragments from

a neighboring abandoned wasps' nest. A nest which Miller (1932:16) found in a royal palm in El Salvador was composed of palm fibers with a little hair intermixed. Most Blue Tanagers' nests have a large amount of moss in the outer wall, making them difficult to distinguish when built on mossy boughs, as they often are. A typical structure measured 4 inches in over-all diameter. The interior was  $2\frac{1}{2}$  inches in diameter by  $1\frac{1}{2}$  inches deep.

#### THE EGGS

The Blue Tanager's eggs are laid early in the morning, usually between about 5:30 and 6:30 a.m., either before sunrise or within half an hour after sunrise. An interval of about twenty-four hours separates the laying of the first and second egg. In Costa Rica and Panamá, the full set normally consists of two eggs; I have records of 29 nests with two eggs or nestlings. Three other nests contained a single egg which was being incubated; but since eggs are often lost, it would be dangerous to conclude that in these nests the bird had not laid more than one. Of three sets from Guatemala, two consisted of two eggs and one of three eggs. The fact that one-third of the Guatemalan nests contained three eggs, whereas not one in more than thirty Costa Rican nests held more than two, may indicate a larger average set in the more northern country, as we may expect from the studies of Moreau (1944) of the variation of set-size with latitude among African birds. It is to be hoped that more records from northern Central America will soon be forthcoming. In Trinidad and Tobago (slightly to the north of southern Costa Rica) the set of eggs (*T. episcopus sclateri* and *T. e. berlepschi*) is "two, sometimes three" (Belcher and Smooker, 1937:534).

The ground color of the eggs is pale blue-gray, much the color of the bird's breast. They are thickly flecked and mottled over the entire surface with brown or chocolate, but the markings are most concentrated in a wreath around the large end, where they are sometimes united into a nearly solid ring of brown. On some eggs the blotches are fine and light, on others coarse and heavy; these contrasts may be found in the two eggs of a single set. Belcher and Smooker remark that in Trinidad and Tobago "the eggs in a clutch of two may differ so as to appear odd, while of three two may be alike and the third differ." Often the eggs bear a few spots or short scrawls of black. Usually the eggs are ovate in form, at times strongly so, with one end very pointed; but some abnormal ones I have seen were very long and slender, elliptical rather than ovate in outline, without the contrasting blunt and pointed ends characteristic of most. The measurements of 32 eggs average 22.7 by 16.0 millimeters. The eggs showing the four extremes measured 26.6 by 14.3, 21.4 by 16.7, and 20.6 by 15.1 millimeters.

The distribution according to the month of laying of 49 nests in the valley of El General, 2000 to 3000 feet above sea level, is as follows: March, 13; April, 23; May, 10; June, 2; July, 1.

#### INCUBATION

I smeared vermilion paint on the rim of the nest which I had watched the Blue Tanagers build in the avocado tree in Guatemala, hoping thereby to make one member of the pair acquire a distinguishing mark upon its plumage in order to determine whether male and female shared the task of incubation. I accomplished my purpose in part, for one member of the pair was conspicuously stained with vermilion on the under plumage. But two days later I found one of the eggs pierced and the other missing, so that attempts to study the mode of incubation at this nest were frustrated.

I have not again tried to mark Blue Tanagers, but from analysis of the records made at several nests, where the birds could not be distinguished by appearance, I feel sure that only the female incubates. At one nest which I watched for six hours (four in the morning and two in the afternoon) the female took 16 sessions ranging in length

from 2 to 36 minutes and averaging 14.1 minutes. An equal number of recesses ranged from 4 to 12 minutes, averaging 7.2 minutes. She spent 66.2 per cent (two-thirds) of the time on the nest. At another nest, watched for three hours, the female's seven sessions ranged from 11 to 28 minutes and averaged 18.4 minutes; her eight recesses varied from 2 to 8 minutes, averaging 5.4 minutes. She covered the eggs 77.3 per cent of the time. These Blue Tanagers were about the most restless sitters of all the members of the family that I have watched incubate; they took the shortest sessions, but also the shortest recesses.

At neither nest was the male seen to replace his mate on the eggs. But he was by no means neglectful of her. At the first nest, he often escorted the female as she returned to her eggs during the morning, but in the afternoon he remained out of sight. Sometimes when he came to the nest he brought food in his bill; but as the female never seemed to desire this food, he would eat it himself while perching near the nest, or else carry it away. Male and female joined in driving a third Blue Tanager from the vicinity of the nest.

At the second nest, which was the remodelled structure originally built by the Boat-billed Flycatchers in the ceiba tree, the male Blue Tanager was particularly attentive. In three hours he fed his mate four times in my presence, and possibly he gave her additional food while they foraged together out of sight. Twice he fed her while she sat on the eggs; twice again she left the nest as he approached, perched beside him on a bough of the ceiba tree, vibrated her wings and took the morsel from him in the attitude of a fledgling pleading for food. He sang much near the nest, sometimes went to look in at the eggs, and drove away a Yellow-green Vireo that had wandered too near. Often his approach to the nest was the signal for the female to depart; then the two would fly away out of sight to seek food. The male Blue Tanager rarely guards the nest during his mate's absences from incubation, but commonly accompanies her when she leaves to forage.

At a nest situated beside the laboratory building on Barro Colorado Island in the Canal Zone, I also saw the male feed his mate. When nesting at a good height, Blue Tanagers may be watched going about their usual activities without the need of concealment by the observer; but when their nest is low I have usually found them very shy, fleeing as soon as they catch sight of an approaching man and not returning unless he goes away or hides himself.

The incubation period, as measured from the laying of the second egg to the catching thereof, was 14 days at four nests, 13 days at two nests, and 12 days at one nest. At three of these nests, more frequent visits were made on the days of laying and hatching in an effort to determine the length of the incubation period in hours. At nest 35, the first egg was laid between 5:20 and 5:47 a.m. on March 21, 1944; the second between 5:40 and 6:30 a.m. on March 22. The first egg hatched between noon and 5:30 p.m. on April 4. At 5:30 p.m. on April 4 the second egg was barely pipped, but by 5:30 a.m. on April 5 it had hatched, apparently not many hours before. Thus the incubation period was slightly under 14 days.

At nest 40, the second egg was laid before 6:30 a.m. on May 4 and hatched between 5:30 and 8:30 a.m. on May 17, giving a period of incubation between 13 days and 13 days 3 hours.

At nest 41, the second egg was laid before 7 a.m. on May 27, 1944, and the nestling was just escaping the shell at 9 a.m. on June 10, giving an incubation period of 14 days 3 hours plus or minus 1 hour (assuming the second egg to have been laid between 5 and 7 a.m.).

At several of the nests that were visited at daily intervals, the first nestling was seen

a day earlier than the second. At nest 41, the first egg hatched at least 21 hours before the second. The long interval between the hatching of the first and second eggs suggests that incubation is begun before the second is laid. At nest 35, the female slept on her single egg, laying the second the following morning.

#### THE NESTLINGS

The newly hatched Blue Tanagers are blind and nearly naked, with only the usual sparse passerine down that quite fails to cover their pink skin. The interior of their mouth is red, as in other species of tanagers. They are fed by both parents and, for tanagers, develop rather slowly. At the age of 14 days, when they are well feathered, they will if alarmed jump from the nest and attempt to hide themselves in the herbage beneath, for they can still fly for only very short distances. Even if these youngsters which have prematurely fled the nest are returned to it, they will not remain, but hop out again, probably incited by the parents' reiterated low, sharp notes of distress. Usually the young Blue Tanagers linger in the nest for 17, 18 or even 20 days, not forsaking its shelter until they can fly very well. The fledglings' body plumage is gray rather than blue-gray, as on the adults, their remiges greenish-blue.

#### THE SECOND BROOD

The Blue Tanagers sometimes, at least, rear two broods in a season. At times there is a surprisingly short interval between the departure of the nestlings of the first brood and the resumption of laying. At nest 13, built in the midst of a bunch of bananas, the nestlings of the first brood left on May 6, 1939. Four days later, on May 10, I found the parents beginning a second nest upon the topmost hand of the same bunch. Both male and female built in the intervals of feeding their two vigorous fledglings. By May 18, the female was again incubating the two eggs, the first of which was laid no more than eleven days after the departure of the nestlings of the first brood.

Nest 26 was built in a sour orange tree in my yard in 1942. On March 13 it contained a single egg, and I never saw more than one in this nest. On April 11 the single nestling departed. Revisiting the nest on April 25, I again found two eggs, the second of which, to judge by the date of hatching, had been laid that same day. The first egg of the second brood was accordingly laid only thirteen days after the departure of the first brood from the same nest. Euler (1867: 186) tells of a pair of *Sayaca* Tanagers that began to lay a second set of eggs about eleven days after the departure of the young of the first brood.

If not successful in rearing their nestlings, the Blue Tanagers may lay an even larger number of sets of eggs in the course of a season. Usually the pair which has lost a nest moves some distance off to build the second nest; and because Blue Tanagers are numerous in the vicinity, one can not be sure of their identity. But in 1943 a female nesting in my yard laid sets each of which contained one abnormally long, slender egg and one of normal shape. The peculiar egg served to identify the bird. Between March and July this Blue Tanager built four nests and laid four sets of eggs, all without rearing a single fledgling. The first nest, built in a lemon tree, contained one egg on March 8; no more appeared and the single egg was not incubated, probably because of some fright or disturbance to the female. A nest built early in April in an orange tree, about fifty yards from the first, apparently belonged to the same pair. The two eggs were laid on April 15 and 16; only one hatched; and four days later the nest was empty. In May this pair built a third nest in a calabash tree between the sites of the first two. The female laid her two eggs on May 11 and 12; on May 24 one hatched; and the following day the nest was empty. In June, a fourth nest was built in another calabash tree very close to the lemon tree that had held the first. A single egg was laid on June 16 and hatched on

June 29. The nestling survived about ten days, then vanished. I suspect that toucans were responsible for the destruction of most if not all these nests. Although this unfortunate pair of tanagers built a new nest for each set of eggs, in the same year a neighboring pair laid again in a nest from which the newly hatched nestlings of the first brood had vanished. The nest remained deserted for nearly two months, then two more eggs were laid and hatched in it.

In El General, where the Blue Tanagers begin to lay in March, their breeding season usually ends in May or June. Only a few pairs feed nestlings as late of July, and I have only one record of eggs during this month. These were being incubated as late as July 17. I doubt if the Blue Tanagers rear more than two broods in a year. Their breeding season is shorter than that of other members of the family in the same area.

#### SUMMARY

Blue Tanagers are common birds of cleared and cultivated lands in both humid and arid regions through much of Central America, from the coasts up to about 5000 feet above sea level in Guatemala and 7500 feet in Costa Rica. In pairs or small flocks they roam through the crowns of fruit and shade trees or through open woodland. They remain mated through the year.

Blue Tanagers eat a great variety of soft fruits, hunt small creatures among the foliage or on the lower sides of branches, catch insects in the air, and come to feeding shelves, where the male offers pieces of banana to his mate.

Both sexes sing a slight yet pleasant song, but the female's voice is weaker than the male's.

Blue Tanagers usually roost in dense foliage. A dozen or more may sleep in a single clump of trees, often in company with tanagers of distinct species and of other kinds of small birds. The members of a pair roost a short distance apart rather than in contact.

Nesting begins early in December in Colombia, in January in the Canal Zone, in February in Caribbean Costa Rica, and in March in El General, where the breeding season continues until July.

Nests vary in height from the ground level up to a hundred feet above ground. In addition to a great variety of sites in trees and bushes of many sorts, Blue Tanagers may place their nests in open sheds and in bunches of green bananas. They also occasionally use abandoned nests of other birds and even take possession of nests already containing eggs, especially those of the Golden-masked Tanager. The thief may incubate the builder's eggs along with her own, and in one instance a pair of Blue Tanagers reared a Golden-masked nestling at least until it could fly.

Both sexes bring material and fashion the cup-shaped nest. While building, they steal much material from unfinished and even occupied nests of other small birds.

Eggs are laid early in the morning on consecutive days. In Costa Rica two appears to be the maximum number, but in Guatemala and Trinidad sets of three are found. Only the female incubates, coming and going frequently and in fair weather rarely sitting more than 30 minutes at a stretch by day. One female sat for 66 per cent of an observation period of six hours, another for 77 per cent of three hours. The male feeds her while she incubates; at one nest this occurred four times in three hours. But another female did not accept the food the male brought to the nest. The incubation period is 13 or 14 days, or, exceptionally, 12 days.

The young are fed by both parents and unless disturbed remain in the nest until from 17 to 20 days old, when they can fly well.

In El General at least two broods may be reared in a season. One female resumed laying only 11 days after her first brood left the nest, another about 13 days later.

## GOLDEN-MASKED TANAGER

### *Tangara nigro-cincta*

The little Golden-masked Tanager wears some of the brightest and most varied colors to be found in all the large and brilliant tanager family. These are arranged in a most elaborate pattern (see frontispiece). Black is the predominant color; against this background brighter hues are delicately laid on. The bird appears to have pulled a golden mask over head and neck, leaving exposed, for the sake of vision, only its eyes and the base of its bill, where the black shows through the gap in the mask. This black area covering the lores and surrounding the eyes is bordered on the forehead and cheeks with a tinge of blue. The rump is bright turquoise blue. The breast is broadly black, but the abdomen and under tail coverts are white; and the flanks are again blue, merging on the sides into deep violet which shades into the black of the chest. The blackness of the wings is relieved by a broad blue patch on the coverts and blue or greenish margins of the flight feathers. The short thick bill, the eyes and the feet are black. Male and female are dressed in the same pattern; and although the colors of the male are usually somewhat brighter, in many pairs the two are so much alike that they can be distinguished only in the most favorable light.

This gem-like bird ranges with minor variations in plumage from southern México through Central America and down the wet west coast of South America as far as western Ecuador. In Guatemala it is confined to the more humid Caribbean lowlands and foothills, and it is none too common there. Becoming more abundant toward the south, in Costa Rica it is very numerous in the Tropical Zone throughout the Caribbean slope. Absent from the Province of Guanacaste in the northwestern quarter of the country, the Golden-masked Tanager first appears on the Pacific side of Central America about the Gulf of Nicoya and to the southward, where higher rainfall is reflected in heavier forests, not greatly different from those of the Caribbean coast. Here is found a smaller race (*T. n. franciscae*) distinct from that in northern Central America (*T. n. larvata*). In the Térraba Valley, where most of my studies of this species have been made, it is one of the abundant birds. On both sides of Costa Rica it is at home from sea level upward to about 5000 feet.

The Golden-masked Tanager is an active, restless, far-flying bird of the tree tops. It is most often met along the edges of the forest, in second-growth woodland, and in plantations and pastures with scattered trees. In the heavy forest it forages high in the trees where it is difficult to see. These birds remain mated through the year and are almost always found in pairs. Rarely, however, even in the breeding season, three adults keep close company. Sometimes two pairs fly together; but except in the vicinity of their roosts, I have not seen Golden-masked Tanagers in flocks.

#### FOOD

The Golden-masked Tanagers eat a variety of berries and other small fruits. Seeds of *Xanthoxylon* enclosed in their black arils and the viscous berries of the mistletoe are included in their fare. They often devour the small green fruits of the Cecropia, clinging to the dangling aments as they tear away masses of the crowded fruits. They appear to be less fond of ripe bananas than many other tanagers. Although they spend much time in my yard, for a long while they paid no attention to the feeding table where bananas are provided. But toward the end of the long, severe dry season of 1945, when birds of many kinds seemed to be experiencing unusual difficulty in finding enough to eat, I for





Fig. 28. Cerro Chirripó, 12,580 feet and the Río Chirripó at the head of the basin of El General, Costa Rica. Buff-rumped Warblers inhabit the shores in the foreground. Golden-masked Tanagers, Silver-throated Tanagers, Blue-rumped Green Tanagers, Blue Honeycreepers, and Bananaquits forage among the trees along the river.

the first time saw a Golden-masked Tanager on the board, which for well over two years had been spread for them. Although, as in previous years, they built a nest only forty feet away, they came only seldom until, toward the end of April, their two nestlings began to make great demands for food. Then, for a brief period, they became constant visitors. Often after delivering food at the nest they flew to the table to satisfy their own appetite with banana or plantain, then flew away to hunt some other fare for their nestlings. At other times they carried food from the table to the nest. Their visits continued for a while, even after a Swallow-tailed Kite carried off their nest and nestlings. But in May they ceased to come; apparently they were finding other foods more to their taste in the neighboring forest and thickets. In addition to fruits, they eat many insects which they find among the foliage or on the thinner boughs of the trees, or which they sometimes capture on the wing.

#### VOICE

The Golden-masked Tanager would have been seized upon with delight by theorists of a past century who believed that birds lavishly endowed with bright colors had poor songs; for this elegant tanager appears to have no song at all. Its most common call is a sharp, dry *tick*; and notes of this same character, compounded in diverse ways, form the whole vocabulary of the bird. A very rapidly uttered series of these *ticks*, becoming higher and sharper at the end, might perhaps be considered to represent the tanagers' song; but it is in no sense musical, nor is it employed to proclaim the possession of territory, which is one of the important functions of song. This rapid ticking is uttered by both sexes. The principal use of the voice is to keep the pair together, for whether flying or at rest, male and female Golden-masked Tanagers are constantly *ticking* back and forth to each other. It would be wrong to conclude that because the

Golden-masked Tanager's language is so poor to our ears, this bird is not capable of expressing as wide a range of emotions or situations as many other species with a far richer range of voice. There is great variety in the timing and emphasis of the *ticks*. When the birds are anxious about the safety of their nest, their *ticking* becomes exceedingly rapid.

#### ROOSTING

Golden-masked Tanagers may roost in pairs, in family groups, or at times in larger companies. In October, 1936, a pair with a youngster who still clamorously begged for food slept in the dense foliage in the top of a sour orange tree growing close beside our thatched cabin. All three of the tanagers would fly into the tree together long before it grew dark, sometimes as early as five o'clock, and remain out of sight until the following morning. In November the young tanager disappeared, but the two parents continued to roost in the same orange tree until the following January. Then they shifted their quarters to a small sweet orange growing close beside the sour orange tree. Going out with a flashlight at night, I promptly picked out one of the birds perching on a long, horizontal thorn, within reach of the ground. Its mate, somewhat better screened by the foliage, roosted on another thorn, less than a foot away. For several weeks the tanagers slept here; but in February the birds chose a more distant roost. In a later year, I watched a Golden-masked Tanager settle down for the night among the broad bases of the leaves of *Dracaena fragrans*, an arborescent relative of the lilies, in a village in southern Costa Rica.

In September and October, 1942, many Golden-masked Tanagers roosted in the trees beside my house. One night I counted eleven sleeping on one low branch of a copalchi tree (*Croton glabellus*). Here they were screened from above and sheltered from the hard rains of these months by leaves much bigger than they. But many were plainly visible from the ground, and their white under plumage gleamed brightly in the beam of my light. In a small orange tree, about twenty feet away, I counted five more birds. Thus at least sixteen tanagers roosted in these two neighboring trees; but without much doubt there were more, so well concealed by the foliage that I could not see them. On a subsequent night, I detected seventeen of the birds in these two trees, but this was my highest count.

I doubt very much whether these seventeen or more Golden-masked Tanagers flocked together by day. Certainly I never saw a flock of anything like this size, but only two, or rarely three or four, individuals together. In the evening, too, they did not come in a body, but a few at a time, over a period of half an hour or so. But now they would become more gregarious than they had been during the day. Sometimes all would gather in a certain tree, usually not the one in which they would roost, then fly as a straggling flock from tree to tree, until at length they settled down to rest; or a part of the whole number that roosted together would behave in this manner. Their flight was accompanied by much rapid *ticking*. Although in September a few individuals were still in transitional plumage, by October all wore the adult colors. They made a beautiful display as they flew up from the trees in the lower pasture, below the level of my eyes as I stood on the porch to watch them.

#### NEST BUILDING

On Barro Colorado Island in the Canal Zone, I found a pair of Golden-masked Tanagers (race *T. n. fanny*) beginning a nest as early as February 10; but in the basin of El General in Costa Rica, at a higher elevation (2000-3000 feet), I have seen no nest building until near the end of the month, and in most years not until March. The compact open cup is generally placed in the crotch of a leafy tree or bush at heights ranging

from 4 feet 9 inches to 50 feet above the ground. Sometimes it is situated in a thick main crotch of a small tree, sometimes near the end of a slender branch, far out from the trunk, amid clustering foliage. An orange or lemon tree, with its protecting spines and compact foliage, is often favored. I have found four nests hidden in the midst of bunches of green bananas or small plantains, where they were entered through a narrow gap between the clustered "fingers," and where the eggs could be reached by human hands with difficulty, if at all. One exceptional pair built a late nest in a maize plant, already dry, at the edge of a ricefield. It rested in the angle between an ear and the stalk and was partly sheltered above by the brown leaf-blades that draped the stem.

Another pair built in a hole at the top of a tall dead trunk, about 90 feet above the ground. The cavity, probably an old woodpecker hole, had a narrow round entrance; and although its depth could not be determined, the birds quite vanished from sight when, one by one, they entered to deposit their material. Still another pair placed its nest in the end of a broken-off, upright, dead branch of a living tree, where it was partly concealed by the dry foliage of a severed branch which had been caught above it. Unlike most Golden-masked Tanagers, this pair nested in an opening in the midst of a small stand of forest. A somewhat similar site was a crotch in a dead, barkless stub standing in the middle of a maize field. Here the nest was placed among dead vines that passed through the crotch and was shaded above by a big, curled dead leaf that had lodged there. One pair fed nestlings in a nest tucked into a niche between a twist of a thick woody vine and the trunk of the dead tree which the former embraced. This nest was about 40 feet above the ground at the edge of the forest and was quite without shading foliage. In the variety of its nest sites, the Golden-masked Tanager is only a little less versatile than the Blue Tanager, and it shows the same tendency to use dark crannies.

The nest is nearly always built by the male and female together; I have seen both sexes working at no less than ten nests. While building, they are inseparable, flying off together to collect material and returning together to place and arrange it in the nest. If one comes alone, the other is not far behind. As a rule, each member of the pair places its own material and takes a share in shaping the nest. While one is engaged in this occupation, the second perches close by, holding the bit of moss or fibrous material in its bill. Then, as soon as the first has finished, the second enters the nest to add its contribution; finally both fly off together. Rarely one member of the pair, probably the male, passes his material to his mate while she sits in the nest. At one nest, I failed to see the male bring material; but at the subsequent nest built, I think, by the same pair, he took the male's normal share in the work. Even if he brings nothing for the nest, the male faithfully follows his mate back and forth as she builds. The male's failure to bring material seems to be his mate's fault; for she, more efficient than he, finds something suitable for the nest and flies toward it before he has gathered his billful. Rather than be left alone, he follows her with empty bill. Building is accompanied by much sharp *ticking*, and at times one of the tanagers utters a rapid series of *ticks* while sitting in the nest.

Although the Golden-masked Tanagers rarely work with the concentrated activity displayed by many birds while building their nests, they continue to bring material through much of the day, and with mutual assistance they complete their nest promptly without strenuous exertion. Two nests of which I have watched the construction were completed in four days, three others in six days; but one pair spent twelve days in finishing its nest.

The nest is a small, compact, open cup. One built on Barro Colorado Island was composed chiefly of fine brown fibers and strips of dead leaves, all bound together with cobweb. In the bottom was a slight lining of black fibrous material. A nest built in El

General was of somewhat different composition. The outer layer contained much green moss, fibrous rootlets, thread-like rachises of mimosa, some lengths of a small-leaved polypody which creeps over trees, coiled tendrils, and some pieces of the inflorescence of *Iresine*, all bound firmly together by cobweb. The middle layer was composed of many small pieces of papery bark, mixed with which were a few dead leaves. The inner lining was of black fungal hyphae and a few rachises of acacia. Some coarse rachises of larger compound leaves, from ten inches to a foot in length, were loosely attached to the outside. The nest built in a maize plant differed from all others I have examined in containing a great deal of brown, dry corn silk in the foundation and outer wall. Mixed with this were a few green pieces of delicate filmy-ferns and polypody, and a few liverworts. The inner wall was composed of many thicknesses of dry and partly decayed leaves of the maize, mixed with which, especially in the innermost portion, were numerous fine black fungal hyphae.

#### THE EGGS

The first egg is often laid a day or two after the completion of the nest; one pair continued to add to their structure during the day preceding the laying of the first egg. The eggs are usually deposited early in the morning, in the hour extending from thirty minutes before to thirty minutes after sunrise. One female Golden-masked Tanager, however, was most erratic in her manner of laying. Her first egg was laid between 5:35 and 6:00 a.m., her second between 7:25 and 11:25 the following morning. At each of six nests, the eggs were laid on consecutive days. The full set appears invariably to consist of two eggs; 26 accessible nests contained this number of eggs or nestlings; and this is the number which without exception I have found in the nests of other species of *Tangara*. The eggs are dull white or pale gray, thickly sprinkled all over with brown or chocolate flecks that may be fine or coarse and that are usually heaviest and most crowded on the large end, where they may cover almost the entire surface. Some eggs bear also a few black spots, others have the ground color suffused with brown. The measurements of 25 eggs average 20.2 by 14.8 millimeters. Those showing the four extremes measured 21.4 by 15.5, 19.1 by 14.3 and 19.4 by 13.9 millimeters.

The distribution according to the month of laying of 50 nests in the valley of El General, 2000 to 3000 feet above sea level, is as follows: March, 11; April, 11; May, 14; June, 6; July, 5; August, 2; September, 1.

#### INCUBATION

Incubation begins with the laying of the second egg and is carried on by the female alone. On Barro Colorado, in 1935, I devoted a morning to watching my first nest of the Golden-masked Tanager. In six hours the female took 6 sessions on the eggs, ranging from 10 to 64 minutes in length in no regular order and averaging 29.3 minutes. An equal number of recesses varied from 6 to 29 minutes in length and averaged 16 minutes. She kept her eggs covered for 64.6 per cent of the time. On her return from a recess, her mate several times escorted her into the orange tree that sheltered the nest. At other times he came with her only as far as a guava tree that grew a few yards from the nest tree; here she almost always paused to look about before proceeding to the nest. After she had settled on the eggs he flew off and usually remained beyond sight and hearing while she incubated. Once while the female was sitting he came into the guava tree and called until at last she flew off with him, although she had been incubating only eighteen minutes.

In May, 1943, I devoted nearly eight hours to watching the female incubate in a nest situated only six feet above the ground in a mossy crotch of a calabash tree in front of my house in Costa Rica. I timed 15 completed sessions on the eggs which varied from

6 to 51 minutes in length and averaged 18.9 minutes. But the 51-minute session was taken during a heavy afternoon shower; the longest period that this female remained on the nest when not held to it by rain was 27 minutes; she twice sat this long. Her recesses ranged from 2 to 17 minutes, with an average for 17 completed recesses of 7.9 minutes. She kept her eggs covered 70.5 per cent of the time. As at the other nest, the male often, but by no means always, accompanied her on her returns to the eggs. Sometimes he came with her to the calabash tree that held the nest, but often he stopped short in a guava tree sixty feet away. Usually he remained out of sight while she incubated, but sometimes he returned after she had been sitting awhile to call her away with him. Once from a neighboring tree he uttered a long, rapid series of *ticks*; the female answered with the same notes from the nest, then after two minutes flew off with him. Once, after the female had left the nest, he went to look into it—his only direct inspection of its contents that I saw in eight hours of watching.

In the three following years the Golden-masked Tanagers built in the same or a neighboring calabash tree in front of my house. In 1946 I watched the nest for 10 hours on the sixth and seventh days of incubation. The female's 20 sessions ranged from 2 to 47 minutes in length and averaged 22.6 minutes. Her 20 recesses varied from 2 to 11 minutes and averaged 7.3 minutes. She spent 75.6 per cent of the 10 hours covering her single egg. Her morning sessions were markedly shorter than her afternoon sessions. Fourteen sessions in the forenoon averaged 18.6 minutes; the intervening recesses averaged 6.7 minutes. Six afternoon sessions averaged 31.8 minutes, the corresponding recesses 8.7 minutes. But both the longest and shortest sessions that I recorded were taken in the forenoon. The male came once to inspect the contents of the nest while his mate was absent.

At neither this nest nor that on Barro Colorado did the male feed the female within sight of the blind from which I watched. But at the Costa Rican nest of 1943, I saw the male feed his mate thrice in the course of the eight hours. Once he gave her food while she sat in the nest, once in the nest tree as she was about to return to the nest, and once in a neighboring tree. Since he fed her away from the nest, it is likely that he gave her food at times when the two were beyond my range of vision. I saw another male Golden-masked Tanager feed his incubating mate from time to time in the vicinity of the nest.

The first minute fracture of the shell may be detected as a slight roughness of the surface from 12 to 26 hours before the chick manages to push off the severed cap and escape from the egg. At 2 nests the incubation period was found to be 13 days, at 2 nests 14 days, and at one nest 15 days. At 2 of these nests an effort was made to determine the length of the incubation period in hours. At the low nest in the calabash tree in front of my house, the second egg was laid before 6:30 a.m. on May 3, 1943, and hatched at about 8:45 a.m. on May 17, giving an incubation period of 14 days and 2 or 3 hours. Two years later there was another Golden-masked Tanager's nest in the exact position of the former. (The site was occupied in the intervening year by a pair of Yellow-bellied Elaenias.) In this nest the second egg was laid between 6:00 and 6:30 a.m. on March 31, 1945, and hatched in the night of April 13 to 14. Since the eggs had been barely pipped on the evening of April 13, it is probable that they did not hatch until toward the end of the night, giving an incubation period of slightly less than 14 days. The eggs may hatch at any time of day, but apparently do so least often in the afternoon. I have records of 3 eggs which hatched in the night, 3 in the first half of the morning and 2 in the afternoon.

#### CARE OF NEWLY HATCHED NESTLINGS

Shortly after noon on May 16, 1943, I found that one of the eggs in the low nest in the calabash tree was barely pipped. At daybreak next morning I entered the blind set

close in front of this nest to witness the events attending the hatching of the eggs. As it grew light the female tanager sat restlessly, constantly rising up to look down into the nest. At 5:22 she ate first the big part, then the cap of an empty shell. A few minutes later another Golden-masked Tanager (her mate?) was heard for the first time in a neighboring tree. The female continued to sit uneasily, rising up at intervals and putting her head down into the nest. At 5:36 she flew off for the first time that morning, and after five minutes she returned to resume brooding, without bringing any food. After sitting restlessly for four minutes more, she went off for another four minutes, again returning without food for the nestling. Then followed 8 minutes of sitting and another absence, lasting 10 minutes. Just as the sun appeared through the mist that filled the valley, she returned again, this time with her mate, who flew rapidly close by the nest without looking into it and apparently without noticing that an egg had hatched. Again the female settled down to brood without feeding the nestling. The male came to rest in a neighboring tree and continued to call until his mate answered from the nest, then flew off with him, after having brooded only two minutes.

Three minutes later, at 6:12, the pair returned together. Both alighted on a slender branch about a yard from the nest and on the same level with it. Then the male hovered momentarily above the nest, on beating wings, and saw the nestling for the first time. After this inspection he returned to the same perch. The female then gave the nestling its first meal, which she had brought in her bill or throat. Meanwhile, the male climbed over a thick, mossy branch close beside the nest until he found a spider, which he took in his mouth. Going to the nest with this, he spent about two minutes presenting the morsel to the nestling, which apparently did not succeed in swallowing it. While he was so engaged, the female flitted restlessly about close beside the nest. Then the male came to perch beside her and gave her the spider that the nestling did not take. She ate it and settled on the nest, answering her mate, who now called from neighboring trees. Thus the male and female brought their first offerings to the nestling at about the same time, and only 50 minutes after the female had eaten the shell from which it had escaped, thereby telling me that it had hatched. Sight of the nestling led the male to bring food to it at once.

Ten minutes after his first attempt to feed the nestling, the male tanager was back again with more food, well mashed in his bill. Finding his mate still on the nest, he passed it to her and she rose to give it to the nestling, taking about a minute to deliver it. Then followed much more feeding and brooding. At 8:48 the female, who had been sitting restlessly again, rose up and ate the shell of the second egg. I continued to watch from the blind until half past ten, and when my long vigil was over made a few calculations. The female's periods of brooding had ranged from 2 to 36 minutes, with an average, for 10 periods, of 17.3 minutes. Her absences fluctuated from 4 to 25 minutes, with an average, for 12 recesses, of 8.5 minutes. Hence she kept the nestlings covered 67.1 per cent of the time. Taking only that part of my earlier record for incubation at this nest which covered the corresponding hours of the morning, I found that this female had sat in the nest 67.9 per cent of the time. The difference in her total time on the nest when she had eggs and when she had newly hatched nestlings is hardly significant.

In the 4 hours and 20 minutes following his first sight of the nestling at 6:12 a.m., the male brought food to the nest 12 times. In the same period, the female brought food 4 times. If the male found the nestlings uncovered, he fed them directly; but if the female was brooding when he came, he passed the food to her. Then she would rise and offer it to the nestlings. When they were not hungry, she would eat what her mate had brought to her. Both parents carried food inside their mouths or throats rather than held visibly in their bills; but it was not actually regurgitated, for there was none of the muscular effort which accompanies this process.

Nearly two years later, when the Golden-masked Tanagers again had a nest in the low crotch of the calabash tree, I again watched from a blind on the morning the eggs hatched. Both had been barely pipped at five o'clock in the afternoon of April 13. Now, as it grew light on the morning of April 14, the female sat restlessly, constantly rising up to look beneath herself, just as the bird had done two years earlier. At 5:31 she ate a piece of shell, and three minutes later another piece. At 5:41 she flew away. Going then to the nest, I found that both eggs had hatched and both shells had quite vanished. Evidently the female had eaten the other shell while it was still too dark to see her clearly. On returning to the nest from her first three brief absences of the day, she settled down to brood without feeding the nestlings; but on her fourth return, at 6:25, she gave them both very small particles of food. She fed the nestlings six times more before the male brought them anything.

The male's tardiness in bringing food this time was certainly not caused by lack of attention to his mate or to the nest. On the contrary, he often came close to the nest and frequently called to the female and was answered in the two hours when he did not feed. He followed the female when she returned from her first absence of the morning, but he came only as far as a neighboring madre de cacao tree and did not go to the nest. Arriving again a quarter of an hour later, he perched near the nest and seemed to look into it, but apparently intervening foliage prevented a clear view. On several other approaches to the nest, he exchanged calls with the female while she brooded. Then, at 7:35, he perched only two feet above the nest, looking down attentively, while the female fed the nestlings. At once he began to hunt over the neighboring boughs, promptly found a small insect, and took it to his mate, who meanwhile had settled down to brood. She rose to pass the food to one of the nestlings beneath her. Three minutes later the pair flew off together. Returning after six minutes, each in turn fed the nestlings. Again, the male brought food to the nestlings within a few minutes after he first saw them, and thereafter he fed them regularly. Only this time it took the male two hours to discover the nestlings, while in the earlier year the bird did so within fifty minutes after the first one hatched. And during this long delay, the female's utterances failed to convey to him the information that there were young in the nest; he did not know until he saw them himself.

I continued my vigil until 10:41. In the first five hours of the morning, the female brooded the newly hatched nestlings 20 times, for periods ranging from 1 to 11 minutes, averaging 5.8 minutes. She took 21 recesses, ranging from 2 to 19 minutes, with an average of 8.7 minutes. Hence she brooded only 40 per cent of the time, as compared with the 67 per cent which she (or her predecessor in this same nest site) had brooded on the morning when the nestlings of the earlier family had hatched. The weather on both days was very much the same, cloudy and cool until the middle of the morning, when the sun burned through the clouds and it grew rapidly warmer.

Although brooded far less, these nestlings, possibly because they had hatched a few hours earlier and were more eager for food, were fed much more often than their predecessors in this same calabash tree. In the four hours and a quarter between her first feeding at 6:25 and the end of my watch at 10:41, the female gave food to the nestlings 21 times. In the three hours between his first feeding at 7:38 and 10:41, the male brought food 12 times. By half-past ten in the morning, these two nestlings had been fed twice as often as the earlier brood. Five times in the morning, the female jumped from the nest, plucked an insect from the neighboring foliage or snatched it from the air, mashed it well in her bill, gave it to a nestling, and then resumed brooding. As with the earlier brood, the male fed the nestlings when he found them uncovered, but he passed the food to his mate if she was brooding when he arrived. Once when the pair returned to-

gether, both bringing food, the male went first to the nest and tried in vain to make the nestlings swallow what he offered. Then the female fed, and after she had settled on the nest the male, clinging to the branch above her, passed to her the food he still held in his bill. She arose and successfully fed a nestling.

#### CARE OF OLDER NESTLINGS

At hatching the Golden-masked Tanagers have pink skins, tightly closed eyes, and sparse gray down of the usual passerine type. When ten days old they are well feathered. The nest in the calabash tree was below the level of my eye as I watched from the porch, and under these conditions I could distinguish the parents by their plumage, which at higher nests is rarely possible. The head of the male was purer, brighter yellow, that of the female being tinged with green; and the boundary between the black of the breast and the white of the abdomen was sharper and more regular in the male. Possibly also the black part of his plumage was glossier. In 1943, the female was last seen to brood by day on May 25 when the nestlings were eight days old and rapidly becoming feathered. On the afternoon of May 29 there were exceedingly hard and long-continued rains, but I looked in vain to see the mother cover her twelve-day-old nestlings, now well feathered. In this she contrasted sharply with the Yellow-bellied Elaenia who nested in the same spot the following year and who under similar conditions brooded a well-feathered, sixteen-day-old nestling almost as constantly as though it had been newly hatched.

Male and female Golden-masked Tanagers nearly always came together with food, especially after the female had ceased to brood, and the male invariably, as far as I saw, went first to the nest to feed the nestlings, his mate meanwhile flitting impatiently among the neighboring branches. After he had delivered the food, the female gave her portion to the nestlings, then settled down to brood them, or, after they were older, flew away with her mate. This order of feeding began the day the nestlings hatched and was continued until they left the nest. In this precedence of the male in delivering food, the Golden-masked Tanager agrees with the Yellow-browed Tanager, the Turquoise-naped Chlorophonia and the Yellow-crowned Euphonia. These small tanagers fly together throughout the year, and male and female usually come to the nest together, whether building, incubating or feeding the nestlings. If the female while brooding the young were to feed them first, she would have to make way for her mate to deliver the food he has brought, then return to sit in the nest. Such a system would result in lost motion and confusion. But if the female feeds after her mate, she can at once sit in the nest, while he flies away. And this order of delivering food, begun in the days when the nestlings are naked and require much maternal coverage, is from force of habit continued after they cease to be brooded, when it would make no difference which of the parents fed first.

After the nestlings in the calabash tree were older, they were fed from 9 to 16 times per hour. The record for a sample hour will serve to show how closely the two parents associated in feeding them. In the hour from 6:30 to 7:30 a.m. on May 31, when the nestlings were fourteen days old and no longer brooded, male and female brought food together six times. The male always fed first, then the female, then they flew away together. Once when the male brought food he was accompanied by the female, who brought nothing; once the female brought food followed by the male, who brought nothing; and twice the male came alone with food. If one parent found food before the other and started to the nest with it, the second would often follow although it came with nothing for the nestlings. The habit of the male and female to fly together was so strong that on another morning, when the male did not wait after feeding for the female to deliver her food, she followed him from the nest still carrying it.



While this pair of Golden-masked Tanagers built their nest in the calabash tree at the end of April, 1943, they were followed occasionally by a young bird in greenish juvenal plumage, doubtless reared by them earlier that same year. Later, while incubation was in progress, I saw little of the youngster. But while the parents fed the nestlings it appeared from time to time. It was now in transitional plumage, beginning to acquire the colors of the adults. Sometimes it followed the parents to neighboring trees, more rarely to the nest tree itself. It seemed to be interested in the nest, and it looked down at it from a higher perch, but did not, while I watched, actually alight on the nest. I never detected any food in the youngster's bill. When it went to the nest tree, the father of the nestlings would assume a threatening attitude; but I never witnessed anything even remotely resembling an attack.

I watched hopefully for this young tanager to feed the nestlings, because eight years earlier, on Barro Colorado Island, I had seen a Golden-masked Tanager in juvenal plumage bring food to the nest. The nest in question was situated thirty feet above the ground in an avocado tree too slender to climb, and about a hundred feet distant from the orange tree where a brood had been successfully reared earlier in the year. If I was correct in assuming that this young tanager was one of those hatched in the nest in the orange tree, it was now, at the beginning of June, three full months of age. The young bird visited the nest about as frequently as the parents. Once I definitely saw something in its bill; but usually it was impossible to distinguish, at the distance from which I was forced to watch, whether any of the attendants, young or old, brought anything when they came to the nest. The parents would always leave promptly after they had fed the nestlings and removed the droppings; but the youngster would hop back and forth across the nest, reluctant to depart.

In 1946, the single nestling reared in the calabash tree in front of the house left on May 21, at the age of 14 days. Two days later a pair of Golden-masked Tanagers, presumably the parents of this fledgling, were building in a neighboring calabash tree, only 30 feet distant from the recently abandoned nest. The new nest was in a situation quite similar to the earlier one—a thick mossy crotch well screened by clustering foliage—but higher above the ground and beyond my reach. Building continued slowly for a week; then incubation followed; and by mid-June the parents were feeding nestlings. At this time a young Golden-masked Tanager in transitional plumage, probably the individual hatched in the earlier nest on May 7, frequented the vicinity and went repeatedly to eat bananas at the neighboring feeding shelf. After the nestlings of the second nest were old enough to go without brooding during the day, this dull green youngster began to attend them. When first discovered at this activity, it was most diligent, bringing food to the nest about as often as either one of the parents. Thus during two hours of the morning of June 22 the parents together brought food 33 times, the youngster 17 times. In the hour from 6:20 to 7:20, the two nestlings were fed by their three attendants a total of 28 times, an unusually high rate, and in the following hour, 22 times. Often all three of the attendants came to the nest together and then flew away in company after delivering the food. But at times the youngster arrived alone. The young tanager did not bring such large billfuls as the parents usually brought. Often I could distinguish nothing in its bill, but again a small morsel would be visible projecting from it. All three attendants of the nest often visited the feeding shelf and carried billfuls of banana from it to the nestlings.

A few days later, perhaps when the novelty of engaging in this adult occupation had worn off, the young tanager brought food much less often than at first. In 3½ hours on June 26 and 27 it came to the nest only 6 times, while the parents together brought food 51 times. The helper often followed the parents on their visits to the nest without bringing anything in its own bill.

In late June, 1948, not far from the site of the foregoing nest, I found another young tanager, its dull plumage marked with the earliest flecks of brighter color, helping its parents to attend two unfeathered nestlings. In 5 hours of the morning it brought food 19 times, the two parents together 67 times. Eighteen times in this period all three of the attendants arrived at the nest together, and 16 of these times the youngster fed the nestlings along with the adults, leaving only 3 times when it came alone to feed them. When the trio came together, either the helper or a parent might deliver its food first.

It has already been recorded that although Golden-masked Tanagers nearly always fly in pairs, occasionally three in adult plumage keep close company. Twice, in the valley of El General, I have found such groups of three attending young together. On May 7, 1937, I discovered on the ground in a banana grove a Golden-masked Tanager, still unable to fly, that had probably been driven prematurely from a nest hidden in a bunch of bananas. As I picked up the youngster to put it in a safer place, all three adults flew around above me, calling excitedly. I made the youngster perch in a bush and, hiding myself behind a banana plant, watched all three of them bring it food repeatedly, always coming and going as a little flock.

On June 2, 1940, I discovered another group of three birds in fully adult plumage feeding nestlings. They, too, nearly always came in company, delivered food one after another, then flew away together. Because the nest was quite inaccessible, I could not determine the number of nestlings it contained. Nor do I know the relationship and sexes of these trios of Golden-masked Tanagers that attend the same nest. On Barro Colorado Island I watched four gray Plain-colored Tanagers feed two nearly feathered nestlings. Like the Golden-masked Tanagers, all the attendants of the nest flew back and forth in a flock, making it easy to count them. Again I am uncertain of the relationship of these birds that joined in feeding the nestlings.

If alarmed by the near approach of a man, the nestlings flutter from the nest when they are only 12 days old and scarcely able to fly. Dropping to the ground, they hop rapidly away and attempt to hide beneath the herbage. But if undisturbed, the young Golden-masked Tanagers leave the nest spontaneously at the age of 14, 15, or even 16 days, when they can fly fairly well.

#### LATER BROODS

The breeding season of the Golden-masked Tanager is very long. In the basin of El General, where nest building begins toward the end of February, the latest nests still contain nestlings in the second half of September. But nests are by no means so abundant in August and September as in April and May. In this long breeding season of seven months, there is theoretically time for the rearing of four or possibly even five broods, although I doubt whether any single pair actually produces so many. I have a good deal of evidence for second broods in this species, and one pair at least attempted to rear a third brood after two successful nestings earlier in that same season.

The interval between the first and second broods may be very short, especially when the female uses the old nest again. A female whose two nestlings jumped from the nest somewhat prematurely, at the age of only 13 days, laid again in the same nest only 12 days later. Another female, whose one surviving young flew from the nest when 15 days old, also laid the first egg of her second set in the old nest 12 days later. In neither instance do I know what befell the fledglings after their departure from the nest, whether they lived to reach maturity or met an untimely end. At the other extreme, the pair that I watched on Barro Colorado Island, whose nestlings departed on March 12, was not found nesting again until April 22, when the female was incubating in an inaccessible nest about a hundred feet from the site of the first. The pair that built the low nest in the calabash tree in front of my house at the end of April, 1943, began another nest

higher in the same calabash tree about 46 days after the spontaneous departure of their nestlings from the former. The interval between the departure of the nestlings and the laying of the first egg in the new nest was 53 days. This pair was the one that was followed by a bird in juvenal plumage while they attended their May nest; they were likewise accompanied by a youngster in transitional plumage while building in mid-July. Hence it is probable that before beginning the first nest in the calabash tree they had already nested at a distance and had reared at least one young bird. The young reared in May would then be their second brood. It is likely that the immature bird who followed the parents while they built the third nest was one from this second brood rather than a member of the first brood still remaining with them. Thus this pair of Golden-masked Tanagers seems to have successfully reared at least one young in each of two broods before building their third nest, from which unhappily the eggs vanished a few days after laying.

In 1945, when the pair that nested in the calabash tree in front of the house lost their nestlings at the age of a week, they began a new nest in a neighboring calabash tree 17 days later, and the female laid the first egg of the new set 22 days after her loss. The eggs from this nest were lost within a day or two of laying, and after an interval of two weeks the pair built still a third nest, midway between the sites of the first two. The third nest was also prematurely lost early in June. In mid-July the female was incubating in a fourth nest in the site of the third, but this was also a failure. Thus between March and July this pair built four nests in front of the house, and possibly additional ones at a distance, without rearing a single young.

#### ENEMIES

I do not know what fate befell the last three nests of the pair just mentioned, but the loss of the first was witnessed. Early one afternoon the parent Golden-masked Tanagers were attending their two-week-old nestlings in the calabash tree fifty feet in front of me. Suddenly a Swallow-tailed Kite, that had been soaring about high overhead, swooped down and carried off the nest along with the two nestlings. A Neotropic Kingbird darted angrily at the kite the moment it seized the nest, but it was not able to distract the kite. Rising high in the air, the hawk soared around on set wings, holding the nest in its talons; it bent its head down to extract a small object that was doubtless a nestling. Then it dropped the nest, which drifted slowly earthward.

When, a few minutes later, the parent tanagers returned together with food in their bills, they found only a bare, mossy crotch where their nest had been. Then they hunted over the neighboring branches and forks, as though they hoped to find their nestlings in some other spot. Over a period of an hour, they returned again and again with food in their bills and searched in the neighborhood of the vanished nest.

The enemies of nesting Golden-masked Tanagers doubtless include all those creatures which prey heavily on other arboreal nests in the same region. Snakes and toucans, as well as Swallow-tailed Kites, must destroy many nests. But aside from the kite, the only enemy of the Golden-masked Tanager which I have watched molesting nests is one that was quite unexpected—the Blue Tanager. Twice I have known these larger tanagers to dispossess the Golden-masked Tanagers of their nests and use them for their own families. One of these nests was built in a bunch of small plantains. When found it contained two eggs that were being incubated by a Golden-masked Tanager. Four days later, there were three eggs in this nest, and the following day four (see p. 194). The mystery was finally solved when a Blue Tanager flew from the bunch of plantains upon my approach. She continued to incubate the Golden-masked Tanager's eggs along with her own, but before any hatched the nest was emptied by some predator. For the ac-

count of another nest of the Golden-masked Tanager taken over by a Blue Tanager see p. 193.

#### PLUMAGE CHANGES

The Golden-masked Tanager leaves the nest in a plumage greatly different from that of its parents. The entire upper parts, from crown to rump, are dull green of varying shades. The remiges are blackish but edged with yellowish-green, broadly on the secondaries and more narrowly on the primaries. The tail is black, the breast gray, the belly white tinged with buff, and the under tail-coverts buff.

A plumage essentially adult is acquired by means of the postjuvinal molt, which is apparently complete. I have detected the first traces of the impending transformation in color as early as May, on a young bird that sometimes followed its parents while they attended a subsequent nest. By October most of the young of the year have completed the molt and are difficult to distinguish from the adults. But in early January I once found a greenish young bird which still followed its parents and was just beginning to acquire the adult colors. This youngster had probably hatched in September, in a very late nest. Near Tucurrique, on the Caribbean slope of Costa Rica, Mr. Carol North called my attention to a nest which in June was being attended by a female in a plumage which was not wholly adult. The black band across her chest was unusually narrow and her remaining under parts were gray rather than white, with no blue on the sides and flanks.

#### SUMMARY

Golden-masked Tanagers are birds of the Humid Tropical Zone, ranging in Costa Rica up to 5000 feet above sea level. In pairs, family groups, or rarely three or four adults together, they roam through the trees both in the forest and in cultivated areas. They remain mated throughout the year.

The food consists of a variety of fruits and of insects captured among foliage or on the wing.

The notes are slight and weak, and the only song is a rapid sequence of dry *ticks*.

These tanagers sleep amid dense foliage, the male and female often close together but not in contact with each other. Sometimes they roost gregariously, seventeen or more gathering from the surrounding country to pass the night among trees in a doorway.

In El General the breeding season extends from February to September. The open nest is usually placed in a tree or bush at a height of 5 to 50 feet; but at times it is situated in a bunch of green bananas or in a hole or cranny in a tree. Both sexes build, completing their work in from four to six days.

Two eggs are laid early in the morning on consecutive days. They are incubated by the female, who by day rarely sits for as long as an hour at a stretch. One female covered her eggs for 64.6 per cent of a six-hour period of observation, another for 70.5 per cent of eight hours, and a third for 75.6 per cent of ten hours. The incubation period is 13 to 15 days.

The male may feed his mate either while she covers the eggs or during her recesses from the nest, although this was not observed in all pairs.

The nestlings are brooded by the female and they are fed by both parents. At one nest both parents brought their first offerings at the same time, 50 minutes after the female ate the shell from which the first nestling hatched. Another male first fed the nestlings about two hours after his earliest opportunity to do so and 71 minutes after the female first fed them. But at both of these nests the male fed the newly hatched nestlings a few minutes after he first saw them.

At one nest newly hatched nestlings were brooded for 67 per cent of the time, but at a second nest they were covered only 40 per cent of the time. Diurnal brooding ceased after the nestlings were eight days old, when they were fairly well feathered. After that they were left exposed even during a downpour.

Two older nestlings were fed from 9 to 16 times per hour. When both parents came together, the male always delivered his food before the female, even after the latter had ceased to brood.

At one nest in Panamá and two in Costa Rica, a young tanager in juvenal or transitional plumage, hatched earlier in the same season, helped to feed nestlings that were probably younger siblings. These young helpers attended the nestlings less regularly than their parents, in some periods bringing food about as frequently as the parents but at other times neglecting the nestlings while the parents actively attended them.

In two localities trios of birds in full adult plumage were found attending the same nest. The relationship of the helper to the parents could not be determined.

If undisturbed, young remain in the nest until 14, 15, or 16 days of age, when they can fly fairly well.

At least three broods may be reared by a single pair in the course of the long nesting season. In two instances the interval between the departure of fledglings and the resumption of laying was 12 days, but in other cases it was apparently far longer. Between March and July, one pair built at least four nests without rearing a single offspring.

A pair whose nestlings were carried off by a Swallow-tailed Kite brought food repeatedly to the empty nest site in the next hour. Two nests containing eggs were stolen from the Golden-masked Tanagers by Blue Tanagers, which laid in them.

Young leave the nest in a plumage very different from that of their parents, but they acquire the adult colors at the postjuvenal molt, which in individuals hatched early begins in May; by October the molt is completed in most of the young of the year. One abnormal female nested in incompletely adult plumage.

## PLAIN-COLORED TANAGER

### *Tangara inornata*

A bird as drably attired as the Plain-colored Tanager hardly seems to belong among the brilliant species of the genus *Tangara*. Only a minute daub of blue appears on each wing of this plain gray bird. The remaining upper plumage is slate gray, the breast dull light gray, and the abdomen white—all plain and unadorned. As in the more brilliantly attired members of this genus, the sexes are alike in plumage.

The Plain-colored Tanagers range from Veragua to central Colombia, the Panamá race (*T. i. languens*) from the Canal Zone southward. It is a lowland species, and how far it extends upward into the mountains appears to be unknown. In the Canal Zone, where it is not uncommon, it frequents the edges of the forest and adjoining clearings, usually foraging well above the ground in the crowns of trees, like most of its congeners. "It is an active species, always on the move, yet is rather deliberate in its manner" (Harrower, MS).

My experience with the Plain-colored Tanager is confined to a single family which in 1935 nested in the fruit trees in the narrow clearing surrounding the main building on forested Barro Colorado Island in the Panamá Canal Zone. Early in April I discovered a nest, situated about thirty feet above the ground in the clustered foliage at the outside of the densely umbrageous crown of a mango tree behind the building. Looking into the open cup by means of a mirror attached to a long pole, I found a single whitish, speckled egg on April 6; there were two the following day. These eggs vanished before hatching, and I then took down the nest for closer examination. It was a neat cup, composed largely of light-colored fibers apparently gathered from some decaying herbaceous vine. A length of vine, disintegrating into a bundle of fibers, had been carelessly allowed to hang down from the rim to a length of seven inches. The exterior of the cup was well covered all around with green moss. The structure was bound together and attached to its support by cobweb and spiders' cocoons liberally used. The interior cavity measured  $1\frac{3}{8}$  by  $2\frac{1}{8}$  inches in diameter by  $1\frac{1}{4}$  inch in depth.

On April 30 a pair of Plain-colored Tanagers, apparently the owners of the earlier ill-fated nest, were discovered making a new nest in the top of an orange tree at the northwestern corner of the main building. The female alone was working at the nest, and while I watched she came about sixteen times with billfuls of fine light-colored fibers or other finely shredded material. Her mate accompanied her on every visit to the nest, waited near by while she arranged the fibers in it, and then followed when she flew away to gather more material. On four occasions he brought material in his own bill. Twice he dropped his burden while waiting for the female to leave the nest, and twice he carried it off again, following his mate. The remaining twelve times he came with empty bill. The net result was that he contributed nothing at all to the nest while I watched. Since I could distinguish the sexes of this pair neither by color nor voice, I called this bird the male merely on the strength of his behavior.

I did not hear the male Plain-colored Tanager sing. As the pair flew from the nest tree both voiced a rapid, low *ticking*, which resembled the common note of the Golden-masked Tanager, but was not uttered in the long, rapid series which the latter species often delivers. Although from February until June I saw a good deal of this pair of Plain-colored Tanagers, I never heard anything from them that I could call a song. Apparently, like some of the brighter species of *Tangara*, they are songless.

So far as I could learn, no egg was laid in this nest in the orange tree. On May 30,

the hunger cries of nestlings drew my attention to a Plain-colored Tanagers' nest which had hitherto escaped my notice, although I had passed many times beneath it. It was situated about thirty feet above the ground in a lime tree beside the kitchen, not far from the site of the first nest in the mango tree. Although the nest itself was difficult of access, by watching from the upper story of the building I could plainly see two nest-

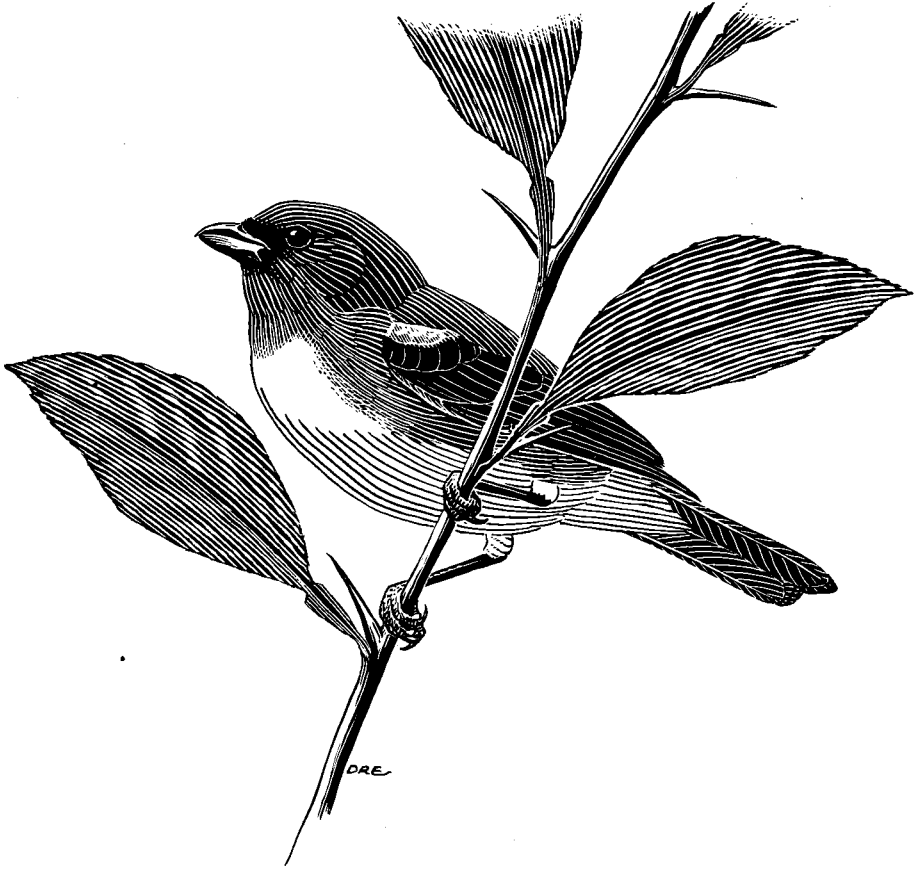


Fig. 29. Plain-colored Tanager.

lings stretch up their heads whenever the attendants came with food. They were already nearly feathered and almost ready to fly, and from time to time they exercised their wings by flapping them vigorously above the nest. While I watched, three grown Plain-colored Tanagers flew up together and in rapid sequence all fed the nestlings. A little later four adults came and each in turn gave food to the nestlings. The attendants were individually too similar in appearance to be distinguished; but their habit of arriving in a little flock, now three, now four, made it plain that at least four were regularly feeding the youngsters in the nest. What was the relationship of these four birds I could only surmise. Possibly a pair which had recently lost a nest had joined the more fortunate parents in attending the nest of the latter; possibly two were offspring of the other

two, reared in an earlier nest, and were helping their parents attend their younger brothers, a relationship which has been recorded for numerous other species of birds (Skutch, 1935).

#### SUMMARY

A pair of Plain-colored Tanagers built three nests in a narrow clearing in the forest on Barro Colorado Island, Canal Zone, in April and May, 1935. The first contained two eggs and the third two young. The first two of these nests were failures.

At one nest the effective building was, so far as seen, all done by the female. The male sometimes came with material which he dropped or carried away again.

At the last nest the two nestlings were fed by four grown birds, who often came together. The relationship of the two helpers to the parents is unknown.



## YELLOW-BROWED TANAGER

### *Tangara chrysophrys*

"Speckled Tanager" would be a good name for this pretty, curiously marked, little bird, that is thickly spotted and streaked with black over nearly all its bright green upper plumage and whitish under parts. Its unusual appearance is increased by the black band that extends from the lores to behind each eye and which is narrowly bordered with yellow both above and below. Its wing feathers are black, broadly margined with bluish-green, its tail black and green, its flanks and under tail coverts pale yellowish-green. Male and female are in some pairs hard to distinguish, but in others the male is more heavily spotted on the back and breast. Spotted plumage is rare in the tanager family, and the heavy black marks on a green ground will at once serve to distinguish this species from any other in Central America.

The Yellow-browed Tanager ranges from Costa Rica south to Ecuador, Venezuela, and Trinidad. In the former country it occurs on the Caribbean slope and the more humid southern half of the Pacific slope in the rain-forests on the foothills from about 1000 to 3500 feet above sea level. In the basin of El General, where alone I have studied its habits, it is, in the zone between 2000 and 3000 feet, the least abundant species of its genus; its relatives, the Golden-masked Tanager, Blue-rumped Green Tanager and Silver-throated Tanager, are all more common. Here the Yellow-browed Tanager wanders through the forest, as a rule keeping well up in the canopy, and it also moves through adjoining clearings with scattered trees. Usually it is seen in pairs or in groups of three or four, which are probably a mated pair with their full grown offspring, some of which may continue to keep company with their parents until the following nesting season. It is a restless bird and it appears to wander over a wide area each day in search of food.

#### FOOD

Yellow-browed Tanagers subsist on insects and a variety of berries and other fruits. They are fond of the black berries of the pokeweed (*Phytolacca rivinoides*) that springs luxuriantly in freshly burned forest clearings. For more than two years they have visited my feeding table, coming in pairs or parties of three or four, more rarely alone. Here they eat the bananas and ripe plantains daily provided for them. The frequency of their attendance varies from month to month, apparently depending on the abundance or scarcity of wild fruits in the surrounding forests and thickets. They are among the most confiding of my visitors and will continue at their meal on the board while I approach very near. One October morning, when I had temporarily laid the bananas on a table on the front porch, a family of four Yellow-browed Tanagers, impatient with the delay in being served, came on the porch to eat them. With the exception of wintering Tennessee Warblers, no others of my visitors have been so fearless.

Not long ago I watched a pair of Yellow-browed Tanagers gathering food for their young among the shade trees of the riverside pasture. They hunted insects and spiders in the foliage at the ends of the slender twigs, moving deliberately about and scrutinizing the leaves in the same careful manner as a Yellow-green Vireo which was foraging among the same trees at the same time. They investigated the interior of curled dead leaves, and often they hung head downward to reach some attractive item. One of the pair, after collecting several insects in its mouth, gathered a few small black berries from a neighboring bush of the melastome family, and with a very full bill flew up to its nest-

lings in the calabash tree at the edge of the terrace. The mate, who was less successful in hunting, followed soon after with a smaller load.

#### VOICE

The Yellow-browed Tanager's song, if song it may be called, begins with a short, clear, somewhat bell-like note, identical with the callnote. This is repeated with increasing rapidity until it becomes almost a trill, which seems to taper off to a sharp point. The notes are too metallic, or too lacking in liquidity, to form a true trill. This utterance

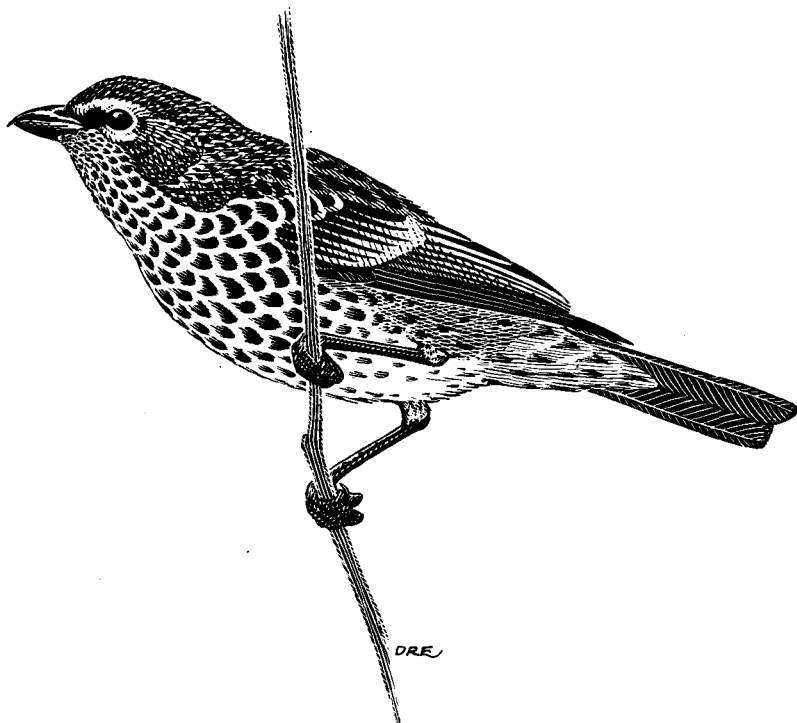


Fig. 30. Yellow-browed Tanager.

resembles in form that of the Golden-masked Tanager but is resonant and musical instead of dry and lacking in timbre. It is delivered chiefly as the tanagers take wing. Nice (1943:172-174) and others have shown that a number of song birds of the North Temperate Zone sing chiefly or exclusively when they are without mates, or when they are temporarily separated from them. Perhaps tanagers of many species sing so little, and have such poorly developed voices, because they remain mated throughout the year and are so constantly with their partners.

#### NEST BUILDING

I have found only five nests of the Yellow-browed Tanager, all in the basin of El General at about 2500 feet altitude. The earliest was being built on April 10, 1940, whereas the latest held newly laid eggs on June 18 of the same year. These few nests cover a period far shorter than the breeding seasons of the other three species of *Tangara* inhabiting the same region, but for the others I have larger numbers of records. Three of my nests were in small trees growing in the shady yards of houses standing in clearings near

the forest; one was in a fig tree on the tree-bordered margin of a river flowing between pastures; the fifth was beside a little used road, at the edge of an abandoned banana plantation grown up with tall bushes. This last was only 10 feet above the ground, in a tuete (*Vernonia patens*); that in the fig tree by the riverside was about 25 feet up and the highest of all. The three near houses were at intermediate heights, between 15 and 18 feet above the ground.

As in the Golden-masked Tanager, the little open cup is built by male and female working together. This was true at all four nests that I watched, but the amount of work done by the male was more at some nests than at others. On May 19, 1945, I found a pair building in a young introduced flame-of-the-forest tree (*Spathodea campanulata*) growing in my yard. Their nest was attached to the petioles of the big, pinnately compound leaves, in contact with the tall, pole-like stem that was just sending forth its earliest branches. Sitting at ease at the dining-room window, I watched the pair of tanagers at work. They had completed the outer layer, probably in a single morning, and were bringing broad strips of dry leaves and fibrous materials when I began to watch at noon. Between 12:00 and 12:30 the two together brought 9 billfuls of material; from 12:30 to 1:00, 4 billfuls, and 2 billfuls in the next 15 minutes.

Next morning the pair of tanagers began work late. They visited the nest only once while I ate early breakfast, and not at all while I watched continuously between 6:40 and 7:15. But in the next half hour (7:15 to 7:45) they brought, together, 10 billfuls of material; from 7:45 to 8:15, 7 billfuls; from 8:15 to 8:45, 6 billfuls. Nearly always male and female came together so that the number of actual visits to the nest was only a little over half of the figures given. On 12 occasions I saw both members of the pair with material in their bills at the same time, indicating that both took substantial shares in the task, although I could not with certainty distinguish the sexes. Usually each placed its own contribution in the nest and sat there to arrange the material and shape the structure. In the care which they devoted to this work, I could detect no difference between the male and female. More rarely one member of the pair passed the material to its mate sitting in the nest. Once, when one bird attempted to deliver material to the other in this fashion, it fell to the ground and was not retrieved. Sometimes, while the second bird sat shaping the nest, the one which had deposited its material first went off for more and returned before the other had left.

The following year a pair of Yellow-browed Tanagers, probably the same which had built in the flame-of-the-forest tree, were discovered constructing a nest in the top of a calabash tree in front of the house on May 9. It was placed between five diverging branches at the end of a long upright stem, and well concealed by the clustering foliage, which in this tree springs from the main trunk. The pair brought material a few times in the early afternoon, before it began to rain. Next morning I watched for three hours, from the porch. As in the preceding year, the pair began work somewhat late, not fetching material actively until a quarter to seven. At best they built at a leisurely pace, the two together bringing no more than seven billfuls in an hour. Whether or not both brought something for the nest, they nearly always arrived and left together. If both came with a contribution, first one and then the other entered the nest to place and arrange what it had brought, then both flew off together. More rarely one passed its billful to the other at the nest.

At both nests, the male fed his mate during the period of nest building. In 1945, he fed her on the feeding shelf. As the pair stood together over the banana or plantain, one sometimes passed a billful of fruit to the other, who had been helping itself liberally from the same source. Similar feeding was witnessed on the board after the failure of the nest; the male might pass four or five billfuls to the female while she stood beside the

banana, making no effort to help herself. But if she did not receive enough from her mate to satisfy her, she might afterward eat directly from the banana. Although in 1946 the nest was much closer to the feeding shelf than in 1945, the tanagers now visited it far less often, possibly because other fruits more to their taste were then available. But I saw the supposed male feed his mate in the calabash tree near the nest.

The nest in the flame-of-the-forest tree was built in about three days. The completed nest of the Yellow-browed Tanager is a small, compact, open cup. One found in 1943 had the exterior composed largely of the slender, curved, brown secondary rachises of the finely divided bipinnate leaves of a species of mimosa, a woody vine that climbs high over the trees at the forest's edge and was abundant in the vicinity. Each rachis was from  $2\frac{1}{2}$  to 3 inches in length, and many of them bore a few minute sharp spines near the base. Mixed with these were a tendril and a few fine wiry rootlets. Placed among the rachises, but becoming more abundant toward the interior, were a number of strips of banana leaf, some 8 inches long, and a few small pieces of dicotyledonous leaf. Interbedded among the leaves were fine black fungal hyphae and a few horsehairs. In the bottom were a number of pieces of light gray foliaceous lichen, loosely placed. Cobweb strengthened the attachment of the rim of the nest to the slender branches that supported it.

The nest found in 1946 was of essentially similar construction, and it likewise contained many of the slender secondary rachises of the climbing mimosa. The middle layer was composed chiefly of small partly decayed leaves of dicotyledonous trees and a few pinnae of ferns, instead of the banana leaves in the first nest, which was nearer a banana plantation. In the bottom were several large foliaceous lichens, and in addition a thick mat of fine black fibrous material, chiefly fungal hyphae and horsehairs. The nests measured 3 to  $3\frac{1}{2}$  inches in over-all diameter, 2 to  $2\frac{3}{4}$  inches in height, 2 to  $2\frac{1}{4}$  inches in inside diameter, and  $1\frac{1}{4}$  to  $1\frac{1}{2}$  inches in depth.

The nests of the Yellow-browed Tanager that I have examined differ from those of the other three species of *Tangara* which breed in El General in the absence of moss, liverworts or living ferns. This green material forms the bulk of the nest of the Silver-throated Tanager and is more or less abundant in the outer walls of the nests of the Blue-rumped Green Tanager and the Golden-masked Tanager.

#### THE EGGS

Three nests whose contents could be viewed with the aid of a mirror contained two eggs each. This number appears invariably to constitute the full set with this as with other Costa Rican species of *Tangara*. In two of these nests the eggs were laid a day or two after the structures were completed, and on consecutive days. At the nest in the flame-of-the-forest tree, which was apparently completed on May 20, the first egg was laid on May 22. At 5:45 next morning, there was still the single egg. At 6:10 I found the female on the nest and she sat until 6:25. Going then to look into the nest with a mirror, I found two eggs.

The eggs are white, heavily mottled with brown, especially on the large end. Because of the difficulty of reaching the nests built on tall, slender, young trees, I removed only one egg for measurement. It was 20.6 by 15.1 millimeters.

The distribution according to the month of laying of five nests in the valley of El General, 2300 to 2600 above sea level, is as follows: April, 1; May, 3; June, 1.

#### INCUBATION

At the nest in the flame-of-the-forest tree, the female began to incubate with fair regularity on the morning her second egg was laid. Between 7:00 a.m. and 1:05 p.m. she

took 6 sessions on the eggs, ranging from 27 to 46 minutes in length and averaging 36.3 minutes. Her 6 recesses varied from 10 to 47 minutes and averaged 22 minutes. She incubated 62.3 per cent of the 6 hours. Thus immediately after laying the second egg she began to sit with fair diligence. Only her longest recess of 47 minutes appeared to be irregular.

Two days later I began to watch this nest at noon, continued until nightfall, resumed my vigil at daybreak, and carried on until the following noon. After longer familiarity with this pair, I learned that the black spots on the breast and back of the male were somewhat heavier than those on the female, yet most of the time I found it difficult to distinguish the two. But I saw nothing to indicate that the male ever took a turn on the eggs. In the 12½ hours of daylight included in my record, the female took 14 sessions on the nest, ranging from 30 to 53 minutes in length and averaging 39.7 minutes. Her 15 recesses ranged from 2 to 27 minutes and averaged 10.1 minutes. She kept the eggs covered 79.8 per cent of the time, a good record for a small bird incubating alone.

I saw the male Yellow-browed Tanager give food to his mate 10 times in the 12½ hours of my watch. Nine times he presented an item to her while she sat in the nest. The tenth time, he came with her during a recess and went to the nest with food in his bill, while she lingered in the guava tree close by. When she did not come promptly to the nest, he flew to the guava tree and fed her there. Eight of the 10 feedings were in the morning and 6 before 10 a.m. On 3 occasions the female was fed twice in a single session, once with an interval of one minute, once of four minutes. Most probably the male also fed her from time to time as they foraged together beyond my range of vision; he sometimes gave her banana at the table on the opposite side of the house. Few tanagers that I have watched have fed their mates so often as he.

Usually the female continued to incubate until she heard her mate among the neighboring trees. Then they might call back and forth many times over with sharp, clear monosyllables; and finally the female jumped from her eggs, hopped from petiole to petiole until she was about a foot above the nest, then flew off with her mate. Or she might call when I could not hear the male; and sometimes she continued to repeat her clear little notes rapidly, for several minutes together, for no reason that I could discover. The male always flew away with her instead of staying to guard the nest in her absence. Usually he escorted her back to the eggs at the end of her recess, but sometimes she returned alone.

Two other nests of the Yellow-browed Tanager were watched for shorter periods while they contained eggs, and at both I repeatedly saw the male feed the female. In a bush near one of these nests, the male gave his mate a caterpillar which he had mashed well in his bill. She begged for it with quivering wings, like a fledgling. Next morning this male brought his mate a berry while she sat in the nest.

On April 29, 1949, Mr. and Mrs. Darwin Norby and I made an all-day record of incubation at a nest situated 30 feet up in the burío (*Heliocarpus*) tree in front of the house that held the feeding shelf. In 12¾ hours of observation we timed 14 sessions on the eggs ranging from 20 to 77 minutes and averaging 37.8 minutes, and 15 recesses ranging from 3 to 23 minutes and averaging 11.4 minutes. The female tanager spent 76.8 per cent of the day covering her eggs—a record surprisingly similar to that of the tanager in the flame-of-the-forest tree. Although in the morning, which was cloudy, her longest session was 36 minutes and her shortest recess 8 minutes, after one o'clock in the afternoon, when light showers fell intermittently until dusk, her sessions lasted 68, 42, 70 and 77 minutes, her recesses only 3, 6, 7 and 3 minutes. Her mate, who often escorted her as she returned to her eggs and frequently went to look into the nest while she was away, seemed to feed her 7 times. He repeatedly chased away the troublesome

Variable Seedeaters that persistently returned to eat the burio seeds that were ripening all around the nest. Once he drove off a female Song Tanager much larger than himself.

The female Yellow-browed Tanager is strongly attached to her nest and will allow a man to approach closely before she flies from her eggs. To view the contents of the nest in the flame-of-the-forest tree, I would set a light ladder nearly upright against the slender trunk, climb half-way up, then lift up a mirror attached to the end of a wand. While I climbed the ladder, shaking the young tree rather violently, the tanager would continue to cover her eggs, not deserting them until the mirror rustled the foliage close beside her. This nest gradually tilted over as the large compound leaves to whose petioles it was attached drooped downward with advancing age. Finally an egg fell out, and to prevent the loss of the other I tied up the nest with string. As I stood on the ladder making this repair, one of the tanagers came within ten or twelve inches of my hands. By the time I had returned to the ground, the female tanager was covering her remaining egg, quite disregarding me and the old man who held the ladder.

At this nest the single surviving egg hatched after  $12\frac{1}{2}$  to 13 days of incubation. At the nest the following year, both eggs hatched after 13 days of incubation.

#### THE NESTLINGS

I watched the nest in the flame-of-the-forest tree on the morning of June 5, when the single remaining egg hatched. At 5:30 a.m. there was still too little light to distinguish the female tanager on her nest. At 5:45 she flew off for a nine-minute recess, returning to brood at 5:54. At 6:06 she left again, and going now to look into the nest with the mirror, I saw that the nestling had hatched. I failed to learn what the female did with the empty shell, but probably she ate it while the light was still too dim to reveal this. On her return at 6:23 the female appeared to give the nestling its first meal; and when she came back from her next recess at 6:49, I saw clearly that she fed it. The male did not come near the nest until 7:34, when he rested in the tree about a yard above it while his mate fed the nestling and settled down to brood. But apparently he did not on this occasion notice that the egg had hatched. Around eight o'clock he called much in a neighboring tree while the female brooded. At 9:28 the male for the second time that morning perched above the nest while the female fed the nestling. Twelve minutes later, at 9:40, he brought food for the first time that morning and gave it to his mate while she sat. She rose to pass it to the nestling beneath her while he stood close beside her. At 10:13 the pair returned together, both bringing food. While the female stood beside the nest, the male fed the nestling. Then the female fed it and brooded. The male brought food only thrice more before noon, making only 5 times during the course of the morning. The female fed the nestling 12 times of which I was fairly certain, and possibly twice more, between 6:00 a.m. and noon.

The male tanager first brought food to the nest, and first saw the nestling, at least 3 hours and 34 minutes after it hatched, and about 3 hours after the female first fed it. When he next brought food and first fed the nestling directly, 33 minutes after seeing it, it had been out of the shell at very least 4 hours and 7 minutes. From the male tanager's attentiveness on the fourth day of incubation, when I made the long continuous watch. I felt certain that he would discover and feed the nestling far more promptly. Then, beginning at 6:14, he had brought food 4 times before 9:40, the hour of his first arrival with a morsel on the hatching day. In the remainder of that morning (9:40 to 12:00) he came with food for the female alone 4 times more, as compared with 5 times in these same hours on the morning the egg hatched. And on the earlier morning he had otherwise been more attentive, calling his mate from the nest and escorting her back far more often. Although I made no long-continued watch of the nest between May 26

and the hatching of the egg on June 5, I believe that in this interval the male tanager gradually became less attentive to his mate and the nest. While sitting at my meals, I heard the pair call and answer each other far less in the last days of incubation than in the earlier period.

In the course of the morning of June 5 the female tanager brooded the newly hatched nestling for 12 periods ranging from 5 to 46 minutes and averaging 19.4 minutes. Her 13 absences varied from 1 to 18 minutes in length and averaged 10.6 minutes. She was in the nest 64.7 per cent of the morning. While she incubated on the morning of May 26, she sat 78.6 per cent of the time.

On June 8, when the nestling was three days old, I watched from 6:15 to 9:26 a.m. and from 1:00 to 4:21 p.m., a total of 6½ hours. In the 3 hours and 11 minutes of the morning, the male tanager brought food 8 times and the female 6 times. In the 3 hours and 21 minutes of the afternoon, the male brought food 9 times and the female 7 times. In the total of 6½ hours, the nestling was fed 30 times, 17 times by its father, 13 by the mother. It was fed at the rate of 4.6 times per hour.

Nine times the male and female came together with food for the nestling. On eight of these occasions the male delivered the food before the female. Only once was this order reversed. In the Golden-masked Tanager, Yellow-crowned Euphonia, and Turquoise-naped Chlorophonia, the male also habitually precedes the female when the two come together with food for the nestlings. This arrangement avoids lost motion.

During the morning, which was cool and cloudy, the female brooded the nestling for 6 periods ranging from 6 to 25 minutes and averaging 14.2 minutes. She was absent for 5 periods ranging from 16 to 26 minutes and averaging 19.6 minutes. In the 3 hours of the afternoon, when the sun shone intermittently and the weather was warmer, she brooded for 6 periods ranging from 1 to 9 minutes and averaging 5 minutes. She was off the nest for 6 periods ranging from 13 to 54+ minutes and averaging 28.5+ minutes.

The leaves of the flame-of-the-forest tree to whose petioles the nest was fastened died with age and gradually became detached from the stem. With the loss of this support, the structure tilted so strongly that on June 10 the five-day-old nestling fell out. I found it on the ground beneath the tree, apparently uninjured by its sixteen-foot fall. How long it had been there I do not know, but it was becoming cold from exposure. The mother still took food to the empty nest, then went off again without either delivering the food or brooding—conduct which had led me to investigate and discover her loss. I righted the nest as best I could and made it more stable by pinning the bottom to the stem of the tree. Then I replaced the cold nestling. It was then about 8:15 a.m. At 9:00 I began to watch from the dining-room window. Two minutes later the mother came to feed and brood her young. In the next two hours she brought it food 8 times and brooded it 6 times for periods ranging from 2 to 8 minutes, a total of 28 minutes. Her 6 absences varied from 3 to 30 minutes in length and averaged 15 minutes. The male tanager had to discover all over again that he was the father of a nestling. He did not resume feeding until 10:41, when he came bringing food with his mate, about 2½ hours after I had replaced the little one in the nest.

In this instance the habit of revisiting a plundered nest after it is found empty, served the parent tanagers well. Except for this habit, they would not have found their nestling after I replaced it, and it would have died of exposure and neglect. But under natural conditions, it must be rare indeed for a helpless nestling that has fallen or been removed from the nest to find its way back.

Next morning before sunrise I again found the nestling Yellow-browed Tanager on the ground beneath its nest. This structure had now become so shallow and misshapen that it seemed hopeless to try to keep the little bird in it; so I took an abandoned nest

of the Song Tanager from a neighboring tree and tied it up in the flame-of-the-forest tree about 6 inches below the Yellow-browed Tanagers' nest, where a short lateral branch provided support. Into this far more capacious nest of the larger tanager I placed the fallen nestling, which although cold was still able to sit upright and lift its mouth for food.

The parent Yellow-browed Tanagers soon found their nestling and brought food for it in its new location. Between 8 and 9 o'clock they came repeatedly, the female at least with food in her bill. She went to the substitute nest and hopped all around it, but the young bird was by now too cold and numb to take nourishment. Yet she would not brood it in the strange nest. When I became convinced of this, I returned the nestling to its own badly misshapen and leaning nest. But in the next half hour the parents did not return and it died of exposure.

The following year the Yellow-browed Tanagers that nested near my house had better luck, rearing their two young at least until they could fly. When these nestlings were 11 and 12 days old, I devoted nearly 10 hours to watching them. The number of feedings per hour varied from 24 between 7:15 and 8:15 a.m. on a cool, cloudy morning, to 3 between 4:15 and 5:15 on a clear afternoon. The total number of feedings recorded in  $9\frac{3}{4}$  hours was 118, the average rate per hour, 12.1. Although rarely one of the parents would come alone with food, usually the pair arrived together, both with laden bills. Each in turn would go to feed the nestlings. But since I could not with certainty distinguish male from female, I could not tell which went first. Often, after delivering the food they had brought from a distance, the parents would rapidly find additional items in the trees close by the nest and take these in turn to the nestlings; sometimes also one would find a second billful near the nest. At times the food found close at hand was banana from the feeding shelf nearby. The nestlings' meal over, the parents would fly away together, uttering their sharp, clear, rapidly repeated notes. The twelve-day-old nestlings were not brooded even when it rained. While rain fell, the parents, which already had food in their bills, darted up into the air and caught additional insects, fly-catcher fashion.

At sunrise on June 10, one of these nestlings was standing on the nest's rim. I was obliged to be absent that day, but when I returned in the middle of the afternoon I found the nest empty. The young birds had apparently been led promptly off to the neighboring forest, and I saw no more of them or of their parents, who now ceased their visits to my feeding table. Both young birds had left the nest at the age of 15 days.

Young in the juvenal plumage, still dependent on their parents, bear a fairly close resemblance to the latter, but their back and breast are not so heavily spotted with black and the yellow brow is lacking. Before the end of the year, it is difficult to distinguish the young birds from the older ones.

#### FAMILY RELATIONS

Early in October, 1944, a pair of Yellow-browed Tanagers began coming to my feeding table with two fledglings quite as large as themselves, who sometimes helped themselves to banana and on other occasions begged for and received bits from their parents. Two weeks later the youngsters still at times pleaded for food with quivering wings and persuaded the parents to pass them billfuls, but by the end of the month parental feeding had ceased. Now I could no longer with certainty distinguish the young tanagers from their parents. Family bonds were growing weaker, for at times only two of the tanagers would come together, at times a single one. Through most of November and December I never saw more than three Yellow-browed Tanagers on the board together. On December 20 the four came in company once more, but after that the tanagers again usually visited the table as a trio. These three tanagers continued to keep



company through January and February. In March I more commonly saw only two individuals on the board, sometimes one alone, but still at times the three would appear in company. During April, the Yellow-browed Tanagers almost always visited the table as a pair, yet still occasionally there would be three together. I can hardly doubt that this was the pair that on May 19 were found building in the flame-of-the-forest tree to the north of the house, about 120 feet away from the feeding shelf.

While I watched the pair build, I only once saw the third individual, which apparently was one of the two offspring that the mated pair had brought to the shelf during the previous October. All three were now confusingly alike in appearance. One afternoon, when the third tanager came to perch in the guava tree close beside the nest, one of the two who were building flew at it in a mildly threatening manner. Whereupon the interloper quivered its wings and uttered a rapid sequence of high, thin notes. This put an end to the threatened attack, and soon all three flew off in the same direction.

I again saw the third tanager late in the afternoon which I devoted to watching the female incubate. As the female approached the nest with her mate, they were followed by the third bird. Then all three flew over the roof of the house; but the female promptly returned and settled on her nest in the rain. On the morning when I placed the dying nestling in the Song Tanager's nest, the third bird several times came near in company with the parents. At times there appeared to be tension between them, but it was not serious. Possibly if the nestling had not died prematurely, the third tanager would have helped the parents to feed it, for I have several times seen three adult Golden-masked Tanagers attending the same nest.

#### SUMMARY

Yellow-browed Tanagers wander through the upper levels of the rain-forest and into adjoining shady clearings; they occur in the foothills up to about 3500 feet above sea level in Costa Rica. Pairs remain mated throughout the year.

Food consists of berries and bananas, and the birds hunt insects and spiders in the foliage in the manner of a vireo.

The song is a rapid sequence of weak notes with slight musical quality.

In El General they nest in April, May, and June. The open cup, usually devoid of green moss, is placed amid foliage in clearings at heights of from 10 to 25 feet and is built by both sexes. One was completed in about three days. The male feeds his mate during the period of construction.

Two eggs are laid early on consecutive mornings. Only the female incubates. In 12½ hours one female sat for 79.8 per cent of the time; and another female, watched from dawn to nightfall, covered her eggs for 76.8 per cent of the period of daylight activity. The first female was fed no less than ten times by her mate, the second about seven times, in about 12 hours of the day. The eggs hatch in about 13 days.

The nestlings are brooded by the female and they are fed by both parents. One male first brought food to the nest at least 3½ hours after the single nestling hatched. A single nestling three days old was fed at the rate of 4.6 times per hour during 6½ hours of observation. Two nestlings 11 and 12 days old were fed at the rate of six times each per hour during nearly ten hours of observation. From one nest the young departed when 15 days old.

Young in the juvenal plumage differ from the parents only in minor details, and before the end of the year in which they hatched, they are difficult to distinguish from the adults. One young bird kept company with its parents until they nested the following year.

## SILVER-THROATED TANAGER

### *Tangara icterocephala*

The elegant little Silver-throated Tanager wears a dress of bright yellow trimmed with black and green (see frontispiece). The whole head is yellow as far as the lower edge of each cheek, which is margined by a black line that begins at the base of the bill and extends to the hindhead. Below these black stripes is the throat-patch, the color of frosted silver. The rest of the under plumage is immaculate yellow. The yellow back is heavily streaked with longitudinal black lines, but the rump is pure yellow. The black wing feathers are broadly margined with green and the tail is blackish. The short, thick bill is black and the eyes are dark brown. The sexes are essentially alike; the male is often somewhat brighter, but in some pairs the difference between the two is very slight.

This tanager is found from Costa Rica to Ecuador. In the former country it ranges from the foothills of both coasts at slight elevation far up into the mountains, possibly as high as 5000 or 6000 feet (Carriker, 1910:864-865). I have met it only on the Pacific slope of southern Costa Rica, between sea level and 4000 feet above sea level, and here I have found numerous nests between 2500 and 3000 feet. The Silver-throated Tanager roams through the tops of the forest trees, sometimes in company with other little tanagers, wood warblers, and vireos. Often it enters adjoining clearings where there are shade trees or berry-laden bushes. Through most of the year Silver-throated Tanagers travel in pairs or family groups. From November to January lone birds often visit my feeding table, but even at this season pairs are not infrequently seen. It seems likely that these tanagers remain mated through the year, but the bonds between male and female become looser in November and December. Silver-throated Tanagers seem never to join in flocks of their own kind.

#### FOOD

Silver-throated Tanagers eat small insects which they find among the foliage of trees or on mossy boughs. They hunt carefully over the smaller limbs of trees, clinging to those which are upright and bending down to examine the lower sides of horizontal boughs, here and there pulling off moss or lichens to see what might lurk beneath. Like most tanagers, they also consume large quantities of fruits. They come regularly to eat ripe bananas or plantains put out for them, arriving either singly, in pairs, or with young still clamoring for food. They are fond of the small purple berries of the pokeweed (*Phytolacca rivinoides*) which grows luxuriantly in newly burnt clearings in the forest, and they pluck the little green fruits from the crowded, dangling spikes of the cecropia trees.

#### VOICE

Most of the exquisite little tanagers of the genus *Tangara* are deficient in song, and the Silver-throated Tanager is one of the least gifted of all. Their short, weak utterances are insect-like, often harsh and grating. In flight they deliver a dry, nasal buzzing call, and at times a deeper and harsher monosyllable of the same character. If they possess a song, I have never heard it.

#### NEST BUILDING

In southern Costa Rica the Silver-throated Tanagers begin building about the first of April. Probably they often place their mossy open nests in the forest; but the thirteen that I have seen were all in trees growing isolated in door-yards or pastures, rising above low thickets, or on boughs of the sotacaballo trees (*Pithecolobium*) reaching far out

over tumultuous mountain streams. Usually the nest is built among clustering foliage, sometimes upon mossy branches with which it blends well. One nest was supported upon a thick vine hanging above a rocky streambed, held in place between an orchid plant rooted on the vine and an ascending portion of the latter. At a little distance, it might have been mistaken for a handful of green moss lodged between the orchid plant and the vine. Ten nests above dry land ranged from 8 to 20 feet in height, and 3 over rivers were from 6 to 35 feet above the water.

The nest is built by the female, the male sometimes making a helpful gesture, and from time to time giving food to his toiling partner. In May, 1943, I watched the construction of a nest in a mossy crotch of a calabash tree in front of my house. Two days after I found this newly begun nest the female tanager was bringing green material for the outer wall, chiefly moss, with now and then a spray of some diminutive fern, and cobweb to bind the pieces together. Coming with a billful of material gathered at a distance, she would arrange this in the nest, then often pluck additional tufts of moss from the mossy boughs of the nest tree, but always from points more than a yard away from the nest. She would gather from one or two to rarely as many as six or seven billfuls of moss in the nest tree itself, taking each in turn to the nest, then fly off with her mate to fetch more from a distance. On about half her visits to the nest tree, she merely deposited and arranged what she had brought from points out of sight, then flew away for more. In the 3 hours from 7 to 10 a.m. she made 23 visits to the nest tree and took 51 billfuls of material to the nest.

The following morning the female Silver-throated Tanager was bringing strips or pieces of papery dead leaves for the middle layer of the nest. Since this material was not available in the calabash tree with its fresh green foliage, she perforce changed her method of working. At each visit to the tree, a single billful of material was placed in the nest. In  $1\frac{1}{2}$  hours from 6:20 to 7:50 a.m., she brought material 35 times.

The male tanager almost invariably followed his mate on her excursions to gather material, but he never brought anything in his own bill. Once, however, when the female dropped a long piece of moss which lodged on a branch, he picked it up, toyed with it, then dropped it, manifesting thereby at least a slight interest in building material. While the female sat in the nest to give it shape, he rested in silence on a neighboring bough or else searched for food over the moss-covered limbs of the nest tree. He never sang. Each morning I twice saw him feed the female with food that he carried entirely within his mouth. Thrice he clung above her while she sat working in the nest and passed the morsel to her. The fourth time, he fed her in the nest tree, but not in the nest. Once when the pair went together to eat banana at the feeding shelf beside the house, I saw the male feed his mate there.

Two years later a pair of Silver-throated Tanagers, possibly the same, built in another calabash tree, even nearer the house, where I could watch them through the open door of my bedroom. The nest was placed ten feet above the ground, in foliage densely clustered on mossy boughs. The method of working was much the same as at the earlier nest, except that now the male was slightly more helpful. While the female was building the mossy foundation of the nest, she would come with material brought from a distance, and after placing this in the nest, bring additional tufts of moss from the nest tree itself. Or perhaps she would bring material taken from an unfinished nest of a Song Tanager in a neighboring bush. Thus in a single period of concentrated building activity she might bring material to the nest from two to five or rarely even ten times. Then she would fly away with her mate to fetch something from a distance. In 3 hours, she came to the nest tree 11 times and took 34 billfuls of material to the nest.

Two mornings later I found her working much harder. In the first 27 minutes of

my watch she brought 20 billfuls to the nest, all gathered within a few yards of the nest from the calabash tree or the Song Tanager's nest. After this period of concentrated activity, she flew with her mate to refresh herself with plantain at the feeding shelf. But in 2 minutes the pair were back in the calabash tree, where in the next 18 minutes the female added 15 more billfuls of moss and dry leaves to her nest. Then after another two-minute visit to the table, the female took material to the nest 7 times in the next 9 minutes. There followed another one-minute excursion to the plantains, with a quick return to the calabash tree, where in 7 minutes the female added 5 more billfuls of material to her nest.

Now, after another hurried two-minute recess, the female tanager abruptly changed her manner of working. Hitherto, moss, liverworts and fibrous rootlets had been her chief materials, and of these she found an abundance right in the nest tree. In the last hour she had mixed occasional small leaves, also gathered close by, with her green material. Now dry leaves for the lining became her chief need, and she was obliged to fly farther off to find a sufficiency of the right kind. Usually she went quite out of sight, mostly flying over the pasture on the lower terrace beside the river. Now her mate, who during the first hour had rested idly in the nest tree or in another close by, aroused himself and followed her back and forth on her longer journeys. As a consequence of the necessity to make far longer excursions, her rate of bringing material suddenly decreased. Between 6:25 and 7:31, when she found material close at hand, she took 47 billfuls to the nest, but between 7:33 and 8:25, she brought only 21 billfuls, chiefly pieces of dry leaf. Her work was still interrupted by occasional hurried visits to the feeding shelf, where she mingled with other tanagers, Tennessee Warblers, and Buff-throated Saltators. In the whole two-hour period from 6:25 to 8:25 she labored almost constantly and brought material 68 times, or slightly more than once every two minutes. Since she spent in aggregate a great deal of time at the nest arranging this material, she made a record for hard work such as has been equalled by few nest-building birds that I have watched in the tropics.

The female tanager worked a little more after 8:30 that morning; but at 3:30 in the afternoon, at the end of a hard shower, I found her again building with zeal. In the next 24 minutes she brought 13 billfuls of material, chiefly pieces of dry leaf, many of them rather large.

The male Silver-throated Tanager was the constant if idle attendant of his toiling mate. While she found material close at hand, he loitered on a low bough in the shade and preened his handsome plumage. But when she needed to fly afar for dry leaves, he followed her back and forth. While resting in the nest tree, he would from time to time bestir himself to pluck a tuft of the moss that grew so profusely on the boughs and carry it to the nest. Twice he presented this to his mate while she sat shaping the nest, billing it to her exactly as though it were a morsel of food. And once he brought a bit of moss in the female's absence, placed it in the nest himself, and sat there to shape it. Again, he entered the nest with nothing that I could see in his bill, although possibly he brought cobweb, and arranged the materials there. Returning with his mate from one of her longer trips, he brought a leaf and took it to the nest at the same time that she arrived with her leaf. Once when she dropped a large dead leaf as she was entering the nest, he picked it up from a lower branch where it had lodged, but instead of returning it to the nest he carried it to one of his customary perches and there dropped it. In 6 hours, he made only 4 or 5 actual contributions to the nest. In the same period, he fed his mate 5 or 6 times where I could see, and possibly a few times more when the pair were screened from view by the dense foliage of the calabash tree. The food was presented either as she approached the nest or while she sat shaping it. Once the male

tried to feed his mate as she came with a big piece of leaf in her bill, but finding that with so full a mouth she could not take the proffered gift, he followed her to the nest and presented it after she had deposited her burden.

On March 15, 1953, a pair of Silver-throated Tanagers began to build in an unusually low site, only 45 inches above the ground, in a bush just in front of one of the windows of our house. During four hours of watching from the window it became clear that both male and female, which were too much alike to be distinguished, were taking substantial shares in building. Of 61 billfuls of material added to the nest, 40 were brought by both birds coming together, each with a contribution, whence it was clear that the male brought at least one-third of the total number of billfuls added to the structure while we watched. Although sometimes one bird passed its load to the other to be arranged in the nest, and sometimes the billful was dropped quite carelessly on the growing accumulation, both helped to shape the structure. Both devoted considerable attention to retrieving materials that fell below the inadequate site and to pulling loosely attached pieces of moss back into place; at times they continued this occupation for three or four minutes. But the accumulation finally fell to the ground and the site was abandoned.

At a third nest which I watched more casually, the male also took at least a slight share in building.

After 4 or 5 days of work the nest is completed. The finished structure is very bulky for so small a bird. The foundation and outer walls are composed of a great mass of green moss, liverworts, and small-leaved ferns with very slender creeping rhizomes, such as *Rhipidopteris peltata* and diminutive polypodies. In the outer layer of one nest were mixed many dry, branched inflorescences of a species of *Cordia*. In the top of this green mass of moss, liverworts and ferns is a relatively shallow hollow lined with dry leaves—nearly whole small leaves of dicotyledonous trees, grass blades, or strips torn from great monocotyledonous leaves such as those of *Heliconia* or *Calathea*. Finally, there is a thin mat of coarse fibers as lining in the bottom. One nest, rather compressed by the crotch in which it was set, measured  $2\frac{1}{2}$  inches in height, 5 in length, and  $2\frac{1}{2}$  in breadth. The interior cavity was 1 inch deep,  $3\frac{1}{2}$  long, and  $2\frac{1}{2}$  broad. When placed in a mossy crotch, as it often is, this green nest is by no means easy to find.

#### THE EGGS

The earliest egg of which I have a record was laid on April 7, 1937. In one nest, which was discovered when just begun on June 10, 1943, the female was still building on June 14 and laid her first egg early on June 15. Another nest, started about April 19, 1945, appeared to be completed on April 24, but the first egg was not laid until April 27. A third nest, found when near completion on May 10, contained its first egg on May 12. Thus the interval between the completion of the nest and the laying of the first egg may vary from less than one to three days.

The eggs, like those of other tanagers, are laid early in the morning, usually before sunrise. Four eggs were laid before 6:10 a.m., one of these before 5:20, and another between 5:25 and 6:10. A fifth egg, laid on a dark drizzly morning, was deposited later, between 6:10 and 7:00. At one nest two days intervened between the laying of the first and second eggs, but at four nests the eggs were laid on consecutive days. At one nest the first egg vanished on the day it was laid, but the second was deposited in the nest the following morning, only to be destroyed the next day. The full set appears regularly to consist of two eggs; eleven of my nests contained this number of eggs or nestlings.

The eggs of the Silver-throated Tanager are dull white or grayish, rather heavily mottled all over with brown. The markings are most concentrated on the thicker end,

where on some eggs they nearly conceal the ground color. The measurements of 8 eggs average 21.3 by 15.6 millimeters. Those showing the four extremes are 22.2 by 16.7, 20.6 by 15.9 and 21.8 by 14.3 millimeters.

The distribution according to the month of laying in 16 nests in the valley of El General, 2500 to 3000 feet above sea level, is as follows: March, 1; April, 4; May, 4; June, 2; July, 1; August, 4.

#### INCUBATION

At two nests which were watched carefully during the period of incubation, only the female was seen to cover the eggs. The first of these nests was situated at the end of a long, drooping branch of a sotacaballo tree reaching out over the channel of a clear, rushing mountain stream. Setting my blind on the rocky shore, I watched for 5 hours in the morning and for 2 hours more in the late afternoon, after the cessation of the heavy downpour usual at this season. The rain began again at 4:30, and while it fell a Cabanis Tiger Bittern suddenly came to rest on a rock on the shore close in front of the blind, chasing the tanager from her nest and keeping her away for about 10 minutes. Soon she returned with her mate and flitted nervously about among the branches above the nest. Since the bittern continued to stand motionless as a statue, she plucked up courage to sit on the nest, which with its supporting bough had sunk down under the load of rain drops, and hung not far above the swollen current. After she had been incubating for a quarter of an hour close above the bittern, the big bird suddenly stretched up its long neck and turned around, chasing the tanager from her nest. Thereupon I decided that the bittern had enjoyed a sufficiently long rest, and vigorously shook the cloth which enclosed me; but this only made him regard it with curiosity. Then I suddenly emerged from the blind, and he quickly took wing, flying across the river.

Disregarding the hour while the routine of the tanager was upset by the bittern, I had watched during 6 hours, timing 12 completed sessions on the nest which ranged in length from 8 to 48 minutes, averaging 21.1 minutes. An equal number of absences varied from 5 to 12 minutes in length, averaging 8.3 minutes. The bird kept her eggs covered 71.8 per cent of the 6 hours. Her longest sessions, of 40 and 48 minutes, were taken after the middle of the morning; her second five sessions of the morning averaged twice as long as her first five. Her recesses, however, showed no significant variation as the day grew older. On nearly half of her returns to the nest she was escorted by her mate, who flew away after she had settled on the eggs. Twice in the morning he fed her while she incubated.

The nest in the calabash tree in front of my house, of which I had watched the construction on May 15 and 16, 1943, was studied again on May 29, after incubation of the two eggs had been going on for 10 days. In slightly more than 5 hours of the dark, threatening morning, I timed 10 completed sessions which ranged from 17 to 33 minutes in length, averaging 24.1 minutes, and 9 recesses which varied from 4 to 14 minutes and averaged 7.2 minutes. This Silver-throated Tanager covered her eggs 77.0 per cent of the time. Her sessions were rather uniform in length and did not become significantly longer as the morning advanced. A light rain that lasted for about an hour did not affect the rhythm of her coming and going. Her recesses, however, lengthened somewhat after the middle of the morning. On the afternoon when the eggs were pipped, I watched this nest for two hours more, in a light rain; but the tanager was disturbed by the horses grazing beneath her. Once, however, she sat for 43 minutes while rain fell. In a total of 7 hours of watching, I repeatedly heard the male, but I saw him in the nest tree only once. Then he came with his mate as she returned from a recess and fed her as she was about to enter the nest. Possibly he gave her additional food when the two were together

during the female's recesses; I sometimes saw him pass banana to her at the neighboring feeding shelf.

This is the only nest at which I was successful in determining the length of the incubation period. The second egg was laid on May 19; both were pipped early on the morning of June 1 and both hatched in the following night, giving an incubation period of nearly 14 days.

#### THE NESTLINGS

I entered the blind before this same nest at dawn on June 2 to witness the events attending the hatching of the eggs. While the light was still so dim that I found difficulty in following her movements with my eyes, the female tanager carried away the four pieces of empty shell, one at a time, and seemed to feed the newly hatched nestlings. At first she brought very small items and spent from half a minute to a minute in delivering them to the nestlings. Usually she brooded after feeding. In the early morning the male was several times heard in the vicinity of the nest, but he did not come near it. At first the female did not answer his calls, although once she flew from the nest upon hearing them. But at 6:33, when he flew past while she was brooding, she repeated a low, sharp, wiry monosyllable. Possibly she was trying to call his attention to the nestlings, but these notes sounded to my ear very much like those I had repeatedly heard from her before the eggs hatched. Again at 7:23, when the male came to a neighboring tree, she called to him, was answered, and the two flew away together.

When they returned in company at 7:33, both brought food in their bills. The male went first to the nest, clung head downward to the thick mossy branch rising beside it, as I never saw the female do, and stretched far down to reach the nestlings and give them food. After delivering this he departed. Thus he first fed the nestlings about 2½ hours after the female. Since he had long been in the habit of feeding his mate occasionally at the nest, we can not take his coming with food at this time as evidence that he was aware that the nestlings had hatched. Yet the fact that on arriving with a morsel in his bill he preceded his mate to the nest suggests that he had foreknowledge of the nestlings. If this is true, it seems likely that he learned about them by finding food in his mate's bill when he offered to feed her at a distance from the nest, rather than that he was informed vocally by her. This last hypothesis is difficult to reconcile with his long delay in feeding the nestlings, for he had been in vocal contact with her for at least two hours before he brought food to the nest.

At all events, the male Silver-throated Tanager was ready to feed the nestlings as soon as he saw them, and he was not, like most male parents among birds, obliged to go off and hunt food for them, causing a distinct interval between the first view of the nestlings and the first delivery of food. Four minutes after the male tanager first fed the nestlings he returned with another billful and gave it to his mate while she brooded. She then rose to place it in the red interior of the mouth of one of the young beneath her. Then after 7 minutes more, he brought a heaping billful, found the nestlings uncovered, and spent two minutes delivering it to them. After this feeding the nestlings were so full that they could take no more. When next he came with food, he found his mate brooding and presented it to her, clinging to the branch well above the nest and hanging head downward, as usual. But her bill was still full with the food she had brought on her last return and could not deliver to the satiated nestlings, and she seemed not to notice his offer. He dropped down to the rim of the nest and repeatedly touched her bill with his own, but still she did not respond. At last, she backed up on the rim and fed the young the food she had been holding. At the same time the male, from the other side of the nest, tried to deliver what he had brought. The female succeeded first in delivering her food, then she took the male's billful from him and resumed incubation.

When next the male gave food to his mate on the nest, she spent two or three minutes patiently offering it to the nestlings, mashing it well in her bill, but in vain. She resumed brooding, still holding it in her bill, and after a few minutes offered the same food once more, continuing to present it for about a minute, but in the end apparently swallowed it herself. At another visit to the nest, the male passed part of what he brought to his brooding mate, then waited beside her until she rose to feed the nestlings. As soon as they were uncovered, he tried to feed them on his own account as well. But he was apparently less skillful in making them swallow food than their mother. Not succeeding in giving them the morsel he had retained, he relinquished this also to the female and flew away. His invariable manner of presenting food, whether to the brooding female or to the nestlings themselves, was to cling in an inverted position well above the nest and to stretch far downward to reach their mouths. This was apparently the carrying-over of a habit formed long before, when he fed his mate while she built the nest and before there was a substantial rim on which he could stand. But at times, if the nestlings were sluggish in taking the food he offered, he would grow tired of his inverted position and drop down to rest on the rim in the manner of the female.

Toward the end of the morning, the female tanager did something which I had never seen any other parent song bird do. Four times she picked up pieces of dry papery leaf from the lining of the nest and carried them away. Once she ate a piece of leaf from the lining; at other times she billed them or tried to eat them before dropping them back into the nest or carrying them away. Later I saw that some of the remaining leaves stood up loosely around the nestlings and possibly interfered with her attendance upon them. This was the only reason for their removal that suggested itself to me. She did not carry off all of the dry leaves from the lining. Armstrong (1942:19) watched a Gannet which "picked up bits of weed, stem and dirt from the nest, and, holding its beak on high, swallowed them with violent and vividly perceptible movements of the gullet. Not once or twice, but again and again, many times in succession, did the bird do this." He suggests that this behavior was the outcome of nervous agitation caused by the observer's presence; but this explanation could hardly apply to the tanager watched from a blind.

In 5 hours on the morning immediately following the hatching of her nestlings, the female tanager brooded them for 19 periods ranging in length from less than 1 to 21 minutes and averaging 10.1 minutes. Her 18 absences from brooding, on some of which she visited the nest to feed, ranged from less than 1 to 17 minutes, with an average of 6.6 minutes. In the first 5 hours of the morning, she kept the nest covered 60.5 per cent of the time, as compared with 77.0 per cent on the morning of May 29, while she incubated. After her mate began to bring food to the nest, her periods of brooding lengthened considerably. The average of 11 periods before he brought food was 7.5 minutes, that of 8 periods after he began to bring food, 13.8 minutes. Her absences also became longer after the male began to visit the nest, but to a far smaller degree. Eleven recesses before he came with food averaged 6.2 minutes; 7 recesses after he began to feed averaged 7.3 minutes.

In the 5 hours the female tanager brought food to the nest about 16 times, but twice as often in the 2½ hours before the male fed the nestlings as in the subsequent 2½ hours, in which he brought food 9 times.

Because of the premature loss of these and all other nestlings in accessible nests found before the eggs hatched, I was unable to determine the length of the period they remain in the nest. This is probably from 14 to 16 days, as with other members of the genus *Tangara*.



## END OF THE BREEDING SEASON

Beginning about the first of April, the Silver-throated Tanagers continue to breed over a long period extending, in southern Costa Rica, until late in September. I have two records of nests with eggs in August. From the latest nest the young did not depart until September 18, 1943. The following year I found a stubby-tailed fledgling on September 8. In 1945, the pair of Silver-throated Tanagers which visited my feeding shelf built nests in April and May, but they lost the eggs from both. Early in June they were carrying food from the table, apparently for nestlings, but I could not find the nest. On July 21 they brought a fledgling to the table. At first it rested on a bough above the table where both parents carried food up to it, but by August 4 it stood on the board and the mother, now the only attendant, placed bits of banana in its mouth. Family ties are weaker among Silver-throated Tanagers than among Yellow-browed Tanagers and Golden-masked Tanagers. In another instance, too, the young birds that were brought to my feeding shelf were attended by a single parent, of undetermined sex. As soon as they are well able to take care of themselves, the young appear to separate from the parents; and even these do not remain so constantly in pairs, after the close of the breeding season, as is customary with many other species of tanagers, including those of the genus *Tangara*.

Young Silver-throated Tanagers still attended by the parents are nearly everywhere dull greenish-yellow instead of the bright yellow of the adults. According to W. E. C. Todd (Carriker, 1910:865), a plumage resembling, but somewhat duller than, the adult plumage is assumed at the postjuvinal molt, and the birds pass their first nesting season in this duller garb. At the close of their first breeding season the yearling tanagers undergo a complete postnuptial molt and acquire the full adult plumage, in which the yellow of the crown and rump is much deeper and brighter than before.

## SUMMARY

Silver-throated Tanagers roam in pairs or family groups through the upper levels of the rain-forest and often enter neighboring clearings. They appear to remain mated though the year, but the bonds between mates become looser in November and December.

These tanagers eat a variety of soft fruits and pull moss and lichens from the bark of smaller branches to expose invertebrates hiding beneath.

The weak, insect-like notes are often harsh and grating, and the species lacks a true song.

In El General the breeding season extends from March to late September. The mossy, open nest is often placed in a cluster of foliage in clearings, from 8 to 20 feet up, or above rushing mountain streams at a height of 6 to 35 feet. Some nests are built by the female alone; at others she receives more or less help from the male, who from time to time gives her food.

The full set contains two eggs; these usually are laid early on consecutive mornings. Only the female incubates. In six hours one female took sessions ranging from 8 to 48 minutes and averaging 21.1 minutes; recesses ranged from 5 to 12 minutes and averaged 8.3 minutes; she covered her eggs 71.8 per cent of the time. In five hours another female took sessions ranging from 17 to 33 minutes and averaging 24.1 minutes; recesses ranged from 4 to 14 minutes and averaged 7.2 minutes; she covered her eggs 77 per cent of the time. The first was fed twice at the nest by her mate, the second once. The incubation period is 14 days.

The nestlings are brooded by the female and they are fed by both parents. At one nest the male first gave food to them about 2½ hours after the female first fed them.

The latter, while attending the newly hatched nestlings, carried away four pieces of dry leaf from the lining of the nest and ate another piece.

Family bonds are weaker in this than in some other species of *Tangara*. Often only a single parent attends a young bird still dependent upon it for food. Soon after they can take care of themselves, the young separate from their parents.

## BLUE-RUMPED GREEN TANAGER

### *Tangara gyrola*

The Blue-rumped Green Tanager easily deceives the eye of the watcher peering up from the depths of the tropical forest into the tops of lofty trees. Only its bright reddish-chestnut head reveals the presence of this little bird amid verdure viewed against the sky. Its back and wings are bright leaf-green, its rump and most of the under plumage turquoise blue, becoming greenish on the lower abdomen and under tail-coverts. The bill, eyes and feet are dark. The male and female are, as with other members of the genus *Tangara*, alike in plumage.

The species ranges from Costa Rica to Bolivia, Amazonia, and the Guianas. In Costa Rica it is found on both the Caribbean and Pacific slopes from near sea level up to about 4000 feet. More southerly races have a wider altitudinal range; in the Santa Marta region of Colombia, Todd and Carriker (1922:495) found the bird from the lower edge of the foothills up to about 7000 feet, and even at times on the coastal plain, where it is rare. Living in pairs at all seasons, the Blue-rumped Green Tanagers wander restlessly through the tree tops of the lofty, humid mountain forests, by themselves or in mixed flocks of tanagers and other small birds. They are most frequently seen when foraging at the forest's edge, or when, as they often do, they wander into adjoining clearings with scattered trees. In such clearings they sometimes nest.

#### FOOD

The Blue-rumped Green Tanager consumes a variety of fruits and insects. It shares the habit, common in its genus, of hopping and flitting along horizontal or ascending branches, an inch or two in thickness, bending over now on this side, now on that, as it searches for the small creatures that might be hiding in crevices of the bark or in moss and lichens on the lower half of the branch. It eats many berries, especially those of trees and shrubs of the melastome family so well represented in tropical America. In company with other brilliantly clad little birds, it enters recently burnt clearings in the forest to feast on the juicy black berries of the pokeweed (*Phytolacca rivinoides*) which flourishes rankly in the scorched ground. Hanging to the long, dangling fruiting spikes of the Cecropia tree, it tears off and devours pieces of the hard, green tissue; and from the brown furry cushions at the bases of the long petioles of the same tree, it plucks the tiny white protein corpuscles, beloved of the ants that dwell in the wide hollow stems. Strangely enough, although these frugivorous birds often visit the shade trees in my yard at the forest's edge, they have never been seen coming to the feeding shelf for bananas and plantains; they are the only kind of tanager that frequents the yard which does not at least occasionally eat at the shelf.

#### ROOSTING

On several evenings in July, 1936, when birds were seeking their roosts in the waning light, I glimpsed a streak of green and blue that vanished in the foliage of a young orange tree growing beside my cabin. One night I went out with a flashlight to look for the bird in the leafage. After considerable searching, peering into the crown of the tree from various angles, I found the tanager, an object of more brilliant and intense green amid the darker verdure of the foliage. It rested on a long, horizontal thorn projecting from one of the upright branches in the center of the tree, six feet above the ground. The thorn formed an ample perch, and upon this the bird slept with its feathers all

fluffed out, its head turned back and buried in their soft depths. I stole only a fleeting glimpse of the tanager, for it stirred when the bright beam fell on it. It was unexpected to find this bird of the forest tree tops roosting in a clearing at least a thousand feet from the forest and so near the ground. For at least a month, this Blue-rumped Green Tanager roosted on the same low thorn. Although these tanagers are mated through the



Fig. 31. Male Blue-rumped Green Tanager.

year, this individual always came alone. Possibly this was a member of the pair which the following May nested in the top of a neighboring orange tree.

#### VOICE

In the genus *Tangara* many species possess no utterance worthy of the name of song. Of those well known to me, the Blue-rumped Green Tanager is the best songster, yet withal it is an uninspired musician. The male's song is a slight, simple performance, consisting of four or five notes descending in pitch, delivered with a most peculiar whining twang, yet most appealing. The bird's call note is a monosyllable with much the same wiry tone quality as the song.

#### NEST BUILDING

In the basin of El General in southern Costa Rica, the Blue-rumped Green Tanager begins to breed in February and continues until September or October. On February 21, 1943, I found a bird building a nest already well advanced. Another nest which held feathered nestlings on March 19, 1942, must have been begun at a somewhat earlier

date in February. It seems likely that the nest is usually placed high up in forest trees, where it is never found by the bird watcher. Of the eight nests that I have discovered, one was situated in a dense tangle of vines at the edge of the forest, the others in clearings but at no great distance from the forest. Of these latter, four were in orange trees, one in a mandarin, one in a calabash (*Crescentia cujete*), and one in a tuete (*Vernonia patens*). With the exception of the sparsely branched tuete, all these trees bore densely crowded foliage which well concealed the nests. In height these nests ranged from 9 to about 25 feet above the ground. The highest was that in the vine tangle at the forest's edge; the lowest was that in the *Vernonia*, which, however, grew at the edge of a high, verdure-clad cliff above a river. Those in the fruit trees varied from about 15 to 18 feet above the ground.

I have watched more or less of the construction of four nests. The work of building is done chiefly or wholly by the female. The male may help a little, especially when the nest is newly begun, but he loses interest in the work as it nears completion. So far as seen, he never enters the work of building as whole-heartedly as the male Golden-masked Tanager and the male Yellow-browed Tanager.

On May 6, 1937, I had the good fortune to find a pair of Blue-rumped Green Tanagers just beginning their nest in the very top of an orange tree close beside the thatched cabin which I then occupied. Here I could watch it while at the open window. At first, the green moss which the birds placed in the crotch all slipped out; but they brought cobweb to bind it to the twiglets and so made it stay. The female was thrifty and gathered up what she could of the moss which in falling caught among the higher branches of the tree; she then returned these pieces to the nest.

When the nest was newly begun, the male accompanied his mate on most of her trips, bringing tufts of green moss or even masses of cobweb, which he laid beside the female as she sat in the crotch where she was starting to build. Then he would perch in the top of the orange tree, or in a neighboring tree, and sing his simple little song while she arranged the material. But from day to day, as the nest grew bigger, he became less and less attentive to his mate. He now brought material less frequently and ceased to follow the female as she flew back and forth between the nest and the distant trees where she gathered her moss. The few times when he did bring something to the nest, he merely laid it in the cavity or beside his mate as she sat there. I did not see him enter the nest to give it shape with his body and arrange the material, as do the male Blue Tanagers and Golden-masked Tanagers. Sometimes, indeed, he still sang in a neighboring tree while his mate built, but much of the time he was out of sight and hearing.

After three days of work, the birds completed the outer layer of green moss. Now, on the fourth day, the female began to bring dry grass blades, pieces of dicotyledonous leaf, and fibrous material for the middle layer. On the fifth day she brought chiefly fine grass inflorescences and fibrous material for the lining. Five or six working days sufficed to complete the bulky structure. Other occupations prevented my watching the nest early in the morning, but after eight o'clock the female tanager's principal time for working was between noon and two o'clock in the afternoon. In this two-hour period she brought material actively every day except on May 10, the last day of building, when rain fell during these hours. But when at 2:15 the hard showers had diminished to a slow drizzle, she made a few visits to the nest. Her mate remained out of sight.

Three other female Blue-rumped Green Tanagers which I watched as they built, and one who was refurbishing an old nest for a second brood, received no help from the male, so far as I saw. In each instance the male followed his mate back and forth on at least some of her trips to the nest but sometimes rested in a neighboring tree and sang while she arranged the materials. One female building in early March worked very hard, bring-

ing 23 billfuls of material in an hour—the most concentrated activity that I recorded in this species.

The completed nest is a fairly bulky open cup, measuring from  $3\frac{1}{2}$  to 4 inches in external diameter by  $2\frac{1}{2}$  to  $2\frac{3}{4}$  inches high. The internal diameter is from 2 to  $2\frac{1}{8}$  inches and the depth is  $1\frac{3}{8}$  to  $1\frac{1}{2}$  inches. There is a thin outer layer of green moss, mixed with which (in both of the nests examined) are some wiry rootlets and rhizomes of small, epiphytic, polypody ferns. Next toward the interior follows a thick layer composed of small dry bamboo leaves or blades of herbaceous grasses, mixed among which are a few fragments of larger dicotyledonous leaves. In their lining the two nests differ more than in their middle and outer layers. One is lined with fine branches of the inflorescences of grasses, and has a few fine black fungal filaments in the bottom of the cup. In the second nest, found nine years later, the lining is composed largely of slender, branching brown strands which are probably also fungal hyphae. These are intermixed with the bamboo leaves of the inner portion of the middle layer, and on the bottom of the nest some black fungal strands are also included.

#### THE EGGS

As with other members of the genus, the full set of the Blue-rumped Green Tanager consists regularly of two eggs; I have records of six sets of two. The eggs are laid on consecutive days, early in the morning. They are white or dull white with a wreath of brown or chocolate spots around the large end and a sprinkling of fine dots of the same color over the remaining surface. One set has shell marks of pale lilac intermixed with the brown. Four eggs measured 19.8 by 13.5, 20.2 by 13.5, 20.2 by 14.3, and 20.6 by 13.9 millimeters.

The distribution according to the month of laying of six nests in the valley of El General, 2400 to 3200 feet above sea level, is as follows: February, 1; April, 2; May, 1; June, 1; July, 1.

#### INCUBATION

Incubation begins with the laying of the second egg and is performed by the female alone. For a tanager, she sits for surprisingly long periods. I devoted a morning to watching the bird who built in the top of the orange tree beside my cabin. In the six hours she took three sessions on the eggs, lasting 63, 93 and 84 minutes. Her four recesses were also long, of 25, 29, 32 and 48 minutes' duration. She devoted 70.5 per cent of the morning to warming her eggs. The male did not once appear in the orange tree in the entire morning, and I did not even hear his song in the distance.

Another Blue-rumped Green Tanager which I watched for four hours on the morning of July 20, 1942, was sitting when I began by vigil at 6:35 a.m. She continued on the nest for 95 minutes longer, went off for 22 minutes, then returned and sat for 134 minutes (2 hours and 14 minutes). This is the longest diurnal session that I have recorded for any species of tanager. As at the earlier nest, the male was inattentive. Once a Blue-rumped Green Tanager, which I took to be the mate of the sitting bird, flew into the next tree, but he did not approach the nest.

At one nest both eggs hatched 13 days after the second was laid. At another nest, the eggs hatched on successive days, the second 14 days after the set was complete. The incubation period is accordingly 13 or 14 days.

#### THE NESTLINGS

The newly hatched Blue-rumped Green Tanagers are typical tanager nestlings, with sparse natal down and the interior of the mouth red. They are fed by both parents, which at one nest came with food quite independently of each other, in sharp contrast

to the custom in Golden-masked Tanagers and Yellow-browed Tanagers. As the nestlings grow older they become very noisy, uttering loud, sharp cries whenever food is brought to them. From one nest both of the young departed at the age of 16 days; from a second, they departed when 15 or 16 days old. In the juvenal plumage the young Blue-rumped Green Tanagers are dull green, lacking the chestnut head and blue under parts of the adults. After leaving the nest they follow the parents through the tree tops, calling shrilly for food. It is not known how long the young are attended by the adults; but after they acquire the adult plumage at the postjuvenal molt, they separate from their parents, who now fly among the tree tops in pairs.

#### LATER BROODS

A nest from which the young departed about March 25, 1942, was on April 8 refurbished by the female, who laid two eggs in it on April 12 and 13. This second brood was also successful, the nestlings flying on May 12. About sixty feet from the site of this nest in which two broods were reared, a nest was built early in July, and probably by the same pair. Eggs were laid on July 9 and 10 and the nestlings departed on August 8. Hence it appears likely that a single pair may rear three broods in a year. In each instance I failed to see the young of the earlier brood while the parents attended the subsequent brood.

The breeding season continues until very late in the year. On October 18, 1943, I watched a fledgling beg food of its parents. On October 17, 1945, I found a tailless fledgling still fed by its parents, and on November 6, 1936, my attention was drawn by loud cries of hunger to two well grown fledglings still attended by their parents. These youngsters were probably hatched from eggs laid in September. On October 1, 1945, I saw a young Blue-rumped Green Tanager in transitional plumage, just beginning to become chestnut on the head and blue on the rump. On the other hand, a youngster in juvenal plumage, with no evident signs of the postjuvenal molt, was seen as late as December 11, 1943. And on March 3, 1948, I watched an adult accompanied by two young birds in transitional plumage, with pale chestnut on their heads, which had evidently hatched late in the preceding year.

#### SUMMARY

Blue-rumped Green Tanagers wander restlessly through the upper levels of the rain-forest and into nearby clearings. In Costa Rica they range up to about 4000 feet above sea level. They remain mated throughout the year.

This species hunts for food on the lower sides of mossy boughs and it eats many berries, but it is not attracted to bananas in the manner of most tanagers.

One of these tanagers roosted on a low, horizontal thorn of an orange tree far from the forest.

Although it is a better songster than other species of *Tangara*, its song is a slight, simple performance with a peculiar whining tang.

In El General the nesting season extends from February to September or October. The nest, a bulky open cup containing green moss, is probably usually placed high in forest trees, but a few were discovered in clearings, mostly in orange and other trees with dense foliage, at heights of 9 to 25 feet. Only one of four building females was helped by her mate, who at first brought a good deal of material but lost interest before the nest was completed. One female built actively each day between noon and two o'clock in the afternoon. Her nest was finished in five or six working days.

The set consists of two eggs, laid early on consecutive mornings. The eggs are incubated by the female, who sits for periods unusually long for a tanager. One female watched for six hours took sessions from 63 to 93 minutes in length and kept her eggs

covered for 70.5 per cent of the morning. Another female sat continuously for 134 minutes. The mates of these incubating females paid little attention to them, at least in the vicinity of the nest. The incubation period is 13 or 14 days.

The nestlings, hatched with sparse down, are fed by both parents, which tend to come to the nest separately rather than together as do other species of *Tangara*. The nestling period is 15 or 16 days.

When they leave the nest, the young are in dull green plumage and lack the chestnut head and blue under parts of the parents. They acquire the adult coloration at the post-juvenal molt.

Three broods may be reared in a season. One female resumed laying about 18 days after the departure of her first brood.



## YELLOW-CROWNED EUPHONIA

### *Tanagra luteicapilla*

The euphonias are very small tanagers which as a rule exhibit striking sexual differences in coloration, the males of most species being clad in bright yellow and blue-black, the females in olive-green and dull yellow. When viewed in a tree top, the male Yellow-crowned Euphonia appears yellow on the crown and forehead and all the under plumage except the throat, which is black, like the back, rump, wings and tail. But when on rare occasions he drops down to some low bush in the full sunshine, he presents richer hues and one can appreciate the true loveliness of his plumage. His hindhead, neck and upper back are in the sunbeams a deep rich purple, while the remainder of the upper plumage, including the wing coverts, becomes an intense steely blue. The female Yellow-crowned Euphonia is very plainly attired, being olive-green above and yellowish below.

This species is confined to southern Central America, from eastern Nicaragua to the Canal Zone. In Costa Rica it is found on both coasts and up on the central plateau to an altitude of about 4000 feet. It is fairly abundant in the Térraba Valley between 1000 and 3000 feet above sea level. Usually in pairs but often alone, more rarely in little groups of three or four, these euphonias roam restlessly through cultivated or neglected clearings with scattered trees and along the edges of the forest, into which they seldom penetrate far. Shady pastures and tree-bordered roadways are attractive to the euphonias and here they often nest. Like other members of the genus, they appear to wander over a fairly wide area, and perhaps they also perform altitudinal migrations of limited extent, for they come and go with the seasons.

Early in May, 1942, a pair — the first I had seen in the neighborhood — suddenly appeared in my yard and started to build a nest. After the young were fledged late in June, the family vanished from the vicinity; and no Yellow-crowned Euphonia was met on the farm until the following April. On May 10, I watched a pair which seemed to be seeking a nest site among the same calabash trees where the euphonias had nested the preceding year, but apparently they were not so easily satisfied as before. They soon disappeared, and no nest was found in the neighborhood until 1946, when in May a pair built very near the site of the nest made in 1942. In the intervening years Yellow-crowned Euphonias were irregular visitors to my feeding table. Here they sometimes ate banana, but they were not nearly so fond of this fruit as many of the larger tanagers. The little berries of various parasitic shrubs of the mistletoe family enter largely into their diet, as also that of other species of euphonias.

#### VOICE

What appears to be the song of the Yellow-crowned Euphonia is a brief phrase with a most peculiar metallic twang. This quality makes it easy to distinguish from the voices of all the other euphonias that I know, but it is impossible to convey in written syllables. The call note, uttered by both sexes, sounds like *be be* or *be be be*; it resembles the call of the American Goldfinch, but is fuller and deeper in tone.

#### NEST BUILDING

The male Yellow-crowned Euphonia takes a year or more to acquire the adult colors, and he may mate and nest in a transitional plumage more closely resembling that of the female than that of older males. Such intermediate plumage has more or less black on the olive-green upper surface and the yellow parts are not nearly so bright as they



Fig. 32. Male Yellow-crowned Euphonia.

will later become. At two of fourteen nests, I noticed that the male wore the transitional plumage with more olive-green than black on his upper parts.

In the basin of El General the euphonias seek their nest sites early in March, and they are actively building by the middle of the month. For their little globular nest with the doorway in the side they need some snug nook or cranny which will provide adequate lateral support. Where this condition is satisfied, they are exceedingly catholic in their choice of a nest site. A living fence post often provides a favorable situation. Such a post commonly sends up sprouts in a ring around its truncate upper end; and on top of the post, in the midst of the ascending shoots, the euphonia finds a favorable niche for its nest, well shaded by the foliage above. Such living fence posts are often set in rows along well travelled roadways; and the euphonias may nest here in the public view. While riding along on horseback, I have sometimes found them building by the roadside. The sprouts from the top of a high, slender stump of any kind, or even the close-set, upright branches of some small tree with multiple stems, provide similar situations for the nest.

Two nests were in crannies amid the matted roots of epiphytic orchids. One of these orchid plants had been set atop a massive fence post by the roadside; the other grew on a tree in a dooryard, and the birds reached their nest by passing through a crotch of the trunk. In the same yard another nest had been built between the close-set stems of an orchid plant growing in a wire basket that hung from a small tree. The leathery leaves of the calabash tree (*Crescentia cujete*), springing in crowded clusters from the thick main stems, provide both support and concealment for the roofed nests, four of which I have found in these trees. Calabash trees often bear a luxuriant growth of moss; and when the nest is set in a crotch between thick branches, amid clusters of dark leaves and cushions of moss, it is most difficult to detect.

Less usual sites were the hollow end of a sharply ascending dead branch of a *targuá* tree; and in a pocket between the layers of brood-cells in an old wasps' nest high in a fig tree, in a most exposed position. So far as I could learn by watching from the ground, incubation was never begun in the wasps' nest. One nest was placed between an obliquely rising branch of a small tree and a tangle of dead vines that hung close beside it; another was built in an ascending fork, with additional support from some slender vines that climbed over the small tree. This last was the most exposed of all.

The nests which I have seen were by roadsides in cultivated country, in dooryards, pastures or maize fields, or at the edge of the forest. The lowest was only 3 feet above the ground, between the close-set, upright, stout branches of a small tree armed with forbidding thorns and growing in open pasture. The highest was about 100 feet up, in the old wasps' nest in a fig tree. Half of the nests were between 6 and 8 feet high.

The nest site is selected by male and female together. At the beginning of March, 1937, a pair of euphonias sought a situation for their nest in the yard of the thatched cabin I occupied. Two living posts with sprouts springing from their upper ends were in turn considered by them; and male and female took turns at sitting on the narrow end of the post, in the midst of the close-set leafy shoots, to make trial of the suitability of each as a nest site. They even brought a few strands of spider web and stuck them on the bases of the shoots which surrounded them as they sat. The placing of the cobweb seemed to be the first step in building the nest. But in the end the pair decided that neither post would serve, and the birds disappeared from the vicinity. Some years later, I watched a pair of euphonias that appeared to be hunting a home site in the calabash trees in front of my house. They moved deliberately over the mossy boughs, investigating the crotches and the nooks among the roots of epiphytes and the points where the stiff leaves were most densely clustered. The male euphonia bore in his bill a tuft of moss that appeared symbolic of their quest. But again the pair left the vicinity without building a nest.

I have seen more or less of the construction of six nests, and in every instance both sexes brought material and placed it in the growing edifice; but at some nests the female, at others the male, took the leading share in the task. At a nest built in front of my house in 1946, the pair worked diligently both morning and afternoon. In 5 hours the male visited the nest 83 times, the female only 48. The hour of greatest activity was between 6:40 and 7:40 a.m., when the male went to the nest 19 times and the female 13 times. But from 2:50 to 3:35 p.m. the male made 17 and the female 12 visits; at 3:35 the sky became very dark and threatening with an approaching storm, and they suspended their labors. Usually I could detect material in the bill of the bird as it approached the nest; but when nothing was visible, delicate strands of cobweb might have been carried in, so in making the count I gave equal weight to every visit.

When the pair arrived together, each with a contribution for the nest, the male would nearly always go first to deposit his billful in the structure, although exceptionally the female would precede him. This point is of interest in connection with the male's precedence in feeding the nestlings, which we shall later consider. While the female was arranging her contribution in the nest, her mate, who had already placed his billful there, would often pluck additional material from a neighboring mossy bough and carry this into the nest after she emerged. But sometimes after her exit he would return to the nest with nothing visible in his bill, apparently to arrange and shape the materials already present. At times both members of the pair would go to the nest twice alternately, on a single visit to the nest tree. Then they would fly off together to obtain material from some more distant source. At times the male, who was in full adult plumage, would voice his *be be* call.

The pair which built in the same row of calabash trees four years earlier worked even later in the day. In the hour between 4:25 and 5:25 p.m. the male went to the nest 17 times, the female 11. In spite of his greater zeal for the work, the male euphonia at times hesitated to approach the nest in the absence of his mate. Once he brought material to the nest tree, waited near the nest for her arrival, and when she did not appear, carried away his billful. But later he took material into the nest in her absence. Even when the female performs the greater share of the work of building, her mate usually follows her faithfully to the nest, although with empty bill; and he may enter to shape the nest even if he brings nothing.

The pair of euphonias which built in front of my house in 1946 continued to take material into their nest for at least 8 days.

The completed nest of the Yellow-crowned Euphonia is a small globular structure with a narrow round doorway in the side. The outer wall is composed of a considerable variety of materials, including fine stems and petioles, shrivelled dead leaves, fibers of various sorts, and green moss, all bound firmly together with cobweb abundantly used. One nest built close to a cotton bush contained many snowy tufts of cotton, conspicuous in its outer wall; another, situated by the roadside, had a long piece of white string intricately twisted into its fabric. The inner layer of the nest is composed of dry grass blades or strips of broader leaves.

#### THE EGGS

In the earliest nest recorded, the eggs must have been laid about the middle of March; for on April 19 this nest held well feathered nestlings. The size of the set varies from 2 to 4 eggs; I have records of 3 sets of 2, 7 sets of 3, and 2 sets of 4. At 2 nests the 3 or 4 eggs were laid on consecutive days, and in one instance the egg was deposited before 6:30 a.m. Because of the delicacy of the operation, only one set of eggs was removed from the nest for closer examination and measurement. These eggs were white, heavily mottled all over with brown. On two the marking was very heavy in a wreath around the large end and lighter elsewhere. On the third, the brown pigmentation was almost uniformly heavy over the entire surface. There were a few small, irregular black marks. The 3 eggs measured 17.5 by 13.1, 17.1 by 12.7 and 17.1 by 12.7 millimeters.

The distribution according to the month of laying of 14 nests in the valley of El General, 2000 to 3000 feet above sea level, is as follows: March, 3; April, 4; May, 7.

#### INCUBATION

The eggs are covered by the female alone. At a nest watched during 4 hours of the morning, her 5 sessions varied from 12 to 42 minutes and averaged 28.8 minutes; her 7 recesses ranged from 5 to 12 minutes in length and averaged 8.6 minutes. She devoted 77.0 per cent of the time to incubation. The call of her mate in a neighboring tree was generally the signal for her to come forth from the nest; but sometimes, if she had been sitting only a few minutes, she disregarded it; and again, if he failed to return and call her after she had been incubating a good while, she emerged without his summons. Upon sallying from the nest, she customarily dropped well below it, then curved gradually upward and rose to the neighboring trees, or she flew away with her mate.

When she returned from a recess, it was usually in company with her mate. The two would perch on a branch near the nest; and when the female made her final dart to the doorway, the male would often fly close beside her, as though the two engaged in a race. But the female would always win and pass deftly through the narrow aperture, while the male at the last moment veered aside from the nest and flew away. When the male failed to escort his mate to her eggs in this dashing manner, it was the result of her own actions; for instead of beginning her final dart to the nest from a point some distance away, she

would go to rest on a twig close beside it, from which point she would flit inside without giving the male an opportunity to accompany her.

At this nest the eggs hatched after 13 or 14 days of incubation.

#### THE NESTLINGS

The euphonias feed their nestlings wholly by regurgitation, in this respect differing from the majority of tanagers, but agreeing with the chlorophonias, and with the goldfinches and small seedeaters (*Sporophila*, *Tiaris*) among the finches. When the parents come to feed their young, nothing is visible in their bills. Clinging in the doorway, they pass particle after particle of food to the open red mouths of the nestlings, bringing it all up from their throats. The delivery of food sometimes occupies half a minute or more; but the process of transfer is not continuous during this period; for after delivering a few mouthfuls the parent may rest for several seconds, then produce from its gullet more nourishment for its hungry offspring.

Although other activities prevented long-continued watches of the nest in the calabash tree in front of my house in 1942, I often saw the nestlings fed; for the well known calls would apprise me of the parents' approach, and I would look up from my carpentry or my writing in time to see them visit the nest. Male and female almost always came together with food, both while the nestlings were brooded and after brooding by day had ceased. On only a single occasion did I see the male arrive to feed the nestlings without his mate, and she as rarely came without him. Upon reaching the calabash tree, the pair would rest on the slender, naked tips of the long, densely leafy branches. Then, after a pause, the male would go first to the nest. As with the Turquoise-naped Chlorophonias, this was almost invariable procedure; only once out of the many times I saw the nestlings fed, was the order reversed. Flying down, the male euphonia would cling head downward to a slender strand of the parasitic *Struthanthus* vine that hung from the crotch where the nest was built. Delaying here in an inverted position, a few inches below the nest, he turned from side to side, surveying the surroundings for possible danger. Then, assured that all was well, he flitted up to the little round doorway and clung there while he regurgitated the contents of his throat to the nestlings within. The somewhat lengthy feeding over, he flew back to the naked slender branch end near his mate; and she in turn went to the nest, more directly than he. After she had delivered the food, the pair would fly away together; or while the nestlings were younger, the female would enter the cozy little chamber to brood, while the male flew off alone.

These two nestlings left at the age of 22 days. A nestling reared alone in an earlier nest remained for 24 days.

#### LATER BROODS

Yellow-crowned Euphonias may rear at least two broods in a season. My earliest nest found in 1936 on April 19 contained well-feathered nestlings which probably took wing a few days later. Returning on May 2, I discovered two eggs in this nest, and the third was laid on the following day. These eggs vanished before hatching, but on May 18 the female laid the first of a new set of three in the same nest. In a nest found the following year, the eggs were laid on March 27, 28 and 29, and the single nestling that hatched left on May 7. In the following week, presumably while feeding the fledgling, the parents completely relined the nest, and on May 15, the female laid the first egg of a second set of three.

#### SUMMARY

Yellow-crowned Euphonias wander widely in pairs or small flocks through open country with scattered trees and through the more open parts of the woodland. In Costa Rica they range to about 4000 feet above sea level.

These tanagers eat many berries of parasitic, mistletoe-like shrubs, and they come to a feeding-shelf for bananas.

Males take more than one year to acquire full breeding plumage, and they sometimes nest in a plumage not greatly different from that of the females and young.

In El General the nesting season extends from March to July. The globular nest, with a doorway in the side, is set in a wide variety of sheltered crotches and snug cranies at heights ranging from 3 to 100 feet. Both sexes build, sometimes one, sometimes the other, taking the leading part. Usually, when they come together with material, the male goes first to the nest. In one instance building was continued for eight days.

Two, three; or four eggs are laid in a set, on consecutive days. The female alone incubates. In the course of four morning hours one female covered her eggs for 77 per cent of the time. As the female returns to her nest she is escorted in spectacular fashion by her mate, who follows her so closely that he seems to be racing her to the doorway. Incubation lasts 13 or 14 days.

Both parents feed the nestlings with regurgitated food. The two nearly always return to the nest together, and the male usually delivers food before his mate. The nestling period is 22 to 24 days.

Two broods are raised. In one instance the female resumed laying eight days after the departure of the single living nestling of the first brood; she used the same nest, which had been relined in the interval.

## BONAPARTE EUPHONIA

### *Tanagra laut*

The Bonaparte Euphonia ranges from southern México to western Panamá, through the lowlands of both coasts and into the highlands to an altitude of possibly 4000 feet above sea level. Like other euphonias, it is a restless bird of the tree tops. Except when it is bound by a nest, it appears rarely to remain long in one spot but wanders widely in search of food through plantations and pastures with scattered trees and doubtless also over the roof of the forest, where it is difficult to see. The male is a brilliant little bird, black glossed with violet and blue over all the upper plumage except the forehead and forepart of the crown, which are bright yellow like the entire under parts. The black area includes the sides of the head, the wings, and most of the tail, which is marked with white on the outer rectrices. From the other black and yellow euphonias that inhabit northern Central America he is readily distinguished by his yellow rather than black throat and by his notably thicker, black bill. The female is olive-green above, with dull yellow under plumage. According to Dickey and van Rossem (1938:544) these euphonias subsist largely on berries of mistletoe, as do other members of the genus.

#### VOICE

The only song I have heard from this little tanager is a short whistle, usually repeated two or three times in rapid sequence, sometimes clear and bell-like, more rarely with a plaintive intonation, reminding me of the opening notes of the White-throated Sparrow's song, but fuller in tone. The female's song, or perhaps it should be considered a call, at its best resembles that of the male, but more often it is thin and chaffy in quality and again is high-pitched and almost trilled.

#### NEST BUILDING

On the morning of March 24, 1932, a male Bonaparte Euphonia with a dry grass blade in his bill led me to my first nest of the species. This was in the foothills of the Sierra de Merendón, at the edge of the Motagua Valley, in Guatemala. The nest was situated in a cranny in the top of a rotting fence post five feet high. It was beside a small corral amid extensive pastures with scattered trees. It was so well shielded behind a small aroid that grew attached to the post that I should never have discovered it, had the movements of the building birds not betrayed its position to me. It was a roofed structure with a little round entrance in the outer side. It was composed of fine tendrils and other bits of vegetation, all bound together with cobweb. The outer shell appeared to have been completed, for the birds were lining the interior with small, dry grass blades. The male and female worked in closest harmony. Usually they arrived together, each with a length of grass blade in its bill; and one would vanish behind the arrow-shaped leaves of the aroid while the mate perched close by, waiting its turn to place the material in the nest. Either male or female might enter first; there was no set order of precedence. As soon as the second member of the pair had come out of the nest, the two were off like a flash for more material. Sometimes the male would follow his mate back to the nest without bringing anything. Then while she took her grass blades inside, he lingered close beside the fence post, uttering a fine metallic *pink pink* that sounded much like the notes of the Cardinal as he goes to roost on a chill wintry evening, but even fainter.

Although this nest was nearly finished when found, the first egg was not laid until April 3. Another was deposited on the following day, and a third on April 6. When I



Fig. 33. Female and male Bonaparte Euphonias.

returned to the nest on April 8, there was a male Boat-tailed Grackle resting atop the post where it was hidden. The nest was in ruins and the eggs had vanished. Although I was not an actual witness of the grackle's predation, the circumstantial evidence against him was very strong, especially when it is remembered that grackles in general are notorious nest robbers. This nest had been so well concealed that the grackle must have found it, as I did, by seeing one of the pair of euphonias enter. The female euphonia was perching nearby, calling incessantly with triple, or sometimes double, reedy whistles; but her mate did not appear while I waited. Possibly I should have found additional eggs in this nest if the grackle had not destroyed it.

On May 8, I found a pair of Bonaparte Euphonias building a nest in the axil of the lowest frond of a young coconut palm,  $7\frac{1}{2}$  feet above the ground. Again both sexes were bringing material. This nest was never completed. The Bonaparte Euphonias choose a considerable variety of nest sites. In the central plateau of Costa Rica they have been found nesting in the banks beside streams and roadways, in holes that they most probably found ready made (Cherrie, 1892:24).

A more fortunate nest was situated in the decayed top of a post only forty inches high, in a fence line between a bushy pasture and light second-growth woodland, on the same plantation where the first was found. This nest measured  $2\frac{3}{4}$  inches from front to back; the doorway was  $1\frac{1}{4}$  inches in diameter. It had no concealment beyond that afforded by the sides of the cranny in the top of the post.



## THE EGGS

When discovered, at 6:05 a.m. on April 15, the nest on the fence post contained three eggs. The female euphonia flew out as I walked past and was probably then preparing to lay the fourth egg; for when I returned at 6:45 the following morning, the set of five eggs was complete. Another set of five eggs was found near San José, Costa Rica, on May 4 (Cherrie, *loc. cit.*). For a tropical bird, this is an unusually large clutch of eggs, and especially so in the tanager family, in which sets of two eggs are the rule and those of more than three are very rare.

The eggs of the Bonaparte Euphonia are short ovate. They are white, heavily blotched with umber in a crown on the thicker end, with a scattering of spots of the same color over the remaining surface. Some have a brownish wash over the entire blunt end, on which the more solid blotches and speckles are laid. Six eggs from Guatemala measured 16.7 by 13.5, 16.7 by 12.3, 16.7 by 12.7, 15.9 by 12.7, 15.9 by 12.7 and 15.9 by 12.7 millimeters (average of the six, 16.3 by 12.8 millimeters).

## INCUBATION

I set up a blind in front of the second nest in the fence post and devoted the morning of April 22 to learning something about the euphonia's mode of incubation. The day dawned with a dense mist; and when I entered the blind at 6:15 there was still insufficient light to distinguish the little tanager in the closed nest. As I raised my glasses to the slit in the front of the cloth blind, a bird flew out, too rapidly to be recognized with certainty, but beyond any reasonable doubt it was the female. At 6:30 she returned alone and entered the nest. At 7:02 she heard her mate calling in the distance, answered him while sitting, then flew out and away to join him. At 7:18 the pair returned together and both flew toward the nest, the female a little ahead, but the male following closely. Each seemed to be trying to reach the doorway before the other. The female won the race and entered; the male turned just short of the doorway and flew off. At 7:53 there was a light flurry of rain. At 8:12 the male, unseen in the distance, called with clear double whistles; the female answered from the nest with similar whistles, but less clear, then left her eggs. At 8:20 the pair came back together, and with a loud whirr of tiny wings raced each other to the nest. Again the female won by her own length and entered, while the male veered aside just in time to avoid striking the fence post, then continued to some neighboring bushes, where he repeated his double whistles.

Twice more in the morning I saw the pair of euphonias engage in this race to reach the nest. Each time the female won by the smallest margin. It seemed that this apparent competition was only a formality. The male had not real desire to get there first and sit on the eggs, but merely escorted his mate back to her duty in this dashing fashion. A similar ceremony may be witnessed at nests of the Yellow-crowned Euphonia, the Tawny-bellied Euphonia, the Turquoise-naped Chlorophonia, the Black-crowned Tody Flycatcher, and the Slate-headed Tody Flycatcher. All these tiny birds build closed nests with a round doorway in the side; in all both sexes share the work of construction, but only the female incubates, as in the Bonaparte Euphonia.

The female euphonia, upon winning the formal race with her mate, did not appear to alight in the doorway of the nest and then step inside, but on the contrary passed through the narrow aperture with no apparent break in her movement. She turned around so rapidly that she hardly seemed to have touched the nest before she was seated on her eggs with her head outward. She always incubated in this position, looking out. For so diminutive a bird, she sat very patiently. Her sessions on the eggs showed a progressive increase in length in the course of the morning, first 32, then 54, 69 and 83 minutes. Her corresponding recesses were 16, 8, 44 and 40 minutes. Her average session

was 59.5 minutes, her average recess 27 minutes; and in six hours of the morning she kept the eggs covered 68.8 per cent of the time.

Although the male euphonia appeared to be very attentive, he was nearly always out of sight and hearing while his mate sat in the nest. Whenever I was obliged to force her to leave the eggs so that I might see whether they had hatched, she would perch close by and call incessantly until I departed. While I measured the eggs, an operation that required about twenty minutes because of the difficulty of removing them through the narrow doorway, she continued her calls of distress without interruption during the whole time. Yet the male never appeared on these occasions; he seemed to forage at a good distance, only approaching the nest when he escorted his mate on her return from a recess, or in the early morning, to call her out to join him. Later in the morning she ended her sessions spontaneously, called to him from near the nest without receiving a reply, then flew off alone to seek him. That she was successful in establishing contact with him, despite the distance at which he habitually foraged, was clear from the fact that on the two occasions when she left the nest alone, she later returned in his company. It will be recalled that when the Boat-tailed Grackle destroyed the first nest, the female euphonia likewise called for a long while in its vicinity without succeeding in attracting her mate.

The set of five eggs had been completed by 6:45 a.m. on April 16. All five were pipped at 2:30 p.m. on May 1, and had hatched by the following day, thus having an incubation period of sixteen days.

#### THE NESTLINGS

The young euphonias developed slowly. When eight days old, their black skin was still nearly naked. Their short, thick bills were black with yellow edges, and, when opened, revealed a bright red interior — an attractive combination of colors. Only three nestlings survived. Time did not permit a study of parental care; but from the fact that the male helped to build the nest, and in view of subsequent observations on related species, there can be little doubt that he took a large share in feeding the nestlings, as appears to be the invariable custom in the tanager family. At the age of fifteen days the young birds were well feathered and could fly a little. One afternoon the adjoining pasture was burnt off, and the smoke enveloping the nest became so dense that I removed the nestlings for a while to prevent their suffocation. On May 19 the three young euphonias left the nest, at the age of seventeen days. Possibly their departure had been hastened by their premature experience in the open on the day of the fire, for young Yellow-crowned Euphonias stay in the nest until from 22 to 24 days old.

Dickey and van Rossem (1938:544) found evidence that young male Bonaparte Euphonias do not attain the adult plumage in the first year, but begin to breed in a transitional plumage, as do the Yellow-crowned Euphonias; according to Todd and Carriker (1922:497) the same is true of the Thick-billed Euphonias.

#### SUMMARY

Bonaparte Euphonias wander widely through clearings and plantations with scattered trees, where they feed largely on the berries of mistletoes.

In the Motagua Valley of Guatemala, they nested from March until at least the end of May.

Nests were found in the decayed tops of fence posts and in the axil of a coconut palm. In other regions they have been discovered in holes in banks. The globular nest with a sideward-facing doorway is built by both sexes, either of which may deposit its material first when they come together.

One of the nests in Guatemala contained five eggs, and a set of the same size has been reported from Costa Rica. The female alone incubates. In six morning hours one female took sessions averaging 59.5 minutes and recesses averaging 27 minutes; she covered her eggs 69 per cent of the time. Her returns to the nest were the occasion of a spectacular ceremony, in which the male seemed to race her to the doorway; but she always arrived first. Her eggs hatched after 16 days of incubation.

This brood left when 17 days old, but possibly their departure was hastened by their temporary removal when fire threatened their nest several days earlier.

## TURQUOISE-NAPED CHLOROPHONIA

### *Chlorophonia occipitalis*

The tanagers, whose bright plumage provides so much of the color of the tropical American bird-world, are most numerous in the lower and warmer regions. Their center of abundance, both in species and individuals, seems to be not in the very hottest districts at the level of the sea but among the foothills from one thousand to three or four thousand feet above it. But from five thousand feet upward they become increasingly rare. In the Central American highlands, the plainly clad little tanagers of the genus *Chlorospingus* are the most numerous representatives of the family. In the mountains of Costa Rica, above five thousand feet, there are only three or four of the more brilliant species of tanagers compared with a dozen or so at lower elevations.

Not the least beautiful of the tanagers which carry the bright colors of their family into the cool highland forests is the Turquoise-naped Chlorophonia, the "dualdo" or "rualdo" of the natives. This tanager is of medium size, that is, about as large as the House Sparrow, and rather stockily built. The male is most elegantly attired: bright green on most of the upper parts, the wings and the tail; the crown and hindneck are light blue; the forehead and a stripe above each eye are yellow; the throat and foreneck, green like the upper plumage, are separated by a black border from the bright yellow which covers the rest of the under parts from the breast to the under tail coverts and which merges into green on the sides and flanks. His bill, eyes and feet are dark. The female is more uniformly green, with less blue on her head and less yellow on her under plumage. Since young males resemble the females and even breed in the duller attire, not acquiring the full splendor of their plumage until over a year old, individuals with the brightly contrasting colors of the mature males always form a small minority in the species.

The dualdos dwell among the tree tops of the highland forests of Costa Rica and western Panamá, chiefly above five thousand feet. Carriker (1910:874) states that when fruit is scarce at high altitudes, they frequently descend as low as 1200 feet among the Caribbean foothills; but on the Pacific side of Costa Rica, where I have spent so much time, I have never once encountered these birds even as low as four thousand feet. From the close of their nesting season in July until October or November, they roam about in small flocks of not over ten or twelve individuals, the great majority of which wear the almost uniformly green plumage of the females and younger males. But before the end of the year, most of them have already paired off and fly two by two.

Like other tanagers, they are largely frugivorous and eat many berries of diverse kinds. While I lived at Vara Blanca in the Cordillera Central of Costa Rica, small flocks would visit some low trees of *Sarauia pittieri* growing in the yard close by the cottage. While the birds feasted on the gelatinous pulp of the green fruits, they constantly uttered low, short, not unmusical notes, which reminded me somewhat of the murmurings of a gate lazily swinging in the wind on unoiled hinges. They continued this same simple music as they flew away after their meal was finished. But they have also other whistled notes, deeper, more resonant and more melodious than those suggested by this comparison, yet still disjointed, never linked into a continuously flowing melody. The first dualdo I ever saw was perching alone in the undergrowth of the forest on Volcán Irazú on a rainy afternoon in November. His plumage gleamed brightly even on that dull, misty day, as he turned slowly from side to side, and at each turn delivered a single low, piping note. Even in the nesting season, I never heard a dualdo utter an articulated song.

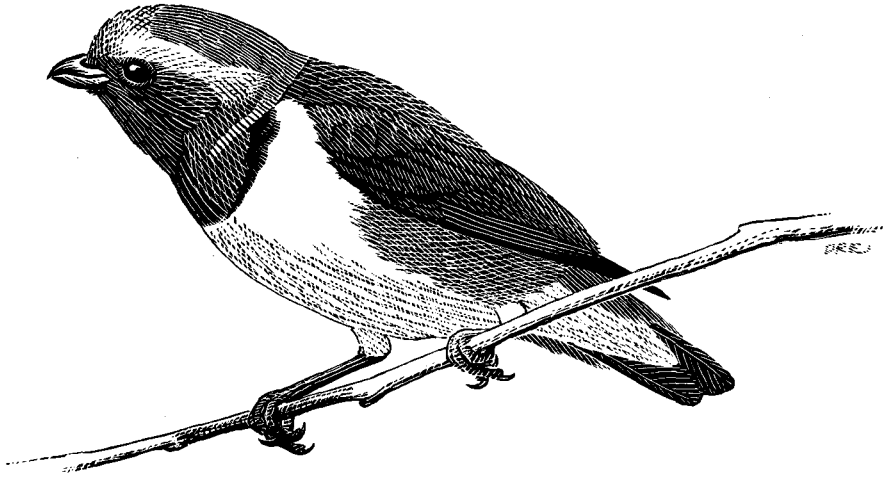


Fig. 34. Male Turquoise-naped Chlorophonia.

But their short, disconnected whistles are clear and musical — one of the characteristic sounds of the Costa Rican cloud forests. At times the birds give voice to harsher monosyllables, one of these sounding like *wup*.

#### NEST BUILDING

At Vara Blanca, in 1938, I found the nests of six pairs of dualdos. Two of these pairs had begun to build in the second half of March; one of the nests was well advanced when discovered on March 24. Three of the six breeding males were in full adult plumage, but the other three still wore the immature dress. One of these males was so similar to his mate that I could not distinguish the sexes as they flew or perched in the tree tops high above me; the other two could with difficulty be distinguished from their mates by the slightly brighter yellow of their foreheads and abdomens. Perhaps it was more than a chance coincidence that the first three nests I found belonged to fully adult males, the second three to males in immature plumage. Two of these young birds were building in May, when their brighter neighbors were feeding nestlings. The pair of which the sexes were too much alike to be distinguished built latest of all, toward the end of May. In the Yellow-crowned Euphonia and other species of *Tanager* in which the sexes are strikingly distinct in coloration, young males also nest while wearing a plumage resembling that of the females; but I know no other types of tanager of which this is true.

All six nests were placed high in trees standing in clearings in the cloud forest. The lowest was at an estimated 35 feet above the ground, the next about 60 feet up, the other three between 75 and 100 feet, in the tops of lofty trees. Five were placed among the moss and other epiphytes which in this humid region covered most of the trees in great profusion; and in such situations the mossy nests could be detected only by watching the activities of the birds which built and attended them. One of the nests, however, was situated conspicuously in the bare crotch formed by the bifurcation of a great trunk, naked and charred, standing in a pasture not far from the edge of the forest. All the nests were roofed structures, entered through a round doorway in the side facing outward from the tree. Euphonias of several species build nests of similar form; but most other tanagers construct cup-shaped nests open above.

Because of the great height of the nests and the danger of climbing trunks with a

treacherous coating of moss and other epiphytic growths, I was unable to look into any of them. Yet by careful watching from the ground, it was possible to learn much of what was taking place in them.

At all four of the nests that were found before completion, male and female shared rather equally the work of construction. In late March, I watched a pair as they built between the bases of the slender stems of an epiphytic shrub that grew on the upper side of a thick, ascending, mossy limb of a great tree. This tree stood beside the deep gorge of the Río Sarapiquí. The male and female worked together in closest harmony; and if there was any disparity in the parts taken by each, the excess seemed to be on the side of the brilliant male, who frequently brought billfuls of material considerably larger than his mate's. Their materials consisted of moss which they found in abundance on nearly every limb of the surrounding trees; also they used slender, fibrous roots of air-plants, which they likewise procured well above the ground, and tufts of spiders' silk. In pulling the moss and rootlets from the branches where they grew, sometimes the birds perched or clung beside them but sometimes hovered as they tore away the desired bit. They always came together to the growing nest. Either the male or the female would enter first to place and arrange its contribution while the other perched nearby to await its turn. Frequently, the member of the pair who had first deposited its burden would tear additional moss or rootlets from the boughs of the nest tree while it waited; it then took these to the nest as soon as the other bird came out. Then the latter would in turn find more material for the structure on the neighboring boughs. Thus both male and female would make several distinct contributions to the nest on a single visit to the nest tree. Their work done, they always flew away together toward the neighboring forest. While they rested in the nest tree, or flew to and fro, they continually repeated their low, musical whistles.

I was at first not certain whether the dualdos actually built the mossy covering over their nest or provided for its shelter by placing it in a cranny among the moss where it was already arched over. But from time to time they added more material to the roof above them, which was, in part if not entirely, the product of their own industry. Later I found a pair working on a nest so recently begun that it still had no indication of the roof.

#### INCUBATION

The relatively low nest in the tree at the edge of the gorge of the Río Sarapiquí continued to receive more of my attention than the higher structures. When completed, the mossy structure blended so well with the surrounding moss that one would never have detected its presence without seeing the female enter or depart. It was not possible to learn exactly when the eggs were laid, or to determine their number. There were at least three, for later I could see three mouths in the doorway at mealtime; and this was also the number of nestlings in the second brood in the same nest.

As at every other tanager's nest that I have watched, a dozen species in all, the female alone incubated. Her six sessions which I timed ranged from 24 to 34 minutes, with an average of 29.2 minutes. Her five recesses varied from 15 to 44 minutes, with an average of 22.6. In the five hours from 6:23 to 11:23 a.m., on April 16, she incubated for a total of 175 minutes and was absent 125 minutes. She sat in the nest always looking outward, with her green head framed in the round doorway. Upon leaving, she invariably darted, or rather fell, almost vertically downward, until she almost touched the ground, then curved sharply upward and rose to the top of one of the trees standing at the lower edge of the clearing. Here she sometimes found her mate, and together they flew across the gorge of the Río Sarapiquí to the forest on the opposite slope. Usually he returned with her, and escorted her almost to the entrance of the nest, flitting from

branch to branch as she advanced through the crown of the tree toward it. Once she had settled herself inside, he usually flew away, but sometimes he stayed in the nest tree, tirelessly repeating his low, slight notes.

I saw the male dualdo feed his mate only once (at 7:03) during my morning watch, and once again while she incubated her second set of eggs — both times just before she entered the nest. Some weeks earlier, I had watched the male of another pair, in immature plumage, try to give his mate some small berries of a melastomaceous tree. Since she had been stuffing herself with the same food, she did not accept all that he offered her. Male tanagers of numerous other kinds give food to their mates, either while they incubate, or as they forage together. The male Tawny-bellied Euphonia sometimes gives food to his mate and sometimes accepts it from her, but I have not seen them exchange food at the nest.

The female dualdo's habit of dropping almost to the ground each time she left her nest is worthy of notice. Incubating Yellow-crowned Euphonias and Tawny-bellied Euphonias leave their covered nests in the same fashion; and the custom is not uncommon among small tree nesting birds. The abrupt downward drop, followed by the turn and slower rise, seems to be a device to deceive any enemy as to her exact point of departure. Unless the predator's eyes were already focussed on the nest, the bird's movement would not be so likely to catch its attention on the sudden swift drop as on the slower turn and rise. When the tanager breaks her fall to turn, she is already far enough from her nest not to betray its position. Were she to fly upward or straight outward from her covered nest, I believe that she would more often call attention to its exact location.

#### THE NESTLINGS

At the lowest nest, I first saw the parents carry in food on April 28. By May 7, I could see three nestling heads in the doorway when the parents arrived to feed them. Soon the notes of the approaching parents caused three red disks with yellow borders to blossom in the round doorway, like three little red flowers nodding forward on long, slender stalks. These nestlings did not depart until May 21, when they were no less than 23 days old.

By June 5, the female dualdo was again incubating in the same nest; and by June 21 she and her mate were again feeding nestlings, which had apparently been hatched since the afternoon of the nineteenth. These three young dualdos departed before 8:30 on the morning of July 15, when they were no less than 24 or 25 days of age.

This is a nestling period exceedingly long for so small a bird. In the tanager family, the length of the nestling period varies in an interesting fashion with the character and position of the nest, but it shows no relation to the size of the bird. The relatively large tanagers of the genus *Ramphocelus* build open nests, usually from one to four or five yards above the ground; and the nestlings of such species as the Crimson-backed Tanager, Scarlet-rumped Black Tanager and Song Tanager hop out at the age of 11 to 13 days, when they can fly very little. The little tanagers of the genus *Tangara* build open nests at usually greater heights; their nestlings stay in the nest until 13 to 16 days of age, when they can fly fairly well. The Blue Tanager places its open cup in the most varied situations, rarely on the ground and often among the tree tops, not infrequently in a sheltered position, as beneath the roof of an open shed or in the midst of a bunch of green bananas. Their young first take flight when from 16 to 20 days old. But the Yellow-crowned Euphonias linger in their covered nests until from 22 to 24 days of age; and the chlorophonias remain for about the same period in their mossy, sheltered nurseries, well concealed high up in mossy trees.

During all their long period in the nest, a most interesting routine prevailed in the

feeding of the young dualdos. Both parents brought food an equal number of times, and apparently also in fairly equal quantities. They always returned together from their foraging expeditions, voicing their low little notes as they flew. When they alighted among the boughs near the nest, no particle of food would be visible in their bills, for it was all carried inside. Then, after a brief rest, the male would fly first to the doorway. Nearly always, as he began this short flight, his mate would also leave her perch and make a little start, as though to accompany him, but soon turned back to wait until he had finished feeding. Reaching the round doorway, he clung in front of it in an upright position, or even with his back somewhat downward, maintaining this attitude for half a minute or more, while he regurgitated and passed food to the nestlings, in a number of small portions. When he had finished, he dropped down to perch near the female. Now she would go to the doorway; and as she started to fly her mate would often fly along with her a good part of the distance, just as she had done when he went to feed the nestlings. On his part, at least, this habit had begun before the eggs hatched, when he escorted her toward the doorway as she returned to incubate. After delivering her food to the nestlings in the same fashion, and in about the same interval of time as her mate, the female would clean the nest by swallowing the droppings, a duty which seemed always to fall to her. Then, while the nestlings were younger, she would enter to brood. Like all male tanagers, her mate never brooded, and he would soon fly off alone. But when the nestlings were old enough to dispense with diurnal brooding, the male would always wait for his mate to complete the delivery of the food and the cleaning of the nest; then the two would fly off together, down into the abysmal gorge of the river, or straight across to the forests on the farther side, voicing their low notes as they went.

Over a considerable period, during the rearing of both the first and second broods, I made almost daily visits to this nest, and waited to watch the parents bring food once or twice, or sometimes more often; for this was my only means of telling whether the nestlings were still within. Thus I witnessed many feedings, and the routine was never varied: the parents would arrive together; the male would go first to deliver what he had brought; and nearly always, as each started toward the nest, the mate would fly a part of the way with it, turning back before the doorway was reached. The same habits prevailed at other nests I watched more briefly, both the invariable precedence of the male in feeding and the false starts of the mate as each pair in turn went to the doorway. In the Yellow-crowned Euphonia, the male also feeds first nearly always. In the genera *Thraupis* and *Tangara*, of which the two parents also as a rule bring food together to the nest, it is usually not possible to distinguish them; but at one nest of the Golden-masked Tanager I could recognize the male by his slightly clearer colors; and it was always he who went first to deliver the food. In the genus *Ramphocelus*, on the contrary, the parents visit the nest independently, and of course no question of precedence in feeding is involved.

After the female has ceased to brood the nestlings by day, it would seem to make little difference whether she or her mate feeds them first. But if she broods them at the conclusion of their meal, this system simplifies the movements of the pair.

The little start toward the nest which each member of the pair makes as its mate goes to feed the nestlings may be merely a manifestation of the dualdos' habit of always flying in pairs. So strong is each bird's impulse to follow its mate that even on the final dart of a few yards from the perch in the nest tree to the doorway of the nest, it starts to follow. But the act may also have ceremonial significance. Among the euphonias, it should be recalled, the male often flies with his mate almost to the doorway of the nest (p. 244).

On the morning of May 21, the three young dualdos of the first brood, now no less



than 23 days of age, left their nest. As I came down the hillside toward the nest tree, I saw a fledgling fly from it, with both parents following closely, in the manner common to so many birds, when their offspring make their first essays at flight. It alighted in a small patch of sugar-cane up the slope, where I was able to examine it at my leisure through the binoculars; it was already too skillful upon the wing to be taken in hand. The young dualdo was entirely green on its upper plumage, but not so bright and glossy as the adults. It quite lacked the blue on the crown, hindneck and sides of the neck, which even the female wore. The under plumage was also green, with a yellowish tinge on the abdomen. A second fledgling rested in its natal tree, near the nest, where its parents fed it. The third had already vanished.

Two weeks later, when the female was again incubating in the same nest, I tried in vain to learn what had become of her three offspring of the first brood. Although the male frequently accompanied his mate when she returned to her eggs after a recess, the young dualdos never appeared in the vicinity of the nest. From this I concluded that, if still alive, they no longer received food from their father, else they would almost certainly have followed him. Since many small passerine birds become self-supporting when about a month old, it is probable that these young dualdos, already more than three weeks of age when they flew from the nest, had been weaned in the ensuing fortnight.

This pair of dualdos were as successful with their second brood as with their first. When, on July 15, the three fledglings left their nest at the age of 24 or 25 days. I saw one fly from the nest tree to the edge of the neighboring forest, a distance of about a hundred feet. It covered this distance with ease, with no loss of altitude, while both parents flew very close beside it, in what I have called "shielding flight."

The critical student of etymologies may well take exception to the name *Chlorophonia*; for it is not the voice of the bird that is green, but its plumage. But if we interpret it as a contraction of *chloro-euphonia* — green euphonia — the generic name is indeed happily chosen, for these highland birds are the green counterparts of the typically yellow and blue-black euphonias of lower altitudes. Like the true euphonias, the green euphonias build covered nests with a doorway in the side, a form of architecture rare in the tanager family. Like the euphonias, and many other genera of tanagers as well, male and female build these nests together; but, as with all other tanagers for which I have information, only the female incubates. Again like the euphonias, the male chlorophonia seems to race with his mate to the doorway of the nest as she enters to cover the eggs or to feed the nestlings. Euphonias and chlorophonias agree in nourishing their nestlings with regurgitated food. Most tanagers come to the nest with food held conspicuously in the bill; but with all, so far as I know, both parents bring it. Young green euphonias, like young euphonias, remain in the nest three weeks or more, considerably longer than most other tanagers for which we have information. And finally, the male Turquoise-naped Chlorophonia, like the male of the Yellow-crowned Euphonia and probably related species as well, needs more than a year to acquire his adult plumage and first breeds in a dress closely resembling that of his mate. In this respect, these two genera are strikingly at variance with other tanagers resident in the tropics. Among the exquisite, multihued little tanagers of the genus *Tangara*, male and female are nearly or quite alike in appearance, and both take on a plumage essentially adult within a few months after leaving the nest, in the postjuvinal molt. Likewise the brilliant, scarlet and jet black Song Tanager acquires his full nuptial dress, so different from that of his mate, soon after he begins to fly.

#### SUMMARY

Turquoise-naped Chlorophonias inhabit highland forests of Costa Rica and western Panamá, chiefly above 5000 feet, where they range through the tops of the epiphyte-

laden trees. From July to November they roam in small flocks rarely exceeding 10 or 12 individuals, the great majority of which wear the green plumage of the females and young. After December they are mostly found in pairs.

The species subsists largely on fruits.

The song consists of a variety of low whistles, disconnected rather than linked into a continuous melody.

At 5500 feet in the Costa Rican highlands, nesting began in the second half of March and continued until July. Half of the six nests found were attended by males in immature plumage, one of them scarcely distinguishable from his mate. These young males nested later than those in bright plumage.

The globular, mossy nests, each with a doorway in the side, were placed from about 35 to 100 feet above the ground in trees standing in clearings in the cloud-forest. Usually they were excellently concealed amid moss and larger epiphytes. Male and female took rather equal shares in building.

All the nests were inaccessible, but a count of nestlings showed that at least three eggs were laid in a set. These were incubated by the female alone. In five hours of the morning one female took sessions which averaged 29.2 minutes and recesses which averaged 22.6 minutes; she sat for 57 per cent of the time. When she returned to the nest, her mate escorted her almost to the doorway. Upon leaving the nest she invariably fell almost to the ground before curving upward to fly away. Her mate fed her once in the course of a morning. Another male offered food to his mate at a distance from a nest.

The nestlings were brooded by their mother and fed by both parents on regurgitated food. The pair regularly came to the nest-tree together, and the male consistently delivered his food before the female. As each flew to the doorway from a perch close by it, the other would start to follow, but returned to a perch before reaching the nest. The young of the first brood left when at least 23 days old, whereas those of the second left when 24 or 25 days old.

One pair raised two broods in the same nest, the female laying again less than two weeks after the first brood left. The young of the first brood were not seen while the female incubated her second set of eggs.

Despite their great difference in appearance, the euphonias and chlorophonias have closely similar habits. In both genera, closed nests are built by both sexes, nesting periods are long, and the young are fed by regurgitation. Even many seemingly unimportant mannerisms are similar in the two groups.

## GENERAL SUMMARY OF INFORMATION ON THE THRAUPIDAE

The tanagers are a large but compact family of small and middle-sized passerines containing, according to Mayr (1946:67) 197 species. They are confined to the Western Hemisphere and almost exclusively to the tropical portion thereof, only four species of the single genus *Piranga* reaching as far north as the United States; correspondingly, few extend much beyond the Tropic of Capricorn in the opposite direction. This is one of the most brilliant and varied of all avian families; the genus *Tangara* (including *Calospiza* and *Calliste*) alone would seem to exhaust the possibilities of color and color combinations in the plumage of a small bird. Black and white plumage is found in the well-named Magpie-Tanager. A few genera, as, for example, *Chlorospingus* and *Schistochlamys*, are dull-colored. In most species, including many of the most brilliant, the sexes are similar in coloration. The majority of such species are non-migratory and appear to remain in pairs throughout the year. Sexual differences in coloration are found chiefly in the migratory species (*Piranga*), and in those non-migratory species of which the male is brilliant and which flock during the non-breeding season (*Ramphocelus*, *Tanagra*, *Chlorophonia*, *Piranga leucoptera*). Seasonal changes in plumage are exceptional, the Scarlet Tanager being the outstanding example of this in the family.

The food of the tanagers includes large quantities of fruits, but all appear to vary their diet with insects. Many capture occasional insects on the wing, and some, such as the Summer Tanager, are adept at this. Numerous species of *Tangara* and to a lesser extent species of *Thraupis* hunt over the mossy boughs of trees, bending down to examine the undersides for hiding insects and spiders. *Eucometis* regularly follows the army ants, capturing small invertebrate fugitives but not the ants themselves. Unless the puzzling *Rhodinocichla rosea* really belongs in this family, I am aware of no member of the Thraupidae that habitually forages on the ground. The genus *Tanagra* (euphonias) as a whole feeds largely upon the fruits of the Loranthaceae (mistletoes) and is instrumental in the dissemination of these parasites.

Voice is not well developed in the tanager family. Many of the most brilliant species of *Tangara* have slight, weak songs or none at all. Few tanagers exhibit at the same time strength, variety and persistence in their singing. Many of the euphonias have bright, clear whistles, but there is little variety in their performances. Species of *Ramphocelus* and *Thraupis* have pleasant but generally weak voices and slight variety. Among those tanagers that I have heard, the best songsters are the Scarlet Tanager, the Summer Tanager, the Red Ant Tanager and the Gray-headed Tanager when at its best. Special dawn-songs are, so far as known, found only in the ant tanagers of the genus *Habia* (*rubica* and *gutturialis*).

Nuptial feeding has been recorded in numerous species of *Tangara*, including the Golden-masked Tanager, Silver-throated Tanager, Yellow-browed Tanager, and, in captivity, in *T. thoracica* (Lack, 1940:177); also in the Blue Tanager, Turquoise-naped Chlorophonia, Tawny-bellied Euphonia (sometimes the female feeds the male), and Scarlet Tanager (Roberts, 1936:332). In the foregoing species observed by me, the female may be fed off or on the nest. (Possibly this is not true in the Tawny-bellied Euphonia and the Turquoise-naped Chlorophonia.) Occasional bringing of food to the nest before the eggs hatch by the Song Tanager or Scarlet-rumped Black Tanager and the Crimson-backed Tanager should be considered as anticipatory food-bringing rather

than as nuptial feeding; although the female of the second species at least may at times eat the morsel brought by the male, it does not appear to be intended for her.

Polygamy appears to be occasional in the Song Tanager, in which females outnumber males. Monogamy is the rule in the family as a whole and even in this species.

The nest is typically an open cup placed in a tree or bush, very rarely on the ground; so far as known no species nests regularly on the ground. Usually the nest is well and thickly made, but some species of *Piranga*, *Eucometis* and *Habia* build slight structures. The nest of the Palm Tanager is placed in a cavity of a tree or in a cranny in a building; the related Blue Tanager exceptionally shares this habit and may occasionally use nests stolen from other species. Domed nests with a round entrance in the side are built by euphonias and chlorophonias; they are placed in crannies in trees or posts or at times in burrows in banks, which doubtless were found already made.

The nest is built by both sexes in numerous species of the genera *Tangara*, *Thraupis*, *Tanagra*, *Chlorophonia* and *Eucometis* but by the female alone in *Ramphocelus*, *Piranga* and *Phlogothraupis* (one observation).

The eggs seem generally to be laid in the early morning and are usually two in a set in *Tangara*, *Thraupis*, *Ramphocelus*, *Eucometis* and *Habia*; only exceptionally are there three in these genera. Larger sets, sometimes up to four or five, are found in *Chlorophonia*, *Tanagra*, and the North American species of *Piranga*. The eggs are nearly always pigmented. The ground color may be bright blue, blue-green, blue-gray, gray, cream or white, and on this are spots, blotches or scrawls of shades of brown or lilac, or of black.

Incubation is carried on by the female alone. Although there are a few published statements to the contrary (for example, Audubon, for Summer Tanager and the Penards, 1910, II:439, for species of *Calliste*), these require further investigation before they can be accepted. Diurnal sessions on the nest are usually short, rarely exceeding an hour in length and in a number of species averaging between 20 and 30 minutes. The species observed kept their eggs covered from 60 to 80 per cent of the time.

The incubation period varies from 12 to 14 days in the species studied, rarely more (a record of 16 days for the Bonaparte Euphonia).

The nestlings are hatched blind, with sparse natal down. The interior of the mouth is red in the species for which we have information. They are brooded by the female but seem always to be fed by both parents, except at rare nests of the occasionally polygamous species such as the Song Tanager. The food is carried in the bill or mouth in *Ramphocelus*, *Thraupis* and *Tangara*, but it is regurgitated by *Tanagra* and *Chlorophonia*. Parent tanagers have never been seen to "feign injury" when eggs or young appear to be in danger; but a female Gray-headed Tanager with newly hatched nestlings made an approach to injury-feigning.

The nestling period is variable; it is shortest in those species which habitually nest low (11 to 13 days in *Ramphocelus*); it is somewhat longer in species whose open nests are placed higher (14 to 16 days in *Tangara*, 16 to 20 days in *Thraupis*); it is longest in species which build roofed nests (17 to 24 days in *Tanagra* and up to 23 or 24 days in *Chlorophonia*).

Helpers at the nest are recorded for the Golden-masked Tanager and Plain-colored Tanager, in both of which species birds that were apparently adult helped the parents to feed the nestlings. Juvenal individuals of the Golden-masked Tanager occasionally but not regularly assist their parents in feeding later broods of the same season. A male

Scarlet Tanager fed nestling Chipping Sparrows until his own young hatched (Hales, 1896:262).

The adult plumage is generally acquired by the postjuvinal molt in the non-migratory species of *Ramphocelus*, *Tangara* and *Thraupis*, but by the prenuptial molt in migratory *Piranga*. Young male Summer Tanagers gradually acquire the red adult plumage over the winter months. Males of the Turquoise-naped Chlorophonia and the Yellow-crowned Euphonia and related species may breed at least one year in a transitional plumage.

## FAMILY ICTERIDAE

### FOUR CENTRAL AMERICAN ORIOLES

The upper Térraba Valley of Costa Rica, where in recent years most of my bird-watching has been done, differs from most other parts of Central America in its poverty in members of the Icteridae. I have discovered but a single resident species, the Chisel-billed Cacique. The Baltimore Oriole is a common winter vistant, and a wintering Orchard Oriole is occasionally seen; but strangely there is no resident species of *Icterus*, a genus well represented in Central America as a whole. To my lasting regret, while working in other regions I did not find nests of orioles in sufficient numbers to learn much about their breeding habits. Yet no account of the Icteridae could be satisfactory without a consideration of the genus from which the family takes its name. In an effort to remedy this defect, I present here such scanty material on four Central American orioles as I have gathered in the hope that, supplementing each other's deficiencies, the accounts of the four species taken together will give some notion of the manner of life of these delightful birds.

The American orioles or hangnests are generously provided with bright plumage, melodious voices, and outstanding skill in nest building to make them and their relatives one of the outstandingly interesting bird families of the Western World.

#### YELLOW-TAILED ORIOLE

##### *Icterus mesomelas*

The Yellow-tailed Oriole ranges from southeastern México to northern Perú. In Central America it appears to be confined to the humid Caribbean side, where it ascends from sea level to about 4000 feet in Guatemala, but in Costa Rica it seems to be restricted to much lower altitudes. Of the two common orioles resident in the humid Caribbean lowlands of Central America, this easily stands first in beauty of both plumage and voice. Like so many other orioles, it is yellow and black: the black is confined to a patch covering the cheeks, throat and the center of the breast, another in the middle of the back, the greater part of the wings, and the middle tail feathers. The forehead and crown, the remainder of the body, and the wing coverts are yellow, and the outer tail feathers are largely yellow. The sexes are alike in plumage.

Avoiding the forest, the Yellow-tailed Oriole is most at home in swamps, canebrakes, thickets of great-leaved heliconias and shell-flowers, the borders of lagoons and rivers, and the dense, vine-entangled thickets which spring up in neglected pastures and abandoned plantations in the river bottoms. It also forages through banana groves, roadside trees and dooryard shrubbery, especially in the vicinity of the low, poorly drained land of which it is so fond. In 1929 I found this oriole abundant about the Research House on Farm 6 in the Almirante Bay region; here neighboring lagoons, swamps, and banana plantations were attractive to it, and it often foraged in the trees and shrubbery which shaded the lawns. Richmond (1893) states that in Nicaragua the English-speaking residents called this the "banana bird" because it was so abundant in the banana plantations. The Yellow-tailed Oriole has a slow and labored flight, and it jerks its tail up and down like a pump-handle as it goes. Often while flying it makes a crashing sound, apparently with its wings.

The Yellow-tailed Oriole's voice would win it a foremost place among the songsters of any land. Taking into consideration all of those qualities which contribute to the



Fig. 35. Yellow-tailed Oriole.

beauty of a bird's song — mellowness and fullness of tone, continued performance, and the absence of harsh notes — I believe that the Yellow-tailed Oriole must be allowed to surpass the Mockingbird; for although his voice has not so great a range, it is more mellow, and his song is seldom marred by the harsh interludes which the Mockingbird so often introduces into his performance. Possessing a great variety of his own phrases, he needs not mimic other birds. He repeats the same verse over and over again, in continuous sequence with hardly a pause, then takes up another entirely different phrase and reiterates it in the same manner. Rarely he introduces a trill. The female's voice is

no less mellow than the male's; but her notes are more limited in range; and her phrases are usually shorter than his, consisting of only from two to four notes whereas his contain five, six, or rarely more. At Almirante these orioles often came close about the house and enlivened the bright days of March and April with their sweet voices.

The single nest of the Yellow-tailed Oriole which I succeeded in finding was in a small, thorny leguminous bush growing in a scrubby pasture beside a brook on "Alsacia" plantation, near Los Amates, Guatemala. Situated seven feet above the ground, it was a deep open cup composed of bright, clean fibers which the oriole herself had no doubt newly stripped from some suitable plant and which she had neatly woven into an open fabric with meshes so wide that the eggs could readily be seen through the bottom. The structure was suspended by its rim between a horizontal branch of the bush and a slender vine that ran parallel to it. A few of the fibers near the rim were passed over the vine and others were twisted about two leaves of the bush; the attachment was so insecure that the nest promised to fall before the nestlings could fly, and I found it necessary to tie it up in a neighboring crotch with cord. The cup measured 3 inches in diameter by  $2\frac{3}{4}$  inches in depth.

When found on April 29, 1932, the nest contained two eggs; the third and last was laid the following day. The eggs were white with the faintest tinge of blue, heavily marked on the thicker end with pale chocolate blotches, among which were mingled irregular spots of black. There were a few faint marks of pale brown over the remaining surface. These eggs measured 24.6 by 17.9, 23.4 by 17.9, and 23.8 by 17.9 millimeters.

Although I did not find time to make a special study of the mode of incubation, I saw a good deal of this nest while watching a burrow of the Green Kingfisher situated in the bank of the neighboring brook. When the female oriole sat in the deep cup, only her head and long tail were visible above its rim. Her mate stayed in the vicinity and all day long sang from the tree tops. Often she responded or joined in while sitting in the nest, in a voice fully as sweet as his, but with shorter phrases. Once the male, high up in a neighboring bamboo clump, seemed to sing "Hold yourself afar, sir, hold yourself afar," while from the nest his mate answered "That's right, that's right, that's right." Sometimes the male accompanied his mate when she returned to the nest from a recess, but he went off again as soon as she was comfortably settled.

After fourteen days of incubation the last egg hatched. The sightless nestlings had salmon-pink skin and long gray down on the head, back, shoulders, wings and flanks. They remained in the nest until twelve and thirteen days old, respectively. Whenever I approached them, both parents came as near as they dared and protested with notes almost as rich and mellow as their song, sounding like *chup chup chup*.

#### SUMMARY

Yellow-tailed Orioles avoid heavy woodland. They live in swamps, cane-brakes, stands of herbs with giant foliage, abandoned plantations and bushy pastures, especially in low, wet land.

The male sings a great variety of full, mellow phrases. The female's songs are usually shorter and less varied, but her voice is hardly inferior to his in tone. While sitting in the nest, she sings in response to her mate.

A single nest found in Guatemala was an open cup suspended by its rim and not deep enough to be called a pouch. It contained three eggs which hatched after 14 days of incubation. The young remained in the nest 12 and 13 days.



## LESSON ORIOLE

### *Icterus prothemelas*

Geographically the range of the Lesson Oriole is more restricted than that of the Yellow-tailed Oriole, for it is found only from southern México to western Panamá. But in Central America the two species are confined to the humid Caribbean region and are often met in the same localities. The Lesson Oriole extends up to 3000 or 4000 feet above sea level in both Guatemala and Costa Rica. Somewhat smaller than the related species, it is easily distinguished by the fact that the entire head, neck, chest, and upper back are black, and there is no yellow on the black tail. The lower back and rump, and the lower breast and belly are bright yellow. The wings are black with a yellow patch at the bend. The bill and feet are black. The sexes are alike.

The Lesson Oriole inhabits banana plantations, open country with scattered trees and palms, and the banks of rivers. Its song is a varied whistle, sweet but hurried, and usually so low that one must stop and listen intently at no great distance in order to appreciate it, for it lacks the mellow volume of the Yellow-tailed Oriole's song. The call notes, heard much more often than the song, are nasal monosyllables. This oriole forages amid the foliage and often hangs head downward from the leaves of palms to pluck insects from the lower side. I have also seen it eat the staminate flowers of the *Cecropia* tree.

The nest is a wonderful structure, an open cup thickly woven of fine fibers, suspended beneath the leaf of a banana or some other great-leaved plant by strands passed through perforations which the birds make for the purpose in the tissue of the leaf blade. In this ingenious hammock eggs and young are well sheltered from sun and rain and are beyond reach of most predatory creatures except those with wings. But the nest is liable to destruction when high winds toss the foliage, or when the banana harvesters cut down the plant. Once I found a nest suspended beneath the eaves of a cottage, attached on one side to an outjutting nail and on the other to the telephone wires which entered the house at this point.

At the end of March, 1929, a Lesson Oriole built a nest beneath the great leaf of a banana plant in front of the office at the research station near Almirante, Panamá. It was situated near the tip of the leaf and hung below the midrib, suspended by strands laced through the blade on either side. So far as I could learn, this nest was not used for eggs. Later a second nest, probably belonging to the same pair, was discovered nearby. Unlike the first, this was attached entirely on one side of the midrib, beneath a fold in the broad blade caused by its splitting across from the margin to the midrib and sagging down below the tear. By May 14, both parents were feeding nestlings in this nest.

In the plantation at Lancetilla, Honduras, a Lesson Oriole suspended her nest beneath the leaf of an introduced "traveler's palm" (*Ravenala madagascariensis*), straddling the massive midrib. Like the two nests found earlier in Panamá, this structure was neatly woven of fine, clean, light-colored fibers of a single kind, which had apparently been stripped from the leaf sheaths of banana plants. The interior of the nest measured  $2\frac{1}{4}$  inches in diameter by 3 inches in depth. When found on June 18, 1930, it contained three recently hatched nestlings. Approaching to feed their young, the parents would perch on the huge leaves of the traveller's palm and interrupt their monotonous nasal calls long enough to deliver a melodious whistled song, very low but pleasing to hear. When the nestlings were fledged, I stood on a box and drew down



Fig. 36. Lesson Oriole.

their sheltering leaf to look in at them. Almost before I knew what had happened, the three had burst out of the nest and vanished into a clump of tall grass close by. The anxious parents perched on the tips of the giant leaves and voiced their complaint with oft-repeated nasal monosyllables. One of them, doubtless the male, interspersed his scolding with snatches of light whistled song, low and rapidly delivered. It was a pleasant surprise to hear such a song burst forth in the midst of a scolding. Yet in birds any strong emotion, be it pleasurable or otherwise, is likely to find its outlet in song. Once I came upon a pair of White-collared Seedeaters defending their nestling from a Kiskadee which had injured it and apparently intended to eat it. In the midst of his attack upon the large flycatcher, the male seedeater delivered his most vigorous song.

After they can fend for themselves, the young Lesson Orioles go about in small

flocks. In their juvenal plumage they bear more resemblance to the adult Yellow-tailed Oriole than to their own parents, for the black on the head is restricted to the cheeks, chin and throat, while the forehead, crown and hindneck are an impure yellow. The Lesson Orioles at Lancetilla roosted in company with innumerable little seedeaters in a patch of tall elephant grass not far from the traveller's palm where the nest was found.

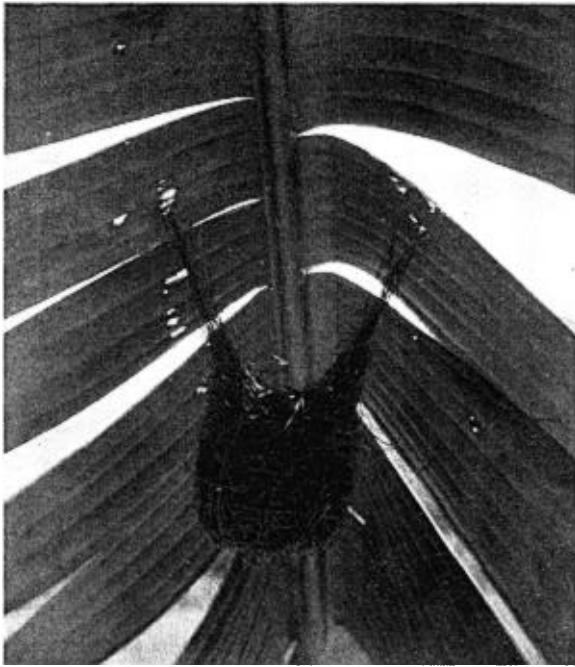


Fig. 37. Nest of Lesson Oriole suspended beneath a leaf of the "travelers palm," at Lancetilla, Honduras, July 5, 1930.

#### SUMMARY

Lesson Orioles inhabit open country, river banks and banana plantations, from the lowlands up to 3000 or 4000 feet above sea level.

Their song is a varied whistle, sweet in tone but low and hurried.

The nest is a cup or hammock suspended beneath the leaf of a banana or other great-leaved plant by fibers passed through perforations which the bird makes for the purpose in the tissue of the leaf; or it may be hung beneath the eaves of a house, attached to projecting nails or telephone wires. In either case it is completely sheltered from sun and rain.

A nest found in Honduras in June held three nestlings which were fed by both parents. When the author visited this nest, one parent interspersed its scolding with snatches of rapid song.

After separating from their parents, the young flock together.

In Honduras, these orioles roosted in a patch of tall grass in company with many seedeaters.

## BLACK-THROATED ORIOLE

### *Icterus gularis*

Along the Pacific coast of southern México and northern Central America as far south as Nicaragua, and in arid valleys of eastern Guatemala and adjacent parts of Honduras, where the lower lands are covered with cacti and thorny scrub and the hillsides bear open stands of pine, lives a third species of oriole. The predominant color of this bird, the Black-throated Oriole, varies from orange-yellow to deep orange; black is found on a shield covering the lores, the anterior portion of the cheeks and the throat, on an area on the back, and on the wings, and the tail. On the wing-coverts is a patch of yellow which is conspicuous in flight. The sexes are similar in appearance, and it is not always possible to distinguish male and female of a mated pair.

The Black-throated Oriole's song is fully worthy of the bird's appearance, and consists of round, mellow whistles uttered deliberately in a clear, far-carrying voice. In the evening, especially, it utters single tinkling whistles spaced with fairly wide intervals. It has a churring call, somewhat resembling that of its neighbor in the arid valleys, the Rufous-naped Cactus Wren, and it delivers also a somewhat nasal note which may serve as a call or a signal of alarm.

In the semi-desert portion of the valley of the Río Motagua in Guatemala, the pendent nests of this oriole, perfect miniatures of those of the Montezuma Oropéndola but only between one and two feet in length, are hung conspicuously from the tips of long, slender branches, generally near the tops of the low trees which are abundant in the region. They are for the most part placed between fifteen and thirty feet above the ground, and it is impossible to reach them except with a long pole. The pouches are neatly woven of fibers of various sorts and of lengths of green vine, and they are lined on the bottom with a very thick layer of fibrous material and with the long, white wool from the tips of the branches of a species of organ cactus. It is difficult to understand why in so hot and dry a region this ample lining should be necessary, unless the eggs sink down into it and so are less likely to be knocked together and broken when strong breezes swing the pensile bag. Such is true of the loose litter of leaves in the bottom of the oropéndolas' nest.

When I arrived at El Rancho in the Motagua Valley at the end of June, 1932, the female Black-throated Orioles were building their nests for the second brood, often in the same tree where the old nest swung, or at least within sight of it. They worked alone, and their mates did not even accompany them on their excursions to gather material as the males of so many kinds of birds do. The first female oriole that I watched had finished the weaving of her pouch at the tip of the highest branch of an acacia tree growing in a dry watercourse and was carrying in down from the cactus for the lining. Each time that she emerged from the nest she paused half-way out, with her tail inside the pouch, and called in a loud voice with a nasal twang. Three young birds of her first brood frequented the vicinity. They were yellow instead of orange, their black markings were not so deep and glossy as in the adults, and they lacked the yellow patches on the wings. Two had black throats like the parents; but the throat of the third was yellow, the black about the head being confined to the lores. Although able to find food for themselves, from time to time they pleaded with fluttering wings to be fed, especially the yellow-throated youngster, who seemed to be the least mature of the trio. The parents were sometimes moved by these entreaties and placed food in the open mouths of the youngsters.

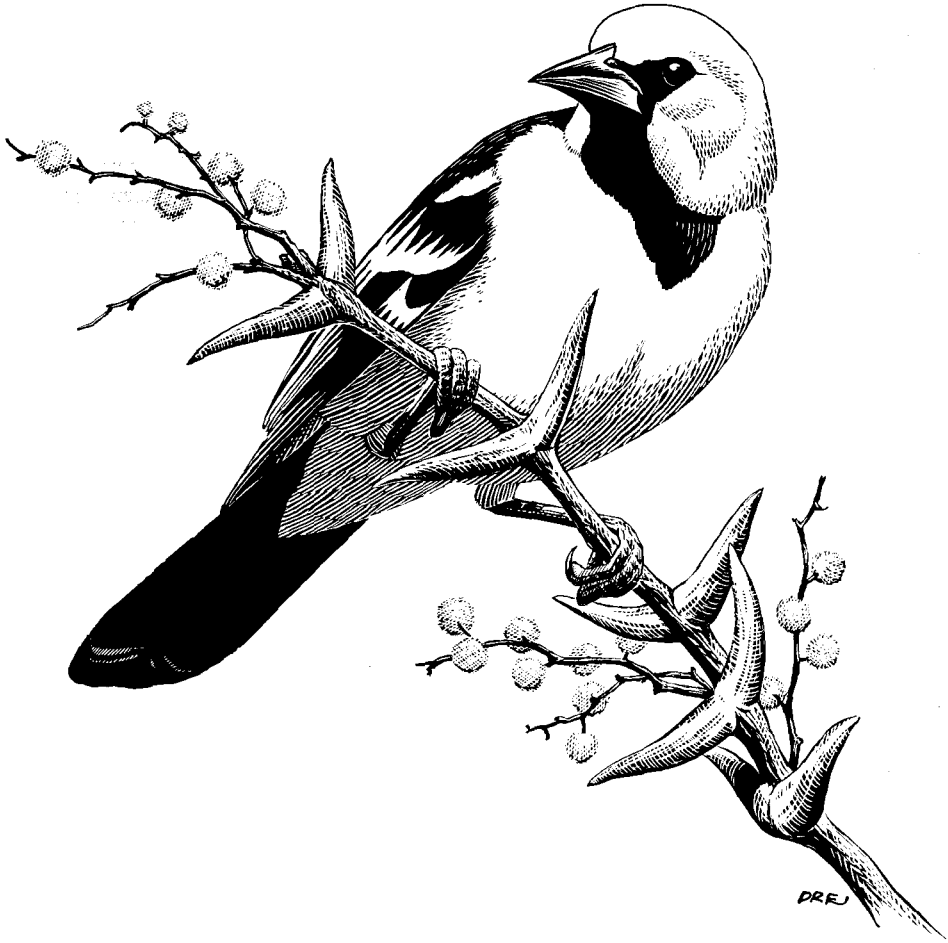


Fig. 38. Black-throated Oriole.

The second oriole had not completed the weaving of her pouch, which still lacked a bottom. She brought fibrous strands and slender green vines and wove them into the lower portion of the structure, hanging head downward on the inside as she worked, exactly as oropéndolas do at the corresponding stage of nest construction. Two young orioles loitered close by; and once one of them perched on the entrance of the unfinished nest; but they were persistently driven off, especially by the male. Were it not for the habit of many kinds of birds of driving away their offspring of the first brood when ready to raise a second, I believe that the young birds would more often remain in the vicinity of the nest and, by force of example or awakening parental instincts, help in the care of the younger brood, as sometimes happens in Brown Jays, Groove-billed Anis, Bluebirds, and other species.

Later, on July 19, I watched at a nest that contained two young about ready to take wing. The repeated passage of the adults while feeding their nestlings had torn and enlarged the entrance until the entire side of the pouch was open to within a few inches

of the bottom — a not infrequent occurrence in nests of this type. Whenever one of the parents clung to the outside to deliver an insect, two heads stretched forth, open-billed, to receive it. A third nestling had already departed, and it awaited its share of the food in the next tree. The whole time that I was within hearing, both parents, who united in feeding their offspring, uttered a continuous succession of single notes of three different kinds, each bright and vivid. Whether they searched among the foliage for larvae and insects, or returned with food in their bills to the nest, or clung to its side

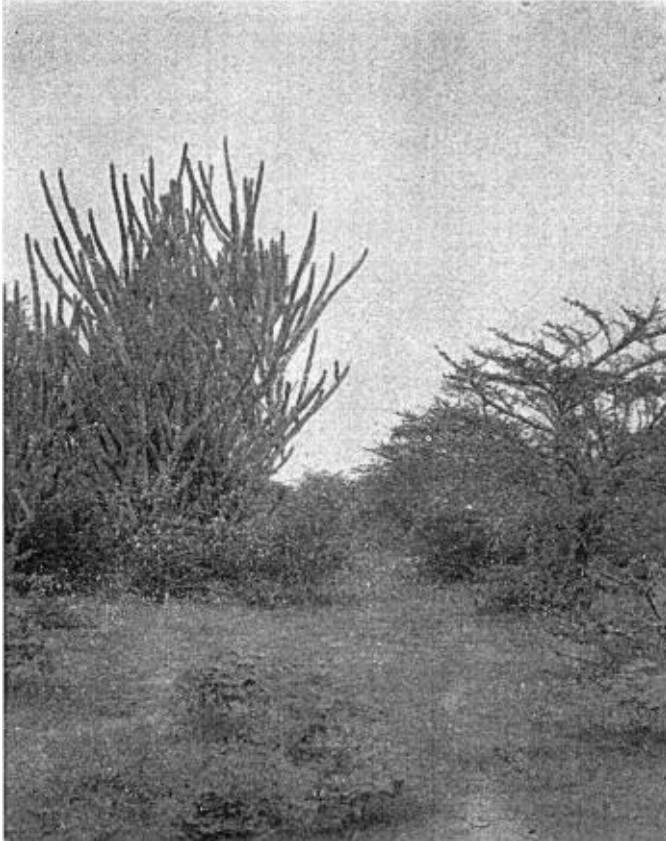


Fig. 39. Cacti and thorny scrub near Zacapa in the arid middle section of the Motagua Valley, Guatemala. Habitat of the Black-throated Oriole, Rufous-naped Cactus Wren, Turquoise-browed Motmot, Rufous-rumped Cuckoo, and other birds of the Arid Tropical Zone.

in the interval between feeding and cleaning their offspring, they constantly expressed themselves in these lively monosyllables. Even when they paused to scold at my intrusion, their churring protests were mingled with these clearer notes which they never seemed able to suppress. Rarely have I heard other birds, except Red-eyed Vireos, sing so continuously.

In the Motagua Valley, all the nests of the Black-throated Oriole that I saw hung well out of reach. But on July 13, 1934, while sweltering amid the cacti and thorn-brush

on the arid plains near San Gerónimo on the Pacific side of the Isthmus of Tehuantepec, I found an accessible nest of another race of this same species. It was the lowest of the dozens of nests of the same kind, most of which were abandoned by this date. Suspended from the extremity of a slender twig of a thorny leguminous tree, it hung only seven feet above the ground. The elongated pyriform pouch, twelve inches in length, was shorter than most of those which I saw, although a few were shorter still. The walls were neatly woven of fibrous materials, and the opening was at the top, at the point

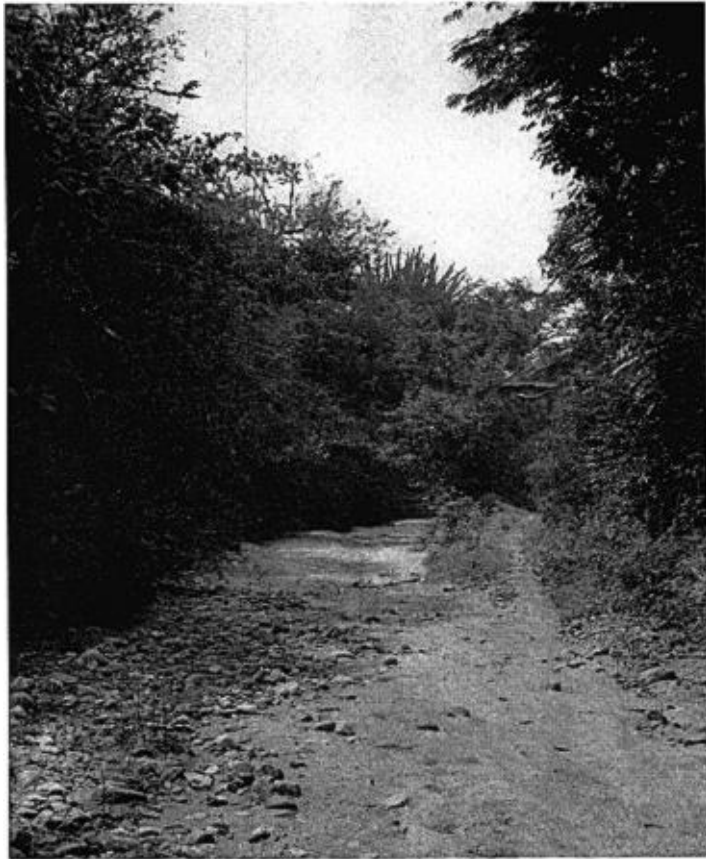


Fig. 40. A dry water course on the plain near Zacapa, Guatemala (see fig. 39).

of attachment. There was no lining of downy material, as in the nests of this species that I found in the Motagua Valley, but the fabric of fibers was much thicker on the bottom than on the sides. The pouch held one newly hatched nestling and one egg on the point of hatching. The egg was very elongate in form, white, and irregularly scrawled with lines of black and pale lilac; it measured 27.4 by 17.5 millimeters. This was probably a second-brood nest, for farther north in México, in the state of Tamaulipas, Sutton and Pettingill (1942:29) found birds of the species building at the beginning of April.

## SUMMARY

Black-throated Orioles are restricted to the more arid lowlands, where cacti and thorny scrub are prominent in the vegetation.

Their song consists of mellow whistles uttered deliberately in a clear, far-carrying voice.

In the semi-desert portion of the Motagua Valley of Guatemala, the pouchlike nests, a foot or two in length, are hung conspicuously from the tips of long, slender branches, usually from 15 to 30 feet up.

In June the females were building their nests for the second brood. The males did not assist with this work, but later they were seen helping to feed nestlings.

An unusually low nest found on the Isthmus of Tehuantepec in July contained one egg and one newly hatched nestling. In the Motagua Valley, families of three young were found.



## SPOTTED-BREASTED ORIOLE

### *Icterus pectoralis*

The Spotted-breasted Oriole inhabits the Pacific coastal region from the Mexican state of Oaxaca to the Peninsula of Nicoya in Costa Rica, but on the Caribbean side it is confined to dry interior valleys of northern Central America. In Guatemala it extends from sea level up to 5000 feet. In plumage this species greatly resembles the Black-throated Oriole; but birds fully mature wear, in addition to the black throat shield, a band of black spots across the chest. On some individuals these spots are so big and numerous that they almost coalesce to form a solid black band; on others they are lighter and more scattered; younger birds, even some of both sexes which breed, lack these spots entirely, and thus are confusingly similar to mature Black-throated Orioles except that their plumage is not so orange.

The song of the Spotted-breasted Oriole is incomparably beautiful. It is a series of the clearest, most mellifluous whistles possible, blended into a continuous liquid stream of melody. One day after listening long to this performance, I recorded in my journal that this was "the finest oriole's song I know; a trifle better even than the song of the Giraud Oriole, to which it is very similar." The female sings a simpler song, consisting of clear whistles spaced at distinct intervals — a pleasant performance which resembles the song of the Black-throated Oriole.

I found these orioles abundant in the tall shade trees of the great coffee plantations on the Pacific slope of Guatemala, in the departments of Quezaltenango and Suchitopéquez, between 2000 and 3000 feet above sea level. Here they wandered about in small flocks during the months of the northern winter. In the breeding season they hung their nests conspicuously high up in the shade trees of the plantations. On the Finca "San Diego" near Colomba, on July 18, 1935, I found a female weaving a long, swinging pouch, attached to the end of a slender twig about sixty feet above the ground. It lacked only the bottom, which she was weaving in with long fibers brought from a distance. She worked without help and flew back and forth unattended by her mate, who sang superbly among the neighboring trees. Frequently she voiced a loud, nasal call, and sometimes while approaching the nest, but more often as she flew away after having woven in her fibers, she delivered clear, musical notes. Neither male nor female of this pair had spots on the breast and they might have been mistaken for Black-throated Orioles had it not been for the very distinct song of the male.

On the same farm, on July 20, I picked up a nest which had fallen when the supporting twig snapped off. It was a pyriform pouch, 18 inches long by 6 inches in greatest diameter, suspended from the forked extremity of a slender terminal twig, between the arms of which, at the top of the pouch, was the entrance. The strong fabric was composed of fibers, fine aerial roots and similar flexible materials, carefully interwoven and knotted together. Some of the ends of the aerial roots had been allowed to hang below the nest, one to a length of  $5\frac{1}{2}$  feet. In the bottom was a thick lining of fine fibers, some light in color and others black. This nest contained the remnants of two eggs, which were white, marked all over with irregular scrawls of black and pale lilac, the latter predominating. An old and weathered nest hung from a tree near the spot where I picked up the fallen one. Apparently this was an earlier nest of the bird whose later structure fell prematurely.

The following day I found a female Spotted-breasted Oriole wrapping fibers about the slender extremity of a twig, almost directly above the point where I had found the fallen nest. The structure thus begun grew rapidly in length and after five or six days



Fig. 41. Spotted-breasted Oriole.

appeared to be completed, externally at least. As at the other nest I had watched, the female worked alone and was not escorted by the male as she flew back and forth bringing material. He was a beautiful bird with deep orange-yellow plumage and heavy black spots on his breast. Although he did not accompany his mate, he stayed in the vicinity and was followed by a young oriole which he fed. The latter, which had evidently been raised in the old nest that still hung from the next tree, was full grown and able to find food for itself, although it begged additional morsels from its father. The youngster was pale yellow in plumage, with blackish wings and tail, the feathers of the latter with yellowish shafts. Its head and neck were entirely yellow, without a trace of the black throat patch of the adults.

#### SUMMARY

Spotted-breasted Orioles inhabit the Pacific coastal region and dry interior valleys in northern Central America, extending up to about 5000 feet above sea level.

The male's song is incomparably beautiful. The female has a simpler song resembling that of the Black-throated Oriole.

The nest, a pouch about  $1\frac{1}{2}$  feet in length hung high above the ground, is built by the female alone. A replacement nest was woven in five or six days. In western Guatemala two broods are raised; while one female was building, her mate fed a youngster already able to find nourishment for itself.

Some of these orioles of both sexes breed in a transitional plumage, lacking black spots on the breast.

## MELODIOUS BLACKBIRD

### *Dives dives*

"Blackbird" is a name which has been applied in different lands to birds of very diverse relationship, but to none is it more appropriate than to *Dives dives*, which is among the blackest of black birds. In their glossy plumage, in bill and feet and iris, male and female are everywhere black, the former somewhat glossier. Although they belong to the troupial family, the more typical members of which wear bright colors, in them the last vestige of yellow, which lingers in the eyes of the grackles, has been extinguished. On the other hand, they have retained, in much fuller measure than many of the other black members of their family, the golden voice of the orioles.

The range of the Melodious Blackbird in Central America extends from southeastern México to northern Nicaragua, and from the lowlands up to about 6500 feet in the Guatemalan highlands. Here the species appears to be restricted to the Caribbean watershed and is particularly abundant in the Alta Verapaz, where I found it much in evidence in the neighborhood of Cobán, 4000 feet above sea level. In the humid lowlands of the Motagua Valley it is not rare. Inhabitants of open fields, pastures, and cultivated country in general, these blackbirds are absent from the heavier woodlands. One race of this species is found in western Ecuador and Perú, isolated from the northern form by a wide intervening territory from which the genus is absent. In Ecuador, I found the Melodious Blackbird abundant in the ricefields and swamps of the low, flat country west of the Guayas estuary. Here I heard it called "tilinga," apparently an imitative name, for it suggests the tinkling notes of this fine musician; it would be equally applicable to the northern form.

#### FOOD

The habits of these interesting birds, both in feeding and nest building, suggest relationship to the orioles on one hand and to the grackles on the other. They forage among the trees, picking insects and larvae from the foliage in the manner of orioles, although they are less agile, and they also hunt over the ground like grackles and cowbirds. They drink the nectar from the staminate flowers of the banana, like Brown Jays, Montezuma Oropéndolas, and Orchard Orioles. Sometimes they pluck a banana flower and hold it beneath a foot while they probe it with the bill, but at other times they hang head downward beside the huge red flower bud and drink from blossoms still attached. They attack ripening ears of maize, thereby earning the enmity of the Indians (Griscom, 1932:400). At "Alsacia" plantation near Los Amates, Guatemala, they joined the stone-turning parties that I used to watch in the evening on the shingly flood-plain of the Río Morjá. Here they turned over small stones in exactly the same manner as the Boat-tailed Grackles, the Giant Cowbirds, and the Red-eyed Cowbirds. Inserting the upper mandible beneath the near edge of the stone, they pushed forward with the bill slightly open until they overturned it, then ate anything suitable that they found beneath.

#### ROOSTING

Their supper over, these stone-turning blackbirds retired for the night into the dense brake of young giant canes (*Gynerium sagittatum*) that was springing up on newly formed land behind the barren flats. Here they were joined by many Red-eyed Cowbirds; but the Giant Cowbirds flew off noisily to a roosting place of their own farther down the river. In the waning light I sometimes sat on the sand at the edge of



## NEST BUILDING

The nest of the Melodious Blackbird is a deep woven cup that bears considerable resemblance to that of the Boat-tailed Grackle; but unlike the grackles, the blackbirds are not gregarious during the breeding season; each pair nests in solitude. The three nests which I have seen were all found at Alsacia in 1932 and were in orange or lemon trees near dwellings, from 10 to 20 feet above the ground and well screened by the dark, glossy foliage. The first was discovered on April 6, when newly begun in an orange tree behind the overseer's house on an exposed hilltop. Male and female shared the task of building. They worked in a very desultory fashion, bringing long fibers once or twice in succession, then going off for from half an hour to an hour before returning to resume building. The first bird to arrive in the nest tree would call with loud, clear whistles and be answered from the distance by its mate, who would soon fly up, sometimes bringing material for the nest and sometimes with nothing. Once the male entered the nest with empty bill and proceeded to weave with the materials already there; at other times he brought long strands with him. The weaving of the cup occupied the pair for about nine days. Less than two days sufficed to plaster the interior with mud and fresh cow dung; two more days were required to add the lining of fine roots and fibers, making a total of about thirteen days for the entire construction of the nest.

The completed nest was a bulky open cup, woven of coarse fibrous strips from the leaf sheaths of the banana and shreds of epidermis and lengths of vines and firmly attached by twisting fibers at the rim around the slender, upright supporting branches. The bottom of this ample cup was heavily plastered with cow dung and mud, this extending up the sides to within an inch or two of the rim. Within this was a lining of slender rootlets and fine fibers. The internal dimensions of this nest were  $4\frac{3}{4}$  inches in diameter by  $2\frac{3}{4}$  inches in depth.

## THE EGGS

A week elapsed between the completion of this nest and the laying of the first egg on April 25. Next day the nest was empty, probably having been pillaged by the Boat-tailed Grackles that nested and roosted nearby. The blackbirds then built a second nest about fifty feet from the first, but this was so well concealed in the foliage of another orange tree that it was not discovered until May 19, when incubation of the three eggs had begun. A third nest, found in the same neighborhood on July 10, contained one infertile egg and two nestlings about a week old. Hence the usual set appears to consist of three eggs.

The eggs of the Melodious Blackbird are clear light blue, marked with scattered large and small black dots, especially on the larger end. Four eggs measured 27.0 by 20.6, 28.6 by 21.4, 28.6 by 20.6, and 31.0 by 20.6 millimeters.

## INCUBATION

At the second nest behind the overseer's house at Alsacia, I endeavored to place a mark on one of the pair of blackbirds for greater ease in distinguishing the sexes. Using an expedient that I had sometimes found successful with flycatchers, I placed a little wad of cotton on the end of a slender twig, soaked it with white paint, then stuck it into the nest above the eggs. Twice the female pulled the paint-soaked cotton from the stick without becoming sufficiently bedaubed. Next I stretched a cord about an inch above the nest and saturated it with paint, thinking that perhaps the blackbird would try to sit upon her eggs beneath it and so rub against the string; but she would not go on the nest so long as the cord remained there. As a result of all my machinations she bore only a faint white smear on the side of her breast, and constant preening was already

effacing this stain from her glossy plumage. I abandoned the attempt to mark the bird, for I feared that I might provoke her to desert the nest.

In the absence of a satisfactory artificial mark of recognition, I found it difficult to distinguish the sexes of this pair. Although the slightly larger male was somewhat glossier, this difference was not obvious except in the most favorable light. Still, after watching the nest from a blind for a total of seven hours, I concluded that incubation was performed by the female alone. I timed 4 full sessions ranging from 50 to 81 minutes in length and averaging 62.5 minutes and 6 recesses varying from 8 to 23 minutes and averaging 17.7 minutes. The female kept her eggs covered for 77.9 per cent of the 7 hours.

Although the male blackbird did not help to warm the eggs, he was not unattentive to his mate. Before sunrise he arrived near the nest, probably from a roosting place down in the valley, and greeted her with a deep-toned, double whistle, *whar-rit whar-rit*, which he repeated over and over, while she answered from the nest in whistles higher-pitched than his. Then together they flew off to feed down in the valley four hundred feet below, both whistling as they went *tink tink tink tink*, clear and silvery. This was their flight call and to my ear the most pleasing of the birds' many whistles. In 23 minutes they returned together and the female entered the nest, whither the male soon brought her food, an attention with which he favored her only once or twice in a morning. Much of the time he stayed near the nest, frequently whistling; and his whistles were answered by his mate as she sat quietly in the deep shade of the orange tree. Sometimes it was she who called first from the nest, and if the male were within hearing he replied. His notes on the whole were deeper and fuller than hers; but hers, too, were very pleasing; the difference was not great. On leaving the nest the female always flew into the low valley lands to forage. Often the male accompanied her; but frequently he stayed near the nest while she went alone to seek food.

#### THE NESTLINGS

On May 28, more than 24 hours after the eggs were pipped, all three hatched. The nestlings bore a few tufts of nearly black down and had tightly closed eyes. When they were two days old, I spent  $3\frac{1}{4}$  hours watching the nest and saw the female bring food 15 times, the male thrice. Sometimes it was difficult to distinguish the sexes, but I believe that most of my identifications were correct. Twice the two came almost at the same time with food. The female alone brooded, for periods ranging from 5 to 14 minutes. Before the nestlings were a week old, two had vanished from the nest, but on June 4 I watched the parents attend the lone survivor. The single seven-day-old nestling was fed 11 times by the female in the course of three hours; the male fed twice; one more feeding was by a parent whose sex I did not succeed in recognizing. Thus the male had scarcely increased in attentiveness during the intervening five days but continued to feed the nestling only once for every four or five times by the female.

Almost everything these birds did was accompanied by melody; as they stood on the rim of the nest delivering food to their young they voiced low, liquid monosyllables very pleasing to hear. Despite their apparent tenderness, these blackbirds were most unspirited parents. Neither made remonstrance nor showed the slightest concern when I handled their nestlings in plain sight of them. This is apparently usual in this species, for the same was true at the nest that I found in July.

#### SUMMARY

Melodious Blackbirds live in cultivated country, in pastures, grainfields and along streams. In Guatemala they range from the lowlands up to about 6500 feet. They travel in flocks, often in company with grackles and cowbirds.

The methods of foraging are most variable. The birds hunt through foliage, sip nectar from banana flowers which they sometimes hold beneath a foot, eat ripening grain, and on open ground turn over small stones with their bills.

The Melodius Blackbirds roost gregariously in cane-brakes, sometimes in company with cowbirds. They are superb musicians with a wide variety of clear, full notes. The female's voice is only slightly inferior to that of the male. Sometimes she sings from the nest.

Three nests found in Caribbean Guatemala were from 10 to 20 feet up in orange and lemon trees. The ample cup is well plastered on bottom and sides with mud or cow dung, within which is a lining of rootlets and fibers. One nest was built by both sexes, who completed their work in about 13 days.

In each of two nests three eggs were laid. At one nest only the female was seen to incubate. She sat from 50 to 81 minutes at a stretch and kept her eggs covered for 78 per cent of seven hours. The male fed her once or twice in a morning.

The nestlings were fed by both parents but chiefly by the female, who alone brooded. They showed no concern when their offspring were handled.

## CHISEL-BILLED CACIQUE

### *Amblycercus holosericeus*

The plumage of both sexes of the Chisel-billed Cacique is uniformly black. Contrasting strongly with this sombre attire, the light yellow eyes stand out prominently. The strong, wedge-shaped bill, flattened at the tip to a narrow, chisel-like edge, is pale greenish-yellow and no less conspicuous than the eyes. The feet are plumbeous. Male and female are similar in appearance; the male, about nine inches in length, is slightly larger than his mate; but the difference in size is not sufficiently great to make them distinguishable in the field.

The species ranges from México to Bolivia and in Central America is widely distributed, occurring throughout the length of both coasts and far upward into the mountains. It is found not only in the most humid districts but also in the most arid, wherever the proximity of a river or the presence of ground-water permits the development of the densely tangled thickets which it likes. In Guatemala it ranges up to about 5500 feet above sea level (Griscom, 1932:386); in Costa Rica, Carriker (1910:833) found it at 8000 feet on Volcán Irazú and among the bamboos just below timberline on neighboring Turrialba. At these heights it is not nearly so common as at lower altitudes.

The denser and more entangled the vegetation, the more at home the Chisel-billed Cacique seems to be. It lurks in the riotous thickets that spring up in abandoned fields and clearings in the humid tropics, thickets through which a man can scarcely take a forward step without cutting his way with a machete. Cane-brakes, tangles of vegetation along the shores of waterways, and the bushy edges of the forest are also attractive to it; grass if sufficiently tall and rank forms acceptable cover. Dense vegetation near the ground is the prime requisite for this bird; in the undisturbed forest, and even in the taller second-growth woodland, the undergrowth is usually too light and open and the cacique is not found.

How reluctant the cacique is to quit the low tangles of bushes and vines was demonstrated to me in a striking manner some years ago when an isolated patch of such vegetation was burnt during the dry weather in March. As the flames spread with a loud crackling and a dense cloud of smoke, the more mobile and wide ranging of the birds fled well in advance of the conflagration. Flycatchers and tanagers flew away first, then the pigeons and doves of several kinds. The more shy and secretive birds, which rarely expose themselves beyond the shelter of the thicket, were the last to show themselves at the edge of the burning tangle of bushes and vines. Finally, when the flames had come very near, a skulking Chinchirigüí Wren could endure it no longer and rushed forth, flying slowly and laboriously over the open field beside the smoking thicket. But a pair of White-barred Antshrikes and three Chisel-billed Caciques refused to desert their sheltering thicket, and braving heat and smoke, stuck steadfastly in a small corner, a few yards across, which escaped being burnt. To see these three caciques at the same time, when the flames had driven them quite to the edge of the thicket at the roadside, was a memorable event. Although I had glimpsed lone individuals, and rarely a pair, at many points in Central America and southern México, I could not recall ever before having seen three together. Indeed, the birds normally stay so well concealed that in this region I seldom saw a single one, although I knew from their voices that they were far from uncommon.

The Chisel-billed Caciques do not flock but appear to remain in pairs throughout the year. For birds so difficult to glimpse, it would be tedious to gather a convincing



amount of ocular evidence on this point; but the evidence from hearing, soon to be considered, is fairly abundant.

#### FOOD

The Chisel-billed Caciques find their food in the depths of the thickets. Their yellow eyes, which from the edge of a dense tangle often return the gaze of the prying bird-watcher, give them an inquisitive air, and this characteristic is amplified by their

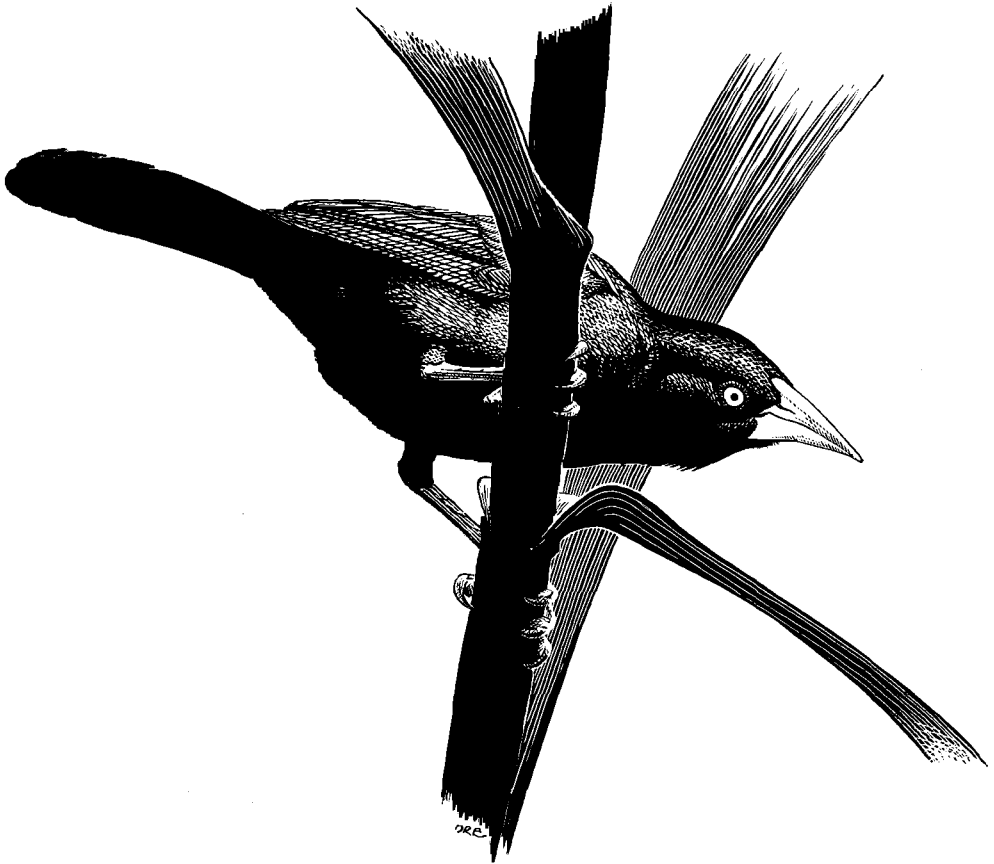


Fig. 43. Chisel-billed Cacique.

mode of hunting. They are constantly peering, prying and tearing into the folds and crannies and hollow spaces of dead and living vegetation. They noisily ransack the rustling dead leaves that thickly drape the stems of banana plants in abandoned plantations grown up with brush. If a plantation of sugar cane adjoins a thicket, they may enter the cane and pry up the edges of the sheathing bases of the leaves to look for small creatures hidden between the leaf and the stem. They break open the ends of slender dead twigs to extract grubs or ants from the pith. On thicker dead stems and vines they hammer vigorously with their yellow chisel-bills, like a woodpecker or perhaps more in the manner of a jay pecking open an acorn. When they have pierced the harder outer rind, they insert the tip of the bill, and by opening the mandibles spread apart the edges

of the gap, laying bare any larvae or boring insects that may be hiding in the center. It is difficult to learn just how the caciques extract their small victims; but since the bill is fully occupied in holding the gap open, the tongue is apparently used for removing the insect. When in searching among the dead foliage of the banana, or some other great-leaved plant, they wish to see what is on the other side of a leaf, they force their sharp bill through the tissue, and by opening the mandibles make a gap through which they can look.

Beecher (1950, 1951*a*) has described and figured the musculature of the jaws of numerous species of the Icteridae and pointed out how a number of them are equipped for opening the bill against pressure. Species of *Icterus* thrust the closed bill into a fruit, then separate the mandibles against the resistance of the pulp, giving the bushy tongue access to the juice. A similar mode of probing fruits is exhibited by the oropéndolas, and by caciques of the genus *Cacicus*. The Meadowlark, like the Tinkling Grackle, thrusts its bill into the ground and opens it powerfully against the resistance of the earth. Forceful gaping in the pursuit of food is not, however, confined to the Icteridae. According to Goodwin (1951:616) the British Jay tries to open objects by inserting the tip of its closed bill into a seam, crevice or small hole, then separating, or attempting to separate, the mandibles. Lorenz (1949) described the special structure of the bill and skull of the Starling which permits this bird not only to make a hole in the earth by pushing in its closed bill and forcibly opening it, but to peer into this hole without removing its bill—an obvious advantage in the search for food. The same modifications are found in *Pastor* and *Acridotheres*.

It is difficult to see exactly what the retiring Chisel-billed Caciques find to eat in their constant search through the thickets, but apparently they subsist chiefly on the larvae and winged insects, spiders and other small invertebrates which hide among the dead leaves and stems.

#### VOICE

Voices that I repeatedly heard floating out of the depths of dense, impenetrable thickets, in widely separated parts of Central America, were over a period of years finally traced back to this secretive black bird. One of these baffling sounds was a beautiful, loud, clear, liquid whistle of two notes; another, as commonly heard, was a long-drawn, rattling *churr*. If the listener happened to be close enough to the source of this loud *churr*, he might hear it preceded by a long, ascending whistle, which sounded as though it were produced by an inhalation—an impression strengthened by the knowledge that much breath was required to make the protracted *churr* that followed. Through the repeated association of the two dissimilar utterances, I became convinced that mellow double whistle and rattling *churr* were the answering songs of a mated pair of caciques and suspected that the more melodious notes belonged to the male. Later, when at last I found a nest, I learned that the sitting bird delivered the *churr*, answering the whistles of the mate, who never covered the eggs. This confirmed my supposition that the male whistles and the female *churrs*. I never heard the female whistle nor the male *churr*, although he uttered a variety of harsh notes that contrasted sharply with his velvety-smooth whistles. In the thickets where the caciques live, double whistle and long-drawn rattle may be heard responding to each other at all seasons of the year, affording good evidence that the caciques remain in pairs. In no other species of bird with which I am familiar do the answering calls of male and female differ so strongly as in this.

#### NESTING

The breeding season of the cacique is long. In the basin of El General, on March 10, 1943, I found a pair accompanied by one or possibly two well grown young. In the

same region, on March 25, 1937, I came upon a parent accompanied by a youngster which still was given an occasional morsel, although it was well able to break open hollow stems by hammering and tearing at them in the manner of the adults. These young birds seen in March were probably raised in nests built in January at latest. Hallinan (1924) found a nest with two eggs at Gatún, Canal Zone, on April 24, 1909. I was shown a nest with two eggs in El General on April 30, 1937, and another in the same locality, with one newly hatched nestling and one egg, on June 11 of the same year.

Although I have passed a dozen nesting seasons in regions where the cacique is more or less abundant, its nests are ordinarily so well concealed in the midst of low, dense vegetation that I have never myself found one. The first nest of the species that I saw was shown to me by some boys to whom I had offered a tempting reward for the nest of the "cacique negro" or "pico plata," as this bird is variously called in El General. And even this long-coveted first nest was discovered during the course of agricultural operations and was not in its original condition when I saw it. A narrow patch of sugar cane, set in the middle of extensive low thickets such as the caciques like, had been neglected so long that it became choked with tall weeds. When at last the owner came to give his cane a much-needed cleaning, he uncovered the nest and sent his little boy to claim the reward. When I was led to see the nest I found that the slender weed stems which supported it had been severed by the machete of the laborer; it was propped against a neighboring cane, where it rested at a height of 39 inches above the ground. Apparently it had been originally somewhat higher.

The nest was a well made, thick-walled, open cup. The outer layer was composed of slender dry vines and narrow strips from the fibrous leaf sheaths of the banana, some of which had been twisted around the supporting stems in typical icterine fashion. The middle layer was made up principally of long, narrow strips torn from the leaves of monocotyledonous plants, and the lining in the bottom was of fine, dry vines. The over-all dimensions of the nest were  $4\frac{1}{2}$  inches in diameter by 3 inches high. The internal measurements were  $2\frac{3}{4}$  by  $3\frac{1}{2}$  inches in diameter by 2 inches deep.

The second nest, shown to me in the same locality on June 11, 1937, was likewise in a small patch of sugar cane overgrown with weeds and vines, amid surrounding thickets. It was in its original position, 4 feet above the ground, supported upon vines and dead cane leaves between two canes 7 inches apart. More bulky than the first, it measured 6 by  $4\frac{1}{2}$  inches in outside diameter, and the cavity was  $3\frac{1}{2}$  by 3 inches in diameter by  $2\frac{1}{4}$  deep. A few slender vines formed the loose outer layer, and more were intermixed with the dead cane leaves that made up the bulk of the thick wall. In the bottom was a fairly thick lining composed of thin dry vines.

#### THE EGGS

The first nest contained two eggs which were pale blue, with a wreath of black spots around the thicker end. Some of the spots were heavy, others very fine; and on one egg there were a few fine black scratches in the wreath. These eggs measured 31.0 by 19.8 and 31.4 by 19.8 millimeters. The unhatched egg in the second nest was of the palest blue, with a few heavy black spots on the blunt end, and it measured 28.6 by 19.8 millimeters.

#### INCUBATION

In the first nest, the shells of both eggs had been slightly cracked in several places when the supporting stems were cut down, but not enough to let the contents ooze out. When I arrived I found these eggs warm, indicating that the cacique continued to incubate in her nest that now was exposed in the middle of the cane patch; the few remaining stalks did little to shade or conceal it, although a short while earlier it must have

been well screened in the tall weeds. Her attachment to the nest must have been very strong, thus to bind her to it after it had been exposed, its position changed, and its eggs broken.

Even while we stood beside the nest to make notes and measurements, the cacique watched us from the margin of the clearing, where she made the circuit just within the edge of the bushes, here and there peering out with keen golden eyes. My note taking done, I dismissed the boy and stood poorly concealed at the edge of the canefield; and although she must have seen me, the blackbird returned to cover her broken eggs. On my subsequent visits she would continue to cover the nest while I approached through the thin stand of sugar cane to within two yards of her, and later until I stood within arm's length. Then she fled to the edge of the thicket, to which she sometimes drew her mate by her harsh complaints. One afternoon, while at the nest, I saw one of the pair bill the feathers of the other's neck as they watched me from the bushes. As I arrived to set up the blind on the afternoon of the day when I first saw the nest, a heavy down-pour began. The cacique continued to sit on her eggs in the rain, watching me arrange the wigwam only twenty feet away from her.

At dawn on May 1, I stole into the blind to pass the morning with the caciques. As the light grew stronger, the male came to the edge of the cane patch and repeated his soft, full whistle many times over. The female on the nest replied with a long, thin whistle followed by a long-drawn rattling *churr*. The male, still in the thicket, uttered many harsh notes. Soon he flew across to the canes that shaded the nest and hunted among the bases of the dead leaves above it. Then he returned to the thicket. After I had seen more of the two caciques, I discovered that I could distinguish the female by the more frayed ends of her tail feathers, although otherwise she greatly resembled the male. She alone covered the eggs; and during each of her sessions I heard her utter the long rattle once or several times in response to the male's whistles. Although he took no part in incubation, he remained in the vicinity much of the time. At times he foraged among the sugar canes, prying up the sheathing bases of the leaves and detaching some that were dead. Once the two hunted together in this fashion before the female returned to her eggs. While the female took a twenty-minute recess from incubation, the male perched the whole time at the edge of the thicket nearest the nest, preening his long, soft, black feathers.

In the 6 hours of my morning's watch, the female cacique took five sessions on the eggs, lasting 30, 52, 84, 25 and 74 minutes. Her recesses were 24, 14, 20, 24 and 11 minutes, respectively. The average of her sessions was 53 minutes and that of her recesses was 18.6 minutes. She spent 74 per cent of the morning on the nest.

This female continued to incubate her cracked eggs for at least 14 days after I found them on April 30. When the days passed and they did not hatch, her attachment to the nest gradually waned. Although at one time she would sit until I came within arm's length, on subsequent days she would fly off while I was farther and farther away. Even on May 15, she was lurking in the vicinity when I visited the nest, and probably she had not entirely ceased to incubate. Opening the eggs then, I found them spoiled.

The second nest held one newly hatched nestling on the day I was led to see it. The chick had pink skin quite devoid of natal down and tightly closed eyes, and the interior of its mouth was red. While I examined the nest one of the parents arrived and began to complain frantically in a loud, harsh voice. It moved about among the canes at a distance of two or three yards from me, and once it ventured within a yard. Soon the mate arrived and added its voice to that of the first. I went away leaving their nest undisturbed.

Young caciques still in company with their parents were only slightly smaller than

adults and greatly resembled them in plumage, which was, however, less glossy. Their yellow bills were of the same color as the adults', but their eyes were dark (brown or black) instead of yellow.

#### SUMMARY

Chisel-billed Caciques frequent cane-brakes, riverside tangles, and the low, dense thickets that spring up on old croplands in humid regions, and they are found even in arid zones where abundant ground water supports suitably dense vegetation. Even fire can scarcely drive them out of their thickets. They live in pairs at all seasons.

They find their food by prying into the folds and crannies in living and dead vegetation. They open stems and the like by inserting the tip of the closed bill and forcibly separating the mandibles.

Mated birds keep in contact amidst the dense vegetation by calling back and forth. The male's beautiful whistle of two notes is answered by the female's long, rattling *churr*.

In El General the breeding season extends from January to at least June. The open nest is placed in low, dense vegetation. Each of two nests contained two eggs.

At one nest only the female incubated. In six hours her sessions averaged 53 minutes, and her recesses 18.6 minutes; she spent 74 per cent of the time on the nest. While sitting she repeatedly uttered her long rattle in response to her mate's mellow whistles.

## MONTEZUMA OROPENDOLA

### *Gymnostinops montezuma*

Of the many families of birds restricted to the Western Hemisphere, none surpasses the Icteridae in variety and interest. In no other family can one find a greater range in breeding habits than that presented by the Bobolinks, which conceal their frail nests at the roots of northern meadow grasses, the oropéndolas which hang their elaborately woven pouches in clusters in the tops of the tallest trees of the tropics, and the cowbirds which build no nests but entrust eggs and young to another's care. And in this family the oropéndolas, of which three species inhabit Central America, are outstanding by reason of their large size and marvellous skill as weavers. The largest of these are the *Montezuma Oropéndolas*, the males of which are the size of a crow. Their striking appearance at once suggests that they are birds of no ordinary attainments. The head, neck and upper chest are black; the remainder of the body and the wings are deep chestnut; and the central tail feathers are brownish-black while the outer ones are bright yellow. The long, sharp bill is orange over its terminal half and is black basally; the horn covering extends up on the forehead as a frontal shield, which on the male is edged with orange along the posterior margin. Each cheek is occupied by a conspicuous oval area of bare skin that is white, faintly tinged with blue. The male wears an additional facial ornament in the form of an elongate warty protuberance of orange-colored skin on either side of his chin. The females are conspicuously smaller than the males, but otherwise they are very similar in appearance.

The *Montezuma Oropéndola* is an almost exclusively Central American species which ranges from southern México to the Canal Zone. Where the continental divide is high and broad, as in Guatemala, it is restricted to the Caribbean slope, but where the barrier is low, as in parts of Costa Rica and Panamá, it spills over to the Pacific side. In northern Costa Rica where the divide is low, this oropéndola is not uncommon on the moister parts of the Pacific slope; but in the southern part of the country, where the Cordillera de Talamanca forms a great barrier between 8000 and 12,000 feet in height, I have not met the bird on the Pacific side, although the forests of the Térraba Valley much resemble those on the Caribbean slope at the same altitude and conditions would seem to be favorable to it. Most abundant at lower altitudes, the oropéndola is occasionally seen in suitable localities as high as 4500 feet above sea level, and very rarely at 5500 feet, at least in Costa Rica. Travelling in large, irregularly straggling flocks or at times singly, the oropéndolas each day cover an extensive area in their search for food, visiting the tree tops of the forest as well as clearings with scattered trees. They are especially fond of banana plantations and of the vegetation along the banks of rivers and lagoons. On the whole they prefer the cleared lands to the forest, and they seem rarely to travel far over heavy, unbroken woodland. Their flight is slow and seems labored, their wing beats regular and measured, like those of a crow. The stiff remiges of the male produce characteristic loud noises as he flies.

#### FOOD

The oropéndolas are largely frugivorous. In the forest they probably eat a considerable variety of soft fruits, but when foraging in the crowns of the great forest trees they are shy and difficult to watch. In the second-growth they eat the hard green fruiting catkins of species of *Cecropia*, and in abandoned plantations they feast on ripe bananas. They suck nectar from the staminate flowers of the banana, clinging head downward



Fig. 44. Male Montezuma Oropéndola in singing posture.

to the knobby rachis of the inflorescence while they insert the sharp orange tips of their bills into the white flowers clustered beneath the fleshy red upturned bract. They lift their heads to let the sweet liquid flow into their throats, as when drinking. They also probe the bright orange blossoms of *Erythrina Poeppigiana*, a tree that is planted abundantly to shade the coffee plantations on the Caribbean slope of Costa Rica.

#### VOICE

Like many other icterids, the Montezuma Oropéndola has an amazingly varied vocabulary. The male sings through most of the year. His song is a long-drawn, far-carrying liquid gurgle, an undulatory sound ascending in pitch. When heard in the distance it is most melodious, but when the performer is nearby his screeching overtones somewhat mar the effect. When delivering this extraordinary utterance, the big bird bows profoundly, bringing his inverted head below the level of his feet and his tail in a forwardly slanting position; at the same time he raises his wings above his back. He seems to be on the point of falling head first from his perch, but with an effort he resumes his normal posture while emitting the closing notes of his refrain. He utters also a variety of harsher notes, one of which sounds like the ripping of strong linen. His cry of alarm is a harsh, stentorian *cack*. The most common utterance of the female is a full, throaty *cluck*, and the male has a similar note. When annoyed, the female complains with an expressive high-pitched whine, and when alarmed for the safety of her offspring she voices a sort of agonized scream. The young in the nest utter high-pitched quavering whines.

## NEST SITE

The Montezuma Oropéndolas nest in communities and usually select as the site of their colony a tall tree standing isolated in a clearing, or one growing on the bank of a river, a little apart from all its neighbors. The preferred nest tree has a tall, clean, erect trunk and a full, spreading crown of many branches. It is most important that the extremities of the boughs do not touch those of neighboring trees or even come very close to them. Such isolated crowns are not often visited by troupes of monkeys or other forest-dwelling mammals, which might work havoc with the eggs and young; and in them the birds need fear only winged enemies and men, who sometimes shoot them for food or out of pure wantonness. The oropéndolas' trees are conspicuous from afar and easily found. They are located with an apparent disregard of the proximity of man and his works, which is surprising because the oropéndolas are ordinarily shy birds. Often the nest tree stands near a railroad. At times a cluster of tall palms is selected to support the nests, which are then attached to the rachises of the fronds well out from the trunk. Seven trees of the pejivalle palm (*Guilielma utilis*), growing close together in a pasture beside the Pejivalle River in Costa Rica, supported a total of 61 nests, the numbers in each palm being, respectively, 1, 3, 4, 6, 7, 18 and 22. In the trees bearing the larger numbers, three or four of the long pouches were in many instances suspended in a cluster from a single frond and hung in contact with each other. Whatever the botanical classification of the nest tree, the oropéndolas' nests are rarely less than 40 feet above the ground and often as high as 100 feet.

## BREEDING SEASON

The nesting season is prolonged and occupies the greater part of the year. In both Panamá and Costa Rica I have found Montezuma Oropéndolas building early in January; and Richmond (1893) states that in Nicaragua they also build early in the same month. In Guatemala I found oropéndolas incubating by the middle of February, which means that here also they had started to build in January. In a colony on the northern coast of Honduras the birds were feeding nestlings as late as September; but by October all the nests seem to be deserted. I have no knowledge of any one colony which was occupied over the long period extending from January to September, and the number of broods reared by a single female is unknown.

## THE FOUNDING OF THE COLONY

Some observations on the initiation of a nesting colony, in which unfortunately the nests were never completed, were made on "Alsacia" plantation in the Motagua Valley of Guatemala in 1932. On a morning at the end of February, while on a hilltop which commanded a view of a broad valley covered with banana plantations, my attention was drawn by a great whining and clucking of oropéndolas arising from somewhere in the distance. Looking downward, I saw a large number of these birds clinging to the outermost twigs of a tall tree with an umbrella-shaped crown that stood alone in the midst of the bananas. Although the tree was half a mile away and several hundred feet below me, I could plainly see the oropéndolas through the binoculars — the flashing of their yellow tails first drew my eye to them. How long these birds remained clinging to the tree and chattering loudly I do not know; but when I reached its foot I found it deserted. I examined it carefully through the glasses but could find no signs of nests.

I kept a careful watch of this tree, expecting that the oropéndolas might return to build in it, for it was the kind of tree that they were likely to choose. For twelve days they showed no further interest in it, but at the end of this period I saw from the hilltop that they had gathered in the tree and were flying to and fro. Riding down, I found



the beginnings of about a dozen nests — the very earliest stages, just a thin wrapping of banana fibers around the twigs. A few of the females flew up trailing fibers while I watched; but work seemed to have been suspended for the day; and one bird which came with a billful of fibers hurried after her companions still carrying her burden.

For the next two days the hen oropéndolas continued to fly into the trees with fibers in their bills, but they did no real work. They acted like children on their first day at school who had brought their copybooks and pencils without knowing what to do with them. They flew around idly trailing the fibers from their bills, perched on the newly wrapped twigs with an absent air, and finally let their material drop, or flew away still carrying it. A male spent much time in the tree, often alone, calling either with or without bowing. He went from one to another of the slender twigs which were suitable sites for nests and, clinging to them, called and bowed profoundly. He seemed to try to encourage the hens to come and build. He made no nuptial demonstrations, at least none addressed to any particular hen. When all the females had left he remained in the tree, calling persistently; but despite all his efforts to hold the colony here the nests never advanced beyond the earliest stages, and the tree was abandoned. I do not know why it should have been deserted after building had actually started, unless because the foliage began at this time to die and fall, soon leaving the limbs bare; yet I hardly doubt that at their first noisy assembly the birds had appraised in their own manner the possibilities of the tree and had decided that it was suitable for their colony.

#### THE COLONY IN THE LANCETILLA VALLEY

My most detailed study of the nesting habits of the oropéndolas was made in the Lancetilla Valley near the Caribbean coast of Honduras. It was late in April, 1930, when I returned to this narrow valley in the foothills and found the oropéndolas well advanced in their nesting in the same tree where they had reared their young the preceding year; for they flock each nesting season to the favored tree, as sea birds congregate from afar to lay their eggs on the same barren islet where they have nested for countless years. The tall, light-barked nest tree towered above an almost impenetrable thicket of low bushes and tangled vines which had taken possession of an abandoned banana grove. Here in May the large-leaved *Cornutia* lifted its great pyramids of lilac flowers. On one side of the narrow strip of thicket ran a well worn path that led to the natives' manacca shacks near the head of the valley, and on the other, beyond a little, grass-choked rivulet, a hillside pasture rose steeply to the west. Its slope offered the best point of vantage from which to view the tree, whose upper boughs were already laden with three-score pendant nests, clustered like great, gourd-like fruits at the extremities of the twigs. One unfamiliar with the habits of tropical birds would hardly have expected to see a big, chestnut-colored bird with a bright yellow tail emerge suddenly from near the stalk of the seeming fruit and fly with measured wing beats toward the steep, forest-covered mountains.

In these nests the incubation of the two white eggs was still in progress, or the young had already hatched and were clamoring to be fed. But a group of twenty-one birds, too eager to build close together, had crowded their twenty-one great nests among the twigs of one slender living bough. Things had apparently gone well with them until many had finished their nests and begun to incubate, when the branch, overladen by its heavy burden, snapped off at a point where it was two inches thick and came crashing down to the brink of the stream. This had happened a week or so before I arrived on the scene; and I found the foliage of the fallen branch already withered and the nests discolored by the dampness. Examination of the contents of these nests furnished no evi-

dence that either parents or young had lost their lives in the crash. This accident gave me an opportunity to study and measure the otherwise inaccessible structures and to watch the birds as they set about to build new nests.

The hens alone undertook the construction of the nests. Throughout the day they worked with tireless industry, although, like most birds, they built most actively in the early morning. The materials employed in weaving were chiefly long, pliant fibers ripped



Fig. 45. Nesting colony of Montezuma Oropéndola in Lancetilla Valley, Honduras, April 28, 1930.

from beneath the midribs of banana leaves; slender green vines with foliage still attached and long, narrow strips of palm leaves were also used. The banana fibers were obtained in a small plantation across the path from the nest tree. Here the females went to gather them in small parties, usually accompanied by a male. I tried several times to watch the birds at this work; but the loud *cack* of alarm of the vigilant male, who stood sentry in a coconut palm or in some other commanding position, sent them hurrying away before I could see as much of the process of stripping the fibers as I desired. Still, through perseverance I discovered how this was done. Standing on the massive midrib of one of the huge leaves, the female, taking advantage of one of the transverse tears made by the wind in the broad blade, bent down and nicked the smooth

lower surface of the midrib with her sharp bill, then pulled off a thin strand, sometimes as much as two feet long, from the fibrous outer layer. Then she doubled her harvest in her bill and returned to the nest, often with one end of the fiber streaming far behind her as she flew. The green midribs of the banana leaves were marked with long, brown streaks where the fibers had been pulled out, and many loose ends of fibers hung down beneath them.

The social urge of the oropéndolas was so strong that they crowded the new nests they were building in two compact groups close together on the same side of the tree, although an entire half of the spreading crown was left unoccupied. They had learned little from their recent calamity. The nests were sometimes attached to a slender, unbranched twig, but more frequently to a crotch, and sometimes to three branchlets which arose close together near the end of a bough. The twigs used for attachment had about the thickness of a lead pencil. They were always at the outside of the tree, never among the branches in the interior of the crown. Thus the nests were more easily reached by the oropéndolas and at the same time were less accessible to any climbing animal.

The first step in nest building was the formation of the anchorage, which was accomplished by wrapping many fibers around the arms of the crotch, or around the single twig if this had been chosen for the support. The length of twig wrapped varied from eight to sixteen inches. The oropéndolas worked just as a man would if permitted to use only one hand in such a task, pushing the fibers under the twig and pulling them over, intertwining and knotting them carefully. The second step consisted in the formation of a loop, which was the real starting point of the pouch. As the mass of fibers encircling the arms of the crotch became thicker, the bird stretched strands across the space between them. When this weft had become sufficiently strong, on returning to work at her nest the female rested on these fibers instead of grasping the twigs themselves with her feet. Thus the strands were gradually forced downward, and as more fibers were stretched from arm to arm a pocket rather than a loop was formed. Then the bird gradually pushed apart the material in the center of the pocket and converted it into a sort of loop, which would later serve as the entrance to her nest.

I was especially interested in one hen (her nest was number 17 on my chart of the colony) who began her nest on a straight horizontal twig. After she had twisted a thick covering of fibers around this support, she perched upon it and, bending down her head, tried to push it between the fibers and the lower side of the twig. Then she hung in the strands below the twig, attempting to force her way through. It was a strenuous struggle, and after a little while she flew off for a rest. On returning, she again perched above the twig, bent down her neck and pushed her head into the mass of fibers, then gradually swung down and pivoted around into the loop she was trying to form and into which she forced her way with considerable difficulty. After she had done this several times the loop became large enough for her to enter it directly as she returned with fibers, but always it was a tight squeeze. Her somewhat violent methods had gradually torn one end of the loop until it was attached to the support by only a few strands. For a week this bird struggled along, sometimes able to enter her loop and sometimes not, for it was constantly on the point of breaking away at that end. But she never lost interest and at length, by adding many banana fibers, she managed to strengthen her work sufficiently and thenceforth had no difficulty in completing her nest.

After the oropéndola had fashioned the loop, she always stood in it as she worked, invariably facing the center of the tree. As she wove more fibers into the lower side of the loop, it gradually lengthened into a sleeve, in which she hung head downward, her yellow tail projecting from the upper end and her head from the nether, as she inter-

twined the fibers at the lower margin. Soon the sleeve became so long that the bird was completely engulfed in it. Then only her orange-tipped bill could be seen as at intervals she pushed or pulled a fiber through the close-meshed network of the fabric, or her head showed as it projected from the bottom. One might imagine that at this stage, when the nest was open at both ends, the oropéndola would have found it easier to emerge through the lower end, since she was already headed that way; but on the contrary she invariably climbed out at the top, as she had entered. Thus the loop remained the entrance of the nest. When her structure had become sufficiently long the bird wove in the rounded bottom, and thus completed the first stage of her labors.

The construction of the nests did not proceed without frequent discord on the part of the laboring hens. The most serious of these arose over the choice of the nest sites. Two birds often began their nests so close together that they were in each other's way as they worked, and they paused to express their annoyance in loud, high-pitched, irritated voices, like children who interfere with each other at their play. Sometimes, completely losing temper, each menaced the other with open bill. Then, meeting face to face in the air, they went fluttering downward until their proximity to the foliage below warned them that it was time to cease their dispute; then they separated and flew up to continue their weaving side by side.

But what surprised me most in these generally orderly, industrious birds was the frequency with which they stole building material from their neighbors. A bird who was weaving could hardly resist the temptation to steal a fiber which hung loosely from the unfinished nest of another and incorporate it into her own. Sometimes, when the upper end of such a fiber was attached more firmly than she reckoned, the would-be thief, grasping it in her bill, hung with half-opened wings beneath the nest until the coveted strand gave way, or until the owner returned to drive her off. Sometimes an oropéndola discovered that the fiber she desired to take from a certain nest was too firmly attached to be torn away and then went straightway to another to attempt robbery there. In the end, I believe that this habit of thievery must be of a certain benefit to the colony, since it discourages careless construction. It is not easy to pull out a fiber which has been well woven into the fabric of the pouch. Those birds which build most carefully and leave fewest loose ends are not often molested by their pilfering neighbors, and they finish the stronger nests.

One morning, when the female of nest number 22 was away gathering material, another hen came up to her unguarded nest, which was then in the loop stage, and tore at it vigorously, pulling apart the fibers and destroying the neat appearance of the work. The loose ends left by the first thief attracted others, who made repeated visits and continued the undoing of the structure until the loop was nearly torn apart at the bottom, where it hung together by only a few strands. The builder's efforts to repair the damage were neither very intelligent nor very successful. While working she grasped each arm of the loop with a foot and straddled the gap, in what appeared to be a most uncomfortable position. She continued to knot fibers along the sides of the loop without at first succeeding in closing up the bottom; and in the course of her difficulties her neighbors persisted in stealing from her. For two days the loop lengthened without becoming sound; but finally the oropéndola succeeded in bridging the gap and completed a serviceable nest, which differed from the others chiefly in the possession of a larger entrance.

Watching the efforts of this bird, and of the other which experienced so much difficulty in forming her loop on a straight twig, convinced me that oropéndolas, skillful artisans though they are, are deficient in mechanical sense. Both of these hens had sufficient skill in weaving to have repaired their nests promptly, but they failed to grasp at

once what needed to be done. A few strands carried across the gap and knotted at either side, by knots which the birds knew well enough how to tie, would have solved their difficulties inside of an hour; but they blundered along for several days before they managed to mend the breaks.

The robberies did not end with the oropéndolas' pulling loose material from the nests; the birds often snatched fibers from another's bill. Sometimes, returning with long fibers trailing behind her, a hen paused for a short rest on a perch near her nest before she proceeded to weave the new material into it. On seeing these banana fibers hanging from her neighbor's bill, a second bird, perhaps just preparing to go afield for more material for her nest, would change her plan and grasp one dangling extremity, then hang on with nearly closed wings, doing her best to pull away the strand. The utterance of a single sound of protest would have been disastrous to the rightful owner; for to have opened her mouth would have resulted in the loss of the material. Again, two birds perching side by side on a bough would engage in a tug-of-war over a billful of fibers, and in the end perhaps unwillingly divide the spoils. Hens who had fibers pulled from their nests or their bills usually took their loss without show of emotion; if fights arose from this cause they were less frequent and less protracted than those over the nest sites. But on the whole the oropéndolas were too industrious to waste much time either in pilfering or in quarreling, and weaving proceeded apace.

The female oropéndolas outnumbered the bigger males by several to one. At the nest tree the males gave no indication of being mated to particular hens or groups of hens; they were ignored by the latter and mostly ignored them. While the hens were building, the males accompanied them on expeditions for foraging or collecting fibers, and at other times they strutted around on the branches of the nest tree with heads held high and pompous gait. Although they were idle, they never quarreled among themselves. The only disputes in the community were those in which the hens engaged over nest sites or building material. Sometimes one male dashed at another; but the latter usually retreated at once and thereby avoided a fight, since the pursuer was always quick to forget whatever cause of enmity he might have had.

At intervals the male oropéndolas delivered their far-carrying calls. Bowing profoundly, until the raised tail stood directly above the inverted head, lifting the spread wings above the back and fluffing all the body feathers, they uttered, or seemed rather to eject with heart-rending effort, an indescribable liquid gurgle. Heard from afar there is no sound, save possibly the ventriloquial call of the Short-billed Pigeon or the melodious wail of the Great Tinamou, which is to me more expressive of the wonder of the tropical lowlands; but close at hand the effect is marred by screeching overtones, as though the machinery which produces this inimitable song was badly in need of lubrication. The male oropéndolas did not worry the hens while they were building in the way the male Boat-tailed Grackles did; and their bows and gurgles were not addressed to individual hens so much as to the world at large.

The males were the watchmen of the flock. At the approach of danger, real or fancied, and not infrequently when there was no evident cause of alarm, they uttered a sharp, harsh *cack* which sometimes sent the whole flock dashing headlong into the nearest sheltering thicket; but at other times this was ignored by most of the community. The approach of a man was generally greeted by a few such *cacks* of alarm; but if the colony had not been persecuted, few or none of the building hens heeded the warning; and thenceforth the man might stand quietly in full view and watch all the activities of the colony without causing the least unrest. One or more male oropéndolas usually accompanied each party which left the nest tree to forage or procure building materials, and

it was extremely difficult to elude the keen eyes of these sentries. The birds were as shy away from the nest tree as they were bold and confident among its boughs; and when they were encountered afield the male's shout of alarm invariably sent them into instantaneous retreat.

Such was the patient application of the hen oropéndolas that their great hanging pouches, which measured from two to four feet in length and from seven to nine inches



Fig. 46. Detail of portion of nesting colony of Montezuma Oropéndola shown in figure 45.

in diameter near the bottom, were completed in an average time of ten days. One bird, who seemed to be in a particular hurry, finished her nest in only seven or eight days, but hers was considerably shorter than the others. The hen who had so much trouble in starting her loop on the unbranched twig finished last of all and took seventeen days in her work; while number 22, who was so greatly harassed by her thieving neighbors, required fifteen days to bring hers to completion. Most of the weavers took from nine to eleven days. Perhaps the quick time made by these oropéndolas is to be ascribed to the fact that they had lost their first nests and were building again; for with most birds replacement nests go faster than first nests of the season. Chapman (1929:97) found

that the Wagler Oropéndolas took three or four weeks to weave their pouches, which as a rule are shorter than those of the Montezuma Oropéndola; but he watched the construction of their first nests of the season.

Sometimes two Montezuma Oropéndolas, building side by side, wove opposite ends of the same fiber into their nests. In other instances two nests hung in contact and were sewn together by the birds' weaving their fibers through the thickness of both walls. At



Fig. 47. Fallen nests of Montezuma Oropéndola from colony at Lancetilla.

times this eventually served one or the other in good stead; for not infrequently a nest was torn from its support by the weight of its occupants, and its attachment to the other nest alone prevented its fall. Once I saw a nest which held nestlings break from its anchorage and hang for a week precariously attached by a few fibers to a contiguous nest, which sustained it until the young were ready to depart. Nests closely attached to others were sometimes unusually long. One such nest, picked up from the ground, measured  $6\frac{1}{2}$  feet in length. The part in contact with the adjoining nest was open rather than tubular and was sewed to the outside of the other throughout its length; the pouch-like portion of this very long nest began at the level of the bottom of the other and hung entirely below it. Exactly how contact with another nest should cause the structure to grow in this abnormal fashion I do not understand.

Fully to appreciate the beauty of the oropéndola's workmanship, one must cut open a fallen nest and spread it to the light. It forms a regular, even fabric, with meshes sufficiently wide to admit air to the brooding female and the nestlings, yet strong and durable.

After the basket work was finished, the hens absented themselves for a day or two, during which courtship and mating probably took place off in the forest. Then they returned and labored assiduously for from three to six days longer, plucking dying or dead leaves from trees growing at a distance, tearing them between foot and bill into pieces an inch or two in length, and carrying them into the pouch. These formed a thick but loose and yielding litter in which the eggs rested and which probably served to prevent their rolling together and breaking when a strong wind rocked the swinging nest. Sometimes at first a bird brought fibers and leaves alternately, as though she had started to line the nest before she had quite finished the weaving. Even during the course of incubation, or while the nest contained young, a hen occasionally took pieces of leaf into it, or more rarely a fiber.

After the completion of the new nests the colony contained a total of 88, but not all were occupied.

#### THE EGGS

At the end of April I examined twenty of the nests which had fallen not long before, at the colony in the Lancetilla Valley. Fourteen of these nests contained eggs or fragments of shells; the other six were without traces of eggs or nestlings. One nest held two whole eggs; four nests had each one whole egg and fragments of the shell of a second. Another nest contained fragments of certainly two eggs. Thus in six of the nests there had evidently been two eggs. Three more held each a single egg with no pieces of shell; but possibly in these the bird had not finished laying before the bough fell. In five more the eggs had been so badly broken that it was impossible to decide how many there had been. The eggs were strongly ovate in form and white or buffy in color. The measurements of three were 39.7 by 26.2, 36.5 by 23.8, and 38.1 by 23.0 millimeters.

#### RELATIONS WITH THE GIANT COWBIRDS

A bustling activity prevailed in the tall nest tree in the Lancetilla Valley at the height of the breeding season, with hens hurrying back and forth with food or fibers in their bills, or clucking as they paused to rest in its branches. Their not infrequent quarrels and high-pitched remonstrances, the males strutting along the boughs or flying with noisy wing-beats from one to another and delivering their frequently repeated liquid calls, the whining cries of the nestlings in their swinging cradles, and the voices and movements of visiting birds of many kinds which flew into the nest tree to rest or hunt for insects, created continual commotion.

This throbbing activity was augmented by the disturbances created by the lurking Giant Cowbirds. So long as any nests remained in which incubation had not yet begun, the big, black female cowbirds continued to haunt the nest tree. Of all birds, save of course dangerous raptors, their presence alone was resented by the oropéndolas. Continually chased by first one and then another of the larger yellow-tails, the cowbirds circled around and returned with undaunted persistency, entirely unabashed either by the repeated rebuffs. By skulking most of the day in the nest tree and repeatedly looking down into the openings of the nests, they apparently kept themselves well informed as to the condition of each, and at the proper time they tried to slip in and lay their eggs. Sometimes they miscalculated the hour of their visit and attempted to enter a nest while the oropéndola was at home; but they beat a hurried retreat when the irate owner came



out as though to demand an explanation of the intrusion. Time and again they were driven away at the very point of entering a nest; but never despairing, one would finally manage to elude many watchful eyes and slip into a nest, where apparently she left an egg to be incubated by the female oropéndola.

The Giant Cowbird who lays in an oropéndola's nest meets far more opposition than the parasitic birds of other species which lay their eggs in the nests of small birds which breed in isolated pairs. The Giant Cowbird that finally succeeds in laying in an oropéndola's nest must not only dodge the watchful oropéndoas of both sexes but sometimes she must also outwit jealous rivals of her own species, each eager to drop her own eggs into the newly finished nest and ready to drive away another cowbird who attempts to get ahead of her. It costs the cowbirds so much effort to foist their eggs on the oropéndoas that I suspect that it would involve very little more labor for them to build some simple nest and rear their own young.

Had the oropéndoas made a concerted attack upon these unbidden guests, they might have driven them permanently from the nest tree; but they are mild-mannered birds and seemed to be content merely to prevent the entry of the cowbirds into their nests. They rarely carried the pursuit of a cowbird for more than five or ten yards from the doorway of a nest and never farther than the next tree. Long-suffering as they were, they were not always deceived by the foreign eggs in their nests. Early one morning toward the end of May, several cowbirds flew into the nest tree and were unusually persistent in trying to enter some of the nests in the group most recently completed. Several times one was on the point of slipping into a nest in which the owner was sitting, but always the latter hurried out and began with great spirit to pursue the black intruder, who fled uttering harsh, nasal whistles. Soon there were several cowbirds chased by as many oropéndoas, and all was confusion in that part of the tree. Apparently one of the cowbirds took advantage of the disturbance to enter a nest and leave an egg within. What I actually saw, a few minutes later, was an oropéndola emerge from one of these nests with something white in her bill. Flying to a higher branch, she dropped what she held. With a loud *plunk* it struck the leaf of a banana plant growing in the thicket beneath the nest tree, rolled off, and came to rest on the dead leaves that carpeted the ground. When I picked up the egg it was unbroken by its eighty-foot fall and still warm. It was white with a tinge of blue, and marked with a few scattered, inconspicuous scratches of brown. Fortunately for the continued existence of the cowbirds, other oropéndoas are more easily deceived than this particular hen, and sometimes, as I have seen, they rear the offspring of the Giant Cowbird.

#### DAILY EVENTS IN THE COLONY

Once incubation had begun, I could only surmise how things were proceeding inside the closely woven nest pouches. Often an idle male oropéndola flew with sonorous wing beats to the side of a nest, upon which he pounced heavily. One seeing him do this for the first time might fear that he had torn it, especially since at the moment of his making contact with the pouch there would be heard a sound that suggested the ripping of strong linen. This, however, is a vocal utterance which may often be heard from males at a distance from the nest tree. Clinging head downward to the side of the nest, the big bird would lift his wings above his back and deliver his liquid gurgle, while the hen brooding within answered with a high-pitched whine, in which she was sometimes joined by the entire group of birds whose nests had been jarred by his boisterous behavior.

One day a mica (*Spilotes pullatus*), a thick black-and-yellow snake fully six feet long, climbed up the tangled mass of vines that reached half-way up the bole of the tall

nest tree in the Lancetilla Valley. When the snake had reached the top of the vines it was spied by a pair of Kiskadee Flycatchers, whose nestlings reposed in a domed nest in the crotch of another tree fully thirty feet away. These bold birds could not tolerate an enemy of such formidable proportions so close to their offspring. They darted toward the head of the snake, often dashing by hardly an inch from its nose, and voicing an angry *eee* when closest to it. A hen oropéndola came down to these lower levels to see what the excitement was about, but did not join in the attack on the snake; and two inquisitive cowbirds perched dangerously close to the reptile. A few courageous lunges by the Kiskadees stopped the advance of their enemy, which turned and went slowly downward among the vines; but until it had disappeared into the rank vegetation near the ground the flycatchers continued their threats. I believe that even without the activities of the Kiskadees, the length of clean trunk between the top of the embracing vine and the lowest branch of the oropéndolas' nest tree would have been a barrier that the mica could not surmount.

The ever-active hen oropéndolas continued their daily tasks even after the sun had sunk behind the western mountain rim. As dusk fell over the quiet valley, they wove a last strand into an unfinished nest, or carried a final mouthful of food to waiting nestlings. Others sat among the high boughs of the nest trees, enjoying the refreshing cool of evening, the hens clucking in contented tones, the males often bowing as they uttered their stirring songs. Then, in little groups of several together, the males, and those hens who had neither eggs to incubate nor young to brood, flew off toward the north, whence floated the calls, mellowed by distance, of those males which had gone before. Finally, as the tree-frogs began their shrilling and the loud *kweahreo* of the Pauraque announced the end of the day, the last lone male oropéndola jumped heavily to the side of a nest, sang loudly while making his deep bow, then flew with resounding wing beats to overtake his companions. Meanwhile the remaining hens retired one by one to cover their eggs or nestlings in the swinging pouches. The older nestlings slept alone until their mother returned with food at dawn; and every oropéndola which remained in the tree was within a nest.

When I first arrived at Lancetilla, the oropéndolas roosted in the double row of tall bamboos which shaded one of the walks on the plantation, half a mile from their nest tree. Here they were joined by numbers of the smaller Wagler Oropéndola, whose liquid *plunk* mingled with the longer-drawn and more melodious calls of the male Montezuma Oropéndolas, and by Gray's Thrushes, which contributed their staccato *tock tock tock* to the general hubbub. At their roost the oropéndolas are shy and apparently for no other reason than because I had stood in the pathway to watch them go to roost, they shifted their sleeping quarters to a larger bamboo thicket somewhat nearer their nests. Finally, not feeling secure here, they selected a site on a distant hillside about two miles from their nest tree. Thither they flew in successive flocks late in the evening, and they returned to their nest tree at break of day, flying up the valley with wing-beats as regular as a crow's, and appearing as black in the dimness of the early dawn. The mothers of nestlings stopped on the way to find food for them and arrived at the nest with the first installment of breakfast in their bills.

#### THE YOUNG

How long a female oropéndola incubated her eggs it was impossible to tell, but the period was probably around two weeks. Finally there came a day when a female was seen returning to her nest bearing fruit that she had gathered in some distant tree; and I knew that the nestlings had hatched. Soon their quavering nasal whines were sufficient

indication of what the nest held. This was a busy time for the female oropéndola; for as she had built her nest and incubated her eggs alone, so she must feed her nestlings unaided by the males; and the food must often be procured at a great distance. These big birds, nesting in populous colonies, can not expect to find sufficient food within a stone's throw of the nest, in the manner of smaller birds that nest alone. Returning with food in her bill, the hen flew directly toward the entrance of the nest and when almost there folded her wings and glided deftly in, never pausing until the pouch had swallowed up her form. She was instinctively aware that to delay with her head inside the doorway would needlessly expose her to the attack of an enemy whose approach she could not see. Coming out was a different matter; and often she lingered with the lower half of her body still inside the nest while she surveyed the outer world before launching forth.

By noting how long an oropéndola continued to carry food into a nest, I was able to learn the approximate length of the nestling period. The nestlings remained in their lofty cradles about thirty days, a period unusually long for a passerine bird. By the time they were ready to take wing, the nests showed many signs of their long use. Newly completed nests were more nearly cylindrical than the old ones, which became strongly pyriform in shape as a result of the continued weight in the bottom. The hen's innumerable passages through the entrance often tore it downward until it extended far along one side of the pouch. Before the occupants were ready to leave, several of the nests hung precariously by only a few strands and swung dizzily as the hens went in and out in feeding the young. The oropéndolas made no attempt to strengthen these inadequately attached nests, as they might well have done by lacing the attachment with additional fibers. The males quite failed to understand the delicacy of the situation, for they continued to jump on these damaged nests, just as they did on the sound ones, to deliver their songs while hanging head downward. The repeated impacts of the heavy birds endangered the nestlings and hastened their fall. The males often cocked their heads and with evident interest peered down into the pouches which sheltered nestlings; but they never entered; and it never seemed to occur to them that the youngsters might be fed.

Early one misty morning toward the end of May, I found the hens flying about the nest tree, clucking earnestly, as I think now, to coax from its nest a fledgling which was ready to leave. Presently I saw one of the nests bow down at short intervals, as though something fairly heavy were moving upward inside by intermittent advances. The pale head of a young oropéndola at length appeared in the doorway. The youngster was perhaps startled by its first view of the world outside, for here it paused a few moments, as though uncertain of its next move. The mother, who had been circling around the tree, now made a turn close before the nest, clucking as though to encourage the fledgling, which now flew boldly forth. Without even touching the branches of the nest tree, it followed her across the rivulet to a small tree on the hillside to the west, completing a flight of about 200 feet on a slightly descending course — not a bad achievement for a young bird which had never before been able to spread its wings to their full extent! Several other hens, who had followed the youngster on its first flight, joined the mother in driving away a Brown Jay which had come into the tree where it perched. After feeding the fledgling here, the mother coaxed it still farther from the nest tree; her every effort seemed to be directed toward leading it to a distance from the colony.

Another newly emerged fledgling, whose mother was also feeding a nest mate which still remained in the pouch, delayed among the nests for at least two hours, but by the end of the morning it had vanished. It was most exceptional to see an exposed fledgling in or even near the colony; and most must have been led away as soon as they came out

of the nest, like the one whose departure I witnessed. The nest tree was too conspicuous and widely known in the neighborhood for the young to remain there with safety after they had left the protection of the pouch. Even the adults would not pass the night in so exposed a situation.

The last young bird to leave its nest that year was apparently, to judge by its size, a male. For a full month I had watched his mother bring food to the pouch. Evidently his development had been somehow retarded; for when at length he emerged he could not fly like the youngster whose departure I had witnessed earlier, but fluttered down



Fig. 48. Young male Montezuma Oropéndola just after leaving nest; Lancetilla, Honduras, June 29, 1930.

into the thicket beneath the nest tree, where despite his ineffectual attempt to flap away I captured him without much difficulty. When I was about to pick him up he beat his wings frantically and squawked madly, while the mother and a half dozen other oropéndolas flew around above us in the greatest excitement. When at last the young oropéndola was in hand I offered him a finger for a perch; his long toes closed on it with such an iron grip that I winced.

Never have I had such an escort of birds as that which followed us back to the house. The one which seemed to be my captive's mother led, flying along from tree to tree and keeping very close to us, clucking with all her might and uttering a kind of scream that I had not previously heard. When we reached the house the other oropéndolas dropped back; but the mother remained with us and perched high in a neighboring tree, holding some orange-colored fruit in her bill, while we took some photographs of her captive

young. Then we put him for safe-keeping on the screened porch of the building while we developed the pictures. All this while the mother flew around the house in great circles, answering the calls of the juvenile. Finally, we returned the impatient fledgling to the spot whence I had taken him a few hours earlier. Here his mother found him again and in this same thicket she attended him during the next three days, after which he disappeared.

Upon leaving the nest the young oropéndolas bear a close resemblance to their parents in plumage. The brown of the body is of a duller shade, but they have the same bright yellow outer tail feathers. They are considerably smaller than the adults; the youngster which I captured measured only about 14 inches in length, whereas skins of adult males average about 19 inches. His bill was orange only at the extreme tip, this color thence gradually merging into the black which covered the major portion. His iris was very dark brown. The bare skin on the face, and the forehead, were an extremely pale pink. The swollen, bean-shaped area of bare orange skin, present in the adult male on either side of the throat, was lacking on the juvenal bird. A newly emerged fledgling viewed through binoculars in the tree top was so much smaller than its mother that I took it for a female. Its bill, so far as could be seen, was entirely black or blackish; but the bare areas on the cheeks were conspicuous.

Although many small oscine birds may build, lay, incubate and rear their young to the age of leaving the nest in about a month, the nesting operations of the large oropéndolas require about double this period. The interval from the beginning of building to the departure of the fledglings varied from 53 to 61, and in a single instance 68 days; but in the case of the periods as short as 53 days, I am not certain that the young were successfully reared.

After the departure of the last young oropéndola, the colony in the tree top stood like a deserted village. Already some of the nests earliest built had fallen through age and decay. Although it was only the end of June, eight or ten of the newly completed nests were abandoned before I saw any food for nestlings carried into them. The young in some of the neighboring nests had fallen victims to some undetermined predator, and perhaps this marauder, whatever it was, stole the eggs from these. A number of fallen nests picked up beneath another nest tree in the same region each had a hole from one to three inches in diameter in the wall near the bottom; these openings, of unknown origin, had been made by both cutting and forcing apart the fibers. Meanwhile the successfully fledged young of the year followed the adults of both sexes up and down the valley, in flocks consisting usually of less than a dozen individuals; and they continued to be fed by their mothers for many weeks after leaving the nest. Young males were given food by mothers far smaller than themselves.

#### MISCELLANEOUS OBSERVATIONS

In January of the following year the oropéndolas, both the Montezuma and Wagler, had returned to roost in large numbers in the bamboo grove where I had found them the preceding April. Beside the bamboos was a row of flame-of-the-forest trees (*Spathodea campanulata*), a rapidly growing species introduced from Africa because of the beauty of its great, orange-red, trumpet-shaped blossoms. Before retiring to rest, the oropéndolas would perch beside the flowers and dip their bills into the upturned cups, then hold up their heads to let the drops run back, clearly drinking the rain-water which had collected there. Once I saw a Wagler Oropéndola drink from the great white chalices of the balsa tree in the same manner. Sometimes, when rain had not recently fallen, there was no water in the opened corollas of the flame-of-the-forest trees; but the birds knew

a source which they then put to good account. The unopened calyx of this flower, as big as the bud of a magnolia when it swells in the early spring, forms a tightly closed vessel which is filled with a liquid secreted by glands on its inner surface. Bathed in this turbid water, and by it apparently protected from the attacks of insects and their larvae, the crumpled corolla and all the inner organs of the flower complete their development, until they are full grown and escape through a cleft along the lower side of the calyx. The oropéndolas tore apart these water-filled buds and drank from them; but how they could enjoy this liquid whose taste was so disagreeable to me, I failed to understand.

The male oropéndola's interest in the nests continues after the close of the breeding season. Long after the last fledgling has flown from the nest tree, the males return from time to time to its crown and examine the deserted nests, perching above the doorway and peering down into the pouch, as they do while there are young within. At other times they jump to the side of the nest, make the peculiar sound as of ripping cloth as they alight, and hang head downward to deliver their song. During the late months of the year, the hens usually associate in flocks; but often one sees a lone male perch at the top of some lofty tree and, scarcely bowing, pour forth his liquid, stirring call.

#### SUMMARY

Montezuma Oropéndolas range from the Caribbean coast of Central America up to 4500 feet altitude, or in Costa Rica very rarely to 5500 feet. Where the continental divide is low they spill over to the wetter regions of the Pacific slope. They wander about in large, irregularly straggling flocks, which each day cover an extensive area in their search for food.

The oropéndolas forage in the crowns of trees in the primary forest, where they seem to eat a great variety of soft fruits; but much of their nourishment is found in cultivated country with scattered trees. In banana plantations they feast on ripe fruit and drink nectar from the staminate flowers. In coffee plantations the shade trees, especially *Erythrina*, supply nectar and other food.

The notes are amazingly varied. The song of the male, a long-drawn, far-carrying, liquid gurgle, is delivered as he bows forward into an inverted position, raising his wings above his back.

In various parts of the Caribbean littoral, breeding continues from January to at least September. Oropéndolas nest socially, by preference in a great tree with a long, clean trunk and an ample crown isolated from other trees. When tall palm trees are used, the nests are attached to the fronds; and a number of palms standing close together may support the colony. The great, woven pouches are not distributed evenly over the crown of the nest tree but are often crowded in clusters so compact that contiguous nests are sewn together in the course of construction. A populous colony may contain nearly a hundred nests.

In these colonies there are several females to each male. The latter, which are much bigger than the females, do not seem to be attached to particular females or groups of them. All the work of building, incubation, and feeding the young is performed by the females, with no help from the males. These, however, serve as watchmen for the community, sounding a strident note of alarm when danger seems to threaten. This note usually sends the birds diving into lower vegetation. The males accompany groups of females on long expeditions to gather building material or food.

The idle males were never seen to quarrel among themselves. When one dashed at another, the second nearly always retreated and avoided a fight. The males did not worry the building females, and all the intimate relations between the sexes seemed to take place at a distance from the colony.

The females, weaving their nests close together, complained and quarreled when they got in each other's way, but they never engaged in serious fights. Frequently one stole loose material from another's nest or even tried to pull it from her bill. Such thieving greatly impeded the less skillful builders, but perhaps profited the colony by discouraging careless work.

The hanging pouches, woven of slender vines and fibrous strips from palm or banana leaves, were usually from 2 to 4 feet in length, but in exceptional cases were  $6\frac{1}{2}$  feet long. Replacement nests were woven in from 7 to 17 days, but the usual time was only 9 to 11 days.

After the weaving was finished, the females remained away from the nests for a day or two, during which courtship and mating probably took place at a distance from the colony. Then they returned and devoted from three to six days to carrying fragments of dead or dying leaves into the pouch. This litter of loose material probably served to keep the eggs from knocking together and breaking when a strong wind swung the nests. Occasionally a female brought additional leaves while she incubated, or even while she attended nestlings.

In fallen nests the maximum number of eggs was two, which seems to constitute the full set.

The colonies are parasitized by Giant Cowbirds, which lay in the oropéndolas' nests. The latter chase cowbirds that seem on the point of entering the pouches but make no concerted effort to drive them from the colony. One female oropéndola was seen to throw a cowbird's egg from her nest. Harmless birds of many kinds are permitted to rest freely in the midst of the colony.

By night the nest tree is tenanted only by those females that are engaged in incubating eggs or brooding nestlings, so that every oropéndola in the tree is inside a pouch. Other members of the community roost together at a considerable distance, sometimes in a clump of giant bamboos.

The young are fed in the nest by the female for about 30 days. Much of the food is brought from a long distance. In this long period of occupancy, many of the nests are damaged by the female's repeated passage through the doorway. Although some hang precariously and others fall, no attempt is made to repair them—an operation for which the bird has the skill, but not the insight, to perform.

Two months or a little more elapse from the beginning of nest building to the emergence of the nestlings. The young, which resemble the adults in plumage, are fed by the females as they wander about in small flocks.

## YELLOW-RUMPED CACIQUE

### *Cacicus cela*

The Yellow-rumped Cacique is a species widespread in the lowlands of northern South America on both sides of the Andes. In Central America it is found only in eastern Panamá as far west as the Canal Zone, where it is represented by the race *Cacicus cela vitellinus*, which occurs also in northern Colombia. The male is a fairly large bird whose black plumage is brightened with clear yellow on the lower back, rump, upper and under tail-coverts, and also on the wing-coverts in small patches readily visible only when the wings are spread in flight. His fairly long, sharp bill is light lemon yellow, his eyes beautiful bright azure, and his feet black. The female is considerably smaller than the male, measuring about nine inches in total length, whereas the male's length is about eleven inches. Although her plumage is similar to that of the male, the black is less glossy, and on some individuals that apparently are mature it is slightly tinged with brown. Her eyes are not so bright a blue as in the male, and in some females that build nests they are brown, evidently a remaining sign of immaturity. The sexes may also be distinguished by the sound of their wings while flying. The wing beats of the males are resonant like those of the males of so many of the Icteridae; the flight of the smaller females is almost silent.

The Yellow-rumped Caciques are gregarious, travelling in loose flocks like the oropéndolas. They frequent the tops of the tall forest trees as well as adjacent clearings, and they are often seen along rivers and lagoons. Apparently they subsist principally on fruits, but more information about their dietary habits is needed.

#### VOICE

As a musician the male cacique is in a class by himself; I know no other songster to compare with him. There is a certain bright, shining quality in his voice that remains in the memory for years after one has last heard it. In its liquid character the cacique's music resembles that of the oropéndola's, but he has a marvellous variety of songs, whereas the oropéndola uses scarcely more than one. Some of the cacique's utterances are beautiful outpourings of fluid melody, others are merely amusing in their quaint phraseology. Most other songsters of the excellence of the cacique sing alone; no other colonial-nester that I know can compare with him as a musician; and to hear so many superb vocalists performing in the same tree makes watching a colony of Yellow-rumped Caciques an altogether unique experience.

I tried to paraphrase some of the caciques' songs and calls, but I fear that our alphabet is not equal to the task of conveying what they are like. Yet my crude transliterations may serve to give a notion of the variety if not the beauty of the birds' utterances, and with this apology I present some of them here: *Chee cha chu chu*—a series of full liquid notes descending in pitch, perhaps the bird's masterpiece; *Key a woo woo a woo*; *Key what*; *A woo woo*; *Kee-ee*; *Key ye yu*.

As the caciques deliver their liquid notes, they bow slightly forward, relax and vibrate their wings, shake their tails and raise the bright yellow feathers of back and rump, all of which makes them more conspicuous. The forward bow is only a faint suggestion of the deep bow of the Montezuma Oropéndola. Like the oropéndolas, the caciques like to sing while clinging to the sides of the pouch-like nests.

Although I hold full admiration for the cacique's vocal powers. I must admit that there is a degree of justice in the appraisal of Chapman (1929:273-274): "It is difficult



to know just what place to accord Lawrence's Cacique in our list of Barro Colorado's song-birds. In his own field he is unquestionably a master, and if we add that his type of bird-song bears the same relation to the pure, chaste notes of the Tinamous that jazz does to Bach or Beethoven, we will accord him full credit. That he has ability no one will deny, but to my mind he is a self-conscious, musical poseur more intent on exhibiting himself and his technique than in giving expression to genuine emotion. There is infinite variety in his high-pitched notes and liquid, gurgling phrases. . . . I should enjoy the performance of the Cacique more if there were an obvious reason for it, and if he were somewhat less voluble. I resent his assumption that, when in a colony of

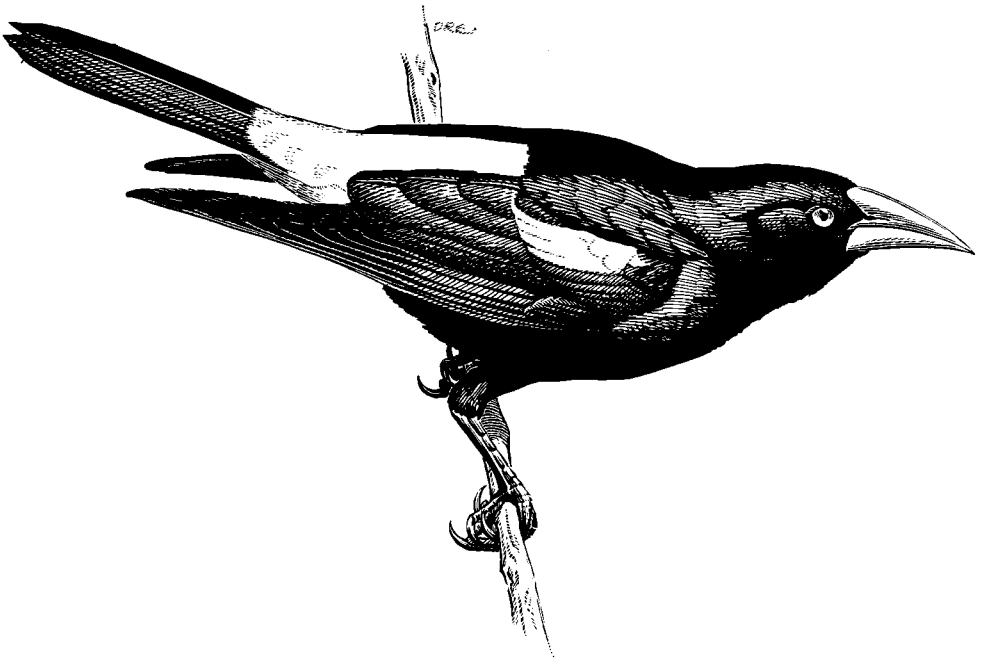


Fig. 49. Male Yellow-rumped Cacique.

Oropéndolas, the center of the stage belongs to him." Elsewhere (1928:161), Chapman states that throughout the nesting season, as he observed it, usually one male cacique was present in the colony of Wagler Oropéndolas on Barro Colorado Island, acting as though it were a member of the community. Arriving at dawn, this cacique or another might pass the greater part of the day in the nest tree, and it would sing at times for an hour or more without ceasing. Since no other individual of its own species was present, and the oropéndolas paid no attention to it, such behavior by the cacique seemed inexplicable; but perhaps it acquires significance when considered in relation to the observation of Sturgis, cited below, that these caciques and the Wagler Oropéndolas sometimes nest in the same tree.

The vocabulary of the female cacique is far more limited than that of the male. I have heard her give only single liquid *cherps* and also *clucks* similar to those of the female Montezuma Oropéndola. These latter are also uttered by the male cacique.

## NEST BUILDING

In Panamá, the breeding season of the Yellow-rumped Cacique extends from January (Sturgis, 1928:427) until at least May or June. Mrs. Sturgis found it nesting along the Chilibri River in the same tree with the Wagler Oropéndola, but its shorter nests were usually grouped together. The single colony that I have seen was found in the Canal



Fig. 50. Colony of Yellow-rumped Cacique in cove of Barro Colorado Island, Panamá, May, 1935. A male occupies the coveted position at the top of the stub.

Zone on April 21, 1935, when the birds were building, some having just started their nests. No oropéndolas had nests in this community.

Near the end of a long, narrow arm of Gatún Lake, reaching far inward between two of the many wooded ridges of Barro Colorado Island, stood a low, decaying trunk, a solitary remnant of the forest which had been drowned when this valley was flooded by

the impounded waters of the Río Chagres, twenty years earlier. Although its own leaves had long since withered and all its branches had fallen, the stump was verdant with the foliage of a variety of orchids, ferns, bromeliads and even bushes which here found a place in the sun; and it was draped and embraced all about, from the water up to its broken summit, with the roots of its aërial garden. Bees had built their hives and wasps attached their nests in this tangled mass of vegetation; and a flock of Yellow-rumped Caciques were weaving their swinging pouches at the extremities of the branches of the bush that flourished at the top of the trunk. This stub was about 25 feet high and stood approximately 100 feet from the nearest shore.

At dawn, when the placid waters of the lake were ruffled by no waves save those spreading from my slender, silent cayuco, I would paddle up the cove to watch the caciques at their work. When I began observations on April 22, the colony contained eleven nests, some just begun, others already long bags with the bottom closed off, completed or nearly so. Subsequently five more nests were started, the last about May 10, bringing the total number in the colony up to sixteen. Apparently the last nest was built to replace an earlier one that had been abandoned. The community, then, consisted of fifteen females; and there were at least eight males. Three of the females which began to build late had brown eyes, and they were apparently younger than their blue-eyed neighbors.

The nests were built by the females alone. To weave the swinging pouch they brought long, pliant stuffs of various sorts, including narrow strips from palm fronds, fibrous strands apparently pulled from vines or leaves, and lengths of slender vines, some dead, others with small green leaves still attached to them. The first step in nest construction was the formation of a loop between the terminal twiglets of a leafy branch. As with the oropéndolas, this would be the doorway of the completed nest, and in this the builder sat while she continued to weave more strands into the fabric, which lengthened downward, forming a sleeve. When it had become long enough to contain her, the bird worked in an inverted position, her widely spread feet clutching opposite sides of the tube; her posture appeared exceedingly strained and uncomfortable, although doubtless she did not find it so. Each new strand was alternately pushed and pulled through the meshwork until it was firmly interwoven and formed an integral part of the lengthening fabric. Although caciques invariably worked on the inside, I could see the sharp yellow bill projecting through the wall of the nest whenever the bird pushed a fiber through from within, or reached out to grasp a loose end and pull it inward. The builders always entered and left through the original loop at the top, never through the open bottom of the sleeve, although at a certain stage in the construction of the nest this would have been the most convenient mode of exit.

The lower end of the sleeve remained open until the nest attained the full length of from 12 to 18 inches. Then the rounded bottom was woven in. Five or six days of hard work was required to weave the pouch, from wrapping the anchorage around the supporting twig to closing off the bottom. To complete her nest the cacique added a soft lining on which the eggs would rest. The fat-boled barrigón (*Bombax barrigon*) trees that grew on the shores of the cove were at that time laden with heavy pods that burst and shed seeds surrounded by silky down. The caciques found this highly desirable for the nest-lining, but other soft or fibrous materials were brought from a greater distance. Two or three days were given to lining the nest, making seven or eight days the approximate period required to build and line the pouch. This was considerably less than the time required by oropéndolas to complete their much longer nests. All of the caciques' materials were brought from the neighboring wooded shores, or from points deeper

within the forest on the island. While the females built, I noticed none of those bickerings between near neighbors in which Montezuma Oropéndolas and Boat-tailed Grackles indulge at this period, and there were no attempts to steal loose materials from each other's nests. Possibly a more populous and crowded community of Yellow-rumped Caciques would have presented a certain number of disorderly scenes.

#### BEHAVIOR OF THE MALES

The epiphyte-covered dead trunk and the long brown pouches hanging from the bush rooted near its top formed the stage on which the male caciques were the conspicuous actors, although the quiet females played the really important roles. While the hen birds toiled steadily at their weaving, the males, which did no work, made the narrow cove resound with their brilliant music. When performing, they liked to perch on the twigs that supported the nests, or even to cling to the sides of the pouches, sometimes head downward. Another favorite position was the broken off top of the trunk that supported the colony. From these coveted stations the singer was often driven by a rival who flew at him in full career, as though determined to knock him down into the water. But the cacique so set upon always took flight just in time to avoid the impact. Sometimes the aggressive one contented himself with occupying the perch that the other had just relinquished, but often he would dash in pursuit over the water. Pursuer and pursued flew rapidly, with resonant wing beats. They might come to rest, not far apart and without apparent animosity, among the boughs of one of the trees standing on the shore, or the chase might continue back and forth between these trees. But however far the pursuit was carried, I never saw it end in combat, and rarely in actual contact. It seemed to be merely a game played by the idle male caciques, the chief rule of which was that the bird who was chased must flee and give the pursuer the pleasure of following. While the females built, this game was almost always going on among the males.

No matter how gently one male flew toward another, the second invariably relinquished his place to the first. Often the bird thus dispossessed of his perch would go at once to a third male and claim the latter's position; and I never saw such a claim contested. Apparently among caciques good manners consisted in giving the latest arrival what he wanted. One morning, however, I saw two males actually come in contact. One had chased another from the nest tree and was pursuing him across the water toward the shore of the cove. The pursued, feeling himself hard pressed, turned in the air and faced his pursuer. The two collided, but did not clinch. After this momentary encounter, they flew together to the shore and rested amicably in the same tree, not far apart. They apparently were without rancor toward each other, and I doubt not that both had been equally surprised by the collision. All this chasing back and forth reminded me of a good-natured game of tag, in which nobody lost his temper.

The males often followed the females when the latter flew from the nest tree to the shore. Sometimes two or three would accompany a single female as she flew over the water toward the forest. And often they followed the females as they returned to their nests with fibers; the males then perched above the nests and sang as the females worked inside. Frequently they peered down into the nests, especially those which had been completed; but I never saw a male cacique enter a nest. They were content to cling to the outside, in almost any attitude, and sing. I saw no indication that particular males were paired with particular females or that they were attached to a certain group of the latter. While in the colony, the male caciques rarely addressed themselves to any one female, and if they did, the demonstration lasted only a few seconds. Apparently court-

ship and mating were performed, as in the Montezuma Oropéndolas, at a distance from the nest tree.

#### NEIGHBORS OF THE COLONY

While the caciques built, a Giant Cowbird lurked among the trees on the neighboring shore, apparently interested in the progress of the nests. Once as it flew across the cove near the nest tree it was chased by a cacique; but I did not see it attempt to enter a nest, as at the Montezuma Oropéndolas' tree (see p. 297). In South America, this cowbird apparently often parasitizes the nests of the Yellow-rumped Cacique and related species (Friedmann, 1929: 358; Chapman, 1928: 152, footnote). A Parasitic Flycatcher was more conspicuous in the vicinity, and far more noisy. At each of my visits to the cove while the caciques were building I found him perching on the trees along the shore, whistling impudently. Sometimes he flew across the cove from shore to shore, looping down to pass close above the caciques' nests. One morning he repeatedly lunged at a male cacique which perched beside the attachment of nest 11, in which incubation was going on, and in which this flycatcher appeared to take special interest. Each time he would dash by within an inch or two of the cacique's head, emitting harsh, unpleasant notes when nearest the larger bird, then rise to a tree on the opposite shore. These feints at whatever cacique was resting near nest 11 were repeated on several days. At other times the flycatcher circled the colony again and again, but without molesting the caciques. This Parasitic Flycatcher appeared to be unmated, and I did not see him actually enter a nest. Since the Parasitic Flycatcher uses other pouchlike nests very similar in form, it is probable that it occasionally captures those built by the caciques.

A Cayenne Flycatcher and a Neotropic Kingbird had built nests among the stems and roots of the epiphytes that grew over the rotting trunk below the caciques' nests. Most of the time these three kinds of birds got along very well together. The kingbirds would sometimes drive the male caciques from the coveted perch at the very top of the stub. One morning the little, black, biting bees, whose hives were plastered in furrows of the trunk, gathered in an angry cloud in the air beside it and attacked the two nestling kingbirds without mercy. The parents could do little to defend their young, which fortunately had now sufficient feathers to afford them some protection. To relieve their feelings the kingbirds drove peevishly at their neighbors the caciques, especially at the larger males. Although the caciques were not directly responsible for the trouble, it is probable that all of their dashing around among the branches of the epiphytic bush that held the nests helped to keep the bees stirred up, and there was more justice in the kingbirds' attacks than there often is in such "substitute reactions," which are as frequent among men as among birds.

Rarely a few of the wasps whose nests were fastened to the trunk attacked the caciques, but the birds would merely nip them with the tips of their sharp bills and drop them mangled into the water. Cherrie (1916: 204) made some interesting observations on the relations between the Yellow-rumped Caciques and wasps in the Orinoco region. He states: "The colonies vary in size from half a dozen to seventy-five or eighty nests placed close beside one another and at heights above the ground of from 7.6 m. to 30 m. No single species of tree seems to be preferred; but the tree selected and the height from the ground appears to be determined by the presence of the nest of some species of wasp (most frequently *Polybia liliacea* Fabricius), or not uncommonly a nest of stingless bees which forms the center about which the bird village is built. The most cordial good-fellowship appears to exist between the birds and their insect neighbors. My observations have not indicated any direct relationship between the size of the bird and insect colonies. However, when through accident or natural causes the

wasp nests are destroyed or abandoned the surrounding bird colonies seem to dwindle in size and are finally also abandoned. A number of colonies of *Arrendajo* [caciques] that I noted when on the Orinoco in 1897 and 1898; were still in existence in 1905, some flourishing, others in decadence and some abandoned. And in every instance where a colony had been abandoned or had decreased in population, the wasp nests were either broken down or had been abandoned." Beebe (1910) and other writers have also noticed the preference of the caciques for nesting in trees where there are wasps.

#### INCUBATION

The last two females to begin their nests, one at least of which had brown eyes, abandoned their work before it was half finished. The others completed their nests and started to incubate. It was impossible to learn the exact dates of laying the eggs, or the number and appearance of the eggs. In the Orinoco region the nominate race lays, according to Cherrie (1916: 205), sets of two eggs which are "white with a faint bluish wash, marked with specks, spots and blotches of chestnut over vinaceous brown."

Incubation was performed by the females alone. By May 1, when all but three laggards had finished their nests and many of the hens were incubating, the colony in the cove became far quieter, presenting a strong contrast to its noise and bustle of the preceding week. The males now spent less time singing and chasing each other in the nest tree and more in the woods along the shores. From time to time one would visit the colony and perch near a nest or cling to its side and sing, but he rarely remained long. The incubating females came and went in a direct, efficient manner and spent little time loitering in the bush near their nests; the colony with its thirteen completed pouches presented an aspect of relative desertion. Even the Giant Cowbird and the Parasitic Flycatcher seemed to be losing interest in it.

The incubating females preferred to fly off to forage in groups. Sometimes one bird, when ready to leave her eggs and go abroad for food, would start a general exodus from the nests; she would be followed by a half dozen of her incubating neighbors, as well as by those of the males who happened to be in the tree. At other times one, two, or three females only would follow the lead of the first. Many times, too, one female left her nest and crossed alone to the land; but she was almost sure to find some males and possibly also other females in the trees along the shore.

The time of a female's departure from the nest appeared to be determined largely by an internal stimulus, in which hunger was doubtless the most important factor; but it could be advanced by the departure of one of her neighbors. If a certain individual flew from her eggs at a time when several others were nearly ready to go, they would hurry out of their nests to join her, although without the stimulus of the first departure they might have incubated a few minutes longer. But if one bird left at a time when no other female was hungry, she had to go alone; for her neighbors would not forsake their eggs until they felt the inner urge. The bird within her nest apparently was made aware of a neighbor's departure by feeling the vibrations which the latter caused as she climbed up the walls of the pouch to the doorway at the top — vibrations very different in character from the rude jolts produced by the males as they jumped and flew boisterously among the nests. Or possibly certain sounds apprised the incubating female, deep within her closed pouch, that a neighbor was leaving.

On May 10 I watched five nests simultaneously, making records of the comings and goings of the occupants of each. All appeared to be incubating. Bird 11 entered her nest at 8:23 and was not seen again in the course of my vigil. The periods of the other four caciques on and off the nests were as follows:

Cacique 2:	On	19	28	17	21	minutes	
	Off	11	8	9			
Cacique 5:	On	10	18	11	19	20	
	Off	8	11	6	5	4	7
Cacique 10:	On	22	13	18	21		
	Off	10	7	8	9	8	
Cacique 12:	On	30	25	16			
	Off	10	8	8	6		

The sessions of the four females ranged from 10 to 30 minutes, and their recesses from 4 to 11 minutes. Birds 2 and 5 each devoted 69.6 per cent of the two hours to incubation; bird 10 devoted 68.8 per cent and bird 12, 74.8 per cent. It would have been interesting to continue these simultaneous records through an entire day, but the effort was too strenuous for a lone observer.

#### THE NESTLINGS AND THEIR FATE

On May 12 I first saw a female cacique enter a nest with food in her bill and heard the weak cries of newly hatched nestlings. Three days later over half of the nests held young, and the cries of those earliest hatched were becoming loud. The females alone fed and brooded the nestlings, as they alone had built the nests and incubated the eggs.

On May 12 I stayed in my cayuco at the head of the cove until it grew dark in order to watch the caciques' preparations for the night. During the late afternoon the community carried on its activities in the usual manner, the females flying back and forth between the nest tree and the shore and darting in and out of their nests; the males dashed to and fro and sang among the swaying pouches. At about six o'clock, long after the sun had fallen behind the wooded ridge to the west of the cove, the females quite generally left their nests and flew to some low trees on the nearest point of land. Here they diligently preened all their plumage and shook out their wing and tail feathers. A few males rested among them, and one moved up close to a female and paid court to her, rapidly bowing up and down and striking her tail with his bill at each forward movement. He continued this until she sidled out of his reach. At 6:25 a female flew over the water, closely followed by a male, and entered nest 11. After she had darted into her nest he turned and flew inland toward the center of the island, soon vanishing behind the tree tops. A minute later the last remaining male stood upon the exposed apex of the stub, sang, and then followed his companions over the island forest. By this time most of the females had finished preening and had retired into their nests; but at 6:30 three others came out and went to the same trees to clean and arrange their feathers in the waning light. They had left their nests for the sole purpose of attending to their plumage, not to eat, and after five or six minutes devoted to this occupation they returned directly to their nests. At 6:37 the last two females flew together to the nest tree and slipped into nests 4 and 5, which hung side by side. There still remained sufficient daylight to enter this fact in my notebook without eye strain and even to distinguish the separate leaves on the neighboring shores. With the entry of these two females, every cacique which remained in the colony was inside a nest; the males, and those few females which had not completed their pouches, roosted somewhere off in the dark forests on the island.

Soon after the eggs began to hatch, I noticed that some of the female caciques no longer visited their nests. Day after day the number of unattended nests increased, until by May 17 half were unoccupied. Since none of the nestlings was yet old enough to fly, it was evident that something was preying upon the eggs and young. Nest 5 was

apparently pillaged in the night of May 14-15. On the morning of May 15 the owner of this nest entered it and came out almost immediately. Leaving her own nest, she went to look into nest 3, but the owner of the latter emerged and drove her away. Next she clung to the side of nest 11 and examined it carefully. This nest had also been despoiled and was deserted. Leaving it, she returned to her own nest, entered it again, came out at once, and flew off to the shore. After that I did not again see this bird manifest interest in nest 5, and hence if I saw her again I had no means of identifying her.

Continued watching pointed to the conclusion that the nests were looted in the course of the night. Seated with a companion in the cayuco tied at the head of the cove, I kept watch as the twilight faded into darkness on May 20. The caciques had retired to the forest to roost, leaving the growing nestlings that still survived alone in their swinging nests. In the dusk the call of the Poor-me-one, most melancholy and one of the most beautiful of bird notes, floated out of the woods on the right side of the inlet. Presently the big, dusky bird emerged from among the trees and flew over the water, heading toward the caciques' colony, then swerving off to the opposite shore. In form and mode of flight it resembled a large, slow-flying hawk, a similarity which quite spontaneously suggested predatory habits.

Could it be that this bird, the Potoo, a large relative of the goatsuckers, preyed on the nestling caciques? I was hesitant to believe this, yet this was my first clue to the mystery of the disappearance of the nestlings. Pushing the cayuco farther back into the shadow of the trees on the shore, where we would be less conspicuous to the penetrating vision of a night-bird, we waited. Again the Poor-me-one flew toward the colony, but passed above it without alighting, then vanished into the forest. It did not again appear.

We continued to watch in the darkness, hearing only the liquid calls of the frogs along the shore, and once the grunts of some peccaries off in the forest. We waited until the waning moon, rising late, appeared over the crests of the trees on the eastern ridge. But all remained quiet among the caciques' nests; and at last we reluctantly paddled away through the moonlight, the mystery unsolved.

The following evening I returned alone to watch the caciques' blighted colony. As day waned, the young birds in one of the nests cried out loudly for food and shook their swinging nest in their impatience; but their mother did not come to feed them. All the other nests of the caciques appeared to be deserted now. The pair of Cayenne Flycatchers were bringing insects at short intervals to their nestlings in the oven-shaped nest situated among the roots of the epiphytes which covered the stump, a few feet above the water. Still laboring under the delusion that the attack on the nests would come from the air, I made a berth for the cayuco among the tall, dense marsh grasses at the head of the cove. There I would wait in partial concealment, watching the nests silhouetted against the sky. As daylight waned, I loaded my revolver, the only firearm I possessed, and placed extra rounds of ammunition and the flashlight in readiness for immediate use.

I waited quietly until long after the last vestige of twilight had faded. The hours slipped by, and since no sign of menace came from the air, I pushed the cayuco out of its bed of grass and paddled toward the colony, into which I threw the beam of the flashlight. Almost the first glance revealed a yellow and gray mica stretched in a sinuous line along a branch which supported several nests, which now hung empty and deserted. Holding the light, I repeatedly fired my revolver at the snake. Neither the sudden blaze of light nor the loud detonations seemed to make any impression on it, and it continued to slither along from nest to nest. Meanwhile the cayuco drifted slowly about and I



found it difficult to load and aim the gun with the flashlight filling one hand. When I had exhausted my ammunition to no avail, the serpent continued its search among the nests it had already despoiled. Finally the snake stuck its head into a nest at the end of a branch and emerged with a bulge behind its mouth. Then it opened wide its jaws and spit up two eggs, which fell with a splash into the water and sank. When it had completed its search among the abandoned pouches on the side of the tree where they hung closest together, it slid across to the opposite side of the colony toward the only nest that I knew to be occupied by nestlings. I had fired my last shot and hurled the last detachable object that I could spare. Unable to do more, I paddled away.

Next morning I returned to the cove, fully expecting to find the caciques' colony wholly deserted. As the cayuco drew near the head of the inlet, to my amazement I saw the mica hanging head downward beside one of the empty nests. A nearby nest, number 2, still sheltered living nestlings; and the mother was carrying food to them, less than a yard distant from the motionless body of the snake. On the neighboring shore I cut a long pole and with it managed to pull down the snake. There were three bullet holes in its posterior half. It is almost incredible that neither loud sounds nor sudden light nor mortal wounds had availed to overcome the lust for prey which led the snake from nest to nest.

The young birds in nest 8 also miraculously escaped destruction and their mother continued to attend them. Other female caciques, bereft of their young, still came to the stub bearing food, which after an interval they swallowed or carried off again in their bills. Still others came to peer into empty nests or to cling to their sides. Despite their losses their attachment to young and nests remained unbroken. Nor did the males, although they took no active part in caring for the nestlings, utterly desert the stricken colony. Until the last youngster could fly away, they came at times to deliver their songs among the swinging empty pouches.

Some days earlier I had seen a mica swim across the cove near the nest tree. Perhaps this was the snake which pillaged the colony, easily climbing up to the nests by means of the roots and stems of epiphytes which thickly covered over the decaying trunk. Possibly by day it had hidden unseen in one of the pouches it had already looted; or else it had returned to pass the hours of daylight in the dense vegetation on the neighboring shores. Now at last I had a vivid realization of the fate which might have overtaken the colony of Montezuma Oropéndolas, five years earlier, if the mica which had attempted to attain the crown of the tree, but was driven back by a pair of Kiskadees, had actually reached its goal. It was plainly evident why a colony of oropéndolas or of caciques, to be successful, must be situated in a tree with an isolated crown and a tall clean trunk which snakes cannot scale.

Possibly because of the premature destruction of this colony, I did not witness an interesting alteration in the form of the nest which has been observed among the Yellow-rumped Caciques of northeastern South America by several naturalists. Cherrie (1916: 204) describes this as follows: "Nesting begins toward the end of the dry season, in April, and continues until June; and what appears to be an intelligent adaptation to circumstances is seen in the finishing of the nests. During the early part of the breeding season, before the rains have begun to come, the nests are almost all open from the top as in the case of our common Baltimore Oriole. As the rains begin to come, after the eggs have been laid, and often the young hatched, the top entrance is gradually roofed over and the nest entrance becomes a bent tube with the opening downward." Beebe (1910) states that the nests built at the beginning of the wet season have arched entrance vestibules, in which, in one case at least, the male spent the nights.

## SUMMARY

Yellow-rumped Caciques occur in the lowlands, where they travel in loose flocks and forage in the tops of trees in the forest or neighboring clearings, consuming many fruits.

The male is a brilliant vocalist with a wide variety of liquid notes. While delivering his song, he bows slightly forward, vibrates his relaxed wings, shakes his tail, and raises the bright yellow feathers of his back and rump.

The author's observations were made in April and May at a single colony established in an epiphytic bush that grew on a dead stub rising above the water on the shoreline of Barro Colorado Island, Canal Zone. This community consisted of at least 15 females and 8 males.

The swinging pouches were woven by the females alone, of strips of palm fronds, vines, and other fibrous materials. Five or six days of steady work were required to weave the pouch, then two or three more were devoted to lining it with downy and fibrous materials, making the total time required for construction seven or eight days. No pilfering or quarreling was seen among the building caciques.

While the females built, the idle males sang much, sometimes while clinging head downward to a nest pouch. They often chased each other, but a resting male so set upon always relinquished his perch to the newcomer, or fled while the latter chased. Thus actual clashes were avoided, and the birds seemed to play a good-humored game of tag.

In the nest tree, the males scarcely ever addressed themselves to particular females. They followed groups of females back and forth on foraging expeditions, and apparently courtship and mating took place at a distance from the nests.

The nesting caciques were molested by a Parasitic Flycatcher, which probably uses their nests for its own eggs. The relations between the caciques and other birds nesting in the same tree were amicable.

In the course of a short watch, the incubating females sat on the eggs for periods ranging from 10 to 30 minutes, and they took recesses of 4 to 11 minutes. There was a strong tendency for them to leave together, and the departure of one would often start a general exodus from the pouches. But not all the sitting females would join in this mass movement.

On May 12 a female was first seen bringing food, and three days later over half of the nests in the colony held young, which were attended by the females alone. Only females actually incubating or brooding stayed in the nest tree by night. All others roosted at a distance.

All except two of the nests were pillaged by a snake (*Spilotes pullatus*), which swam out from the neighboring shore and climbed the root-covered trunk. The mothers of the surviving nestlings were not driven away by the disturbance; and some which had lost their young continued to bring food, which they later swallowed or carried away.

## GIANT COWBIRD

### *Psomocolax oryzivorus*

Two species of cowbirds inhabit Central America. Seen at a distance, both appear entirely black in plumage and both have red eyes; but one is so much larger than the other that it is not difficult to distinguish them on the wing. The Red-eyed Cowbirds, which really have no better title to this name than their larger relatives, are of about the size of the North American Cowbird, but more handsome in their glossy, bronzed, black plumage. The Giant Cowbirds are fully twice as big; yet for all their impressive size and the aristocratic company they keep — entrusting the care of their young, so far as we know, only to oropéndolas and caciques — they are true cowpen birds a trifle overgrown. To continue to give them the book-name "Rice Grackle" would be not only pedantic but misleading. Like other cowbirds, they settle upon the backs of cattle and mules to pluck vermin from their skin. Goodfellow (1901:479) observed this habit in Ecuador, and I saw it repeatedly in Guatemala. It is amusing to watch the big cowbirds hunting over the side of a sleek-haired cow reclining in the pasture, for their long toes are little adapted to gripping such a surface, and if they venture too near the edge they slip clumsily down. Sometimes one finds both kinds of cowbirds, together with Groove-billed Anis, feeding in a flock in the pasture — verily a black assemblage. All three keep close to the heads of the grazing cattle to snatch up the insects they drive up from the grass; and the two cowbirds often alight on the big animals' backs to vary their diet.

The Giant Cowbirds, although parasitic on oropéndolas and caciques which rarely or never alight on the ground, are highly terrestrial in their manner of foraging. At Almirante, Panamá, they used to settle in flocks in the late afternoon to hunt over the golf links, where they were wary and difficult to approach. They frequent also cane-fields, savannas, and cultivated districts in general. Although most authors have considered them rare in Central America, they are very much in evidence about the colonies of oropéndolas as far north at least as the Caribbean coast of Honduras; and it would perhaps be more correct to call them local in distribution rather than rare. Mr. C. H. Lankester tells me that since the beginning of the century they have become increasingly abundant in the Central Plateau of Costa Rica. In this country I have seen them rarely as high as 5500 feet above sea level.

They are in general silent birds. The male sometimes utters an unlovely, spluttering screech; and I have heard harsh, nasal whistles from the females when fleeing from the angry oropéndolas whose nests they attempted to invade. The flight of the males of many species of the troupial family is accompanied by a characteristic sound made by the passage of the wind through the primaries. This does not depend entirely on the size and weight of the bird, for the wings of some of the smaller orioles are resonant in flight. The sound made by the male Giant Cowbird as he flies is particularly loud, and of a peculiar quality suggesting that his feathers are stiff and vibrant. After each five or six rapid wing beats both sexes fold their wings momentarily; and by this trait these cowbirds may be distinguished at a considerable distance from the Boat-tailed Grackles, which are of about the same size and look equally black against the sky, but fly with continuous and regular strokes.

Along the Río Morjá in Quatemala there was a broad, bare flood plain, covered with small, water-worn stones, where I could count on watching the cowbirds forage almost every evening during the dry season, from an hour or so before sunset until the sun had

fallen behind the tall cane-brakes. The Giant Cowbirds formed the nucleus of these assemblages, but their party was joined by Red-eyed Cowbirds, a few Boat-tailed Grackles (especially the males), and Melodious Blackbirds. Often a few Muscovy Ducks would be foraging near by in the shallows of the river; from a distance, all five species appeared black, and this mixed company was certainly proof of the adage that

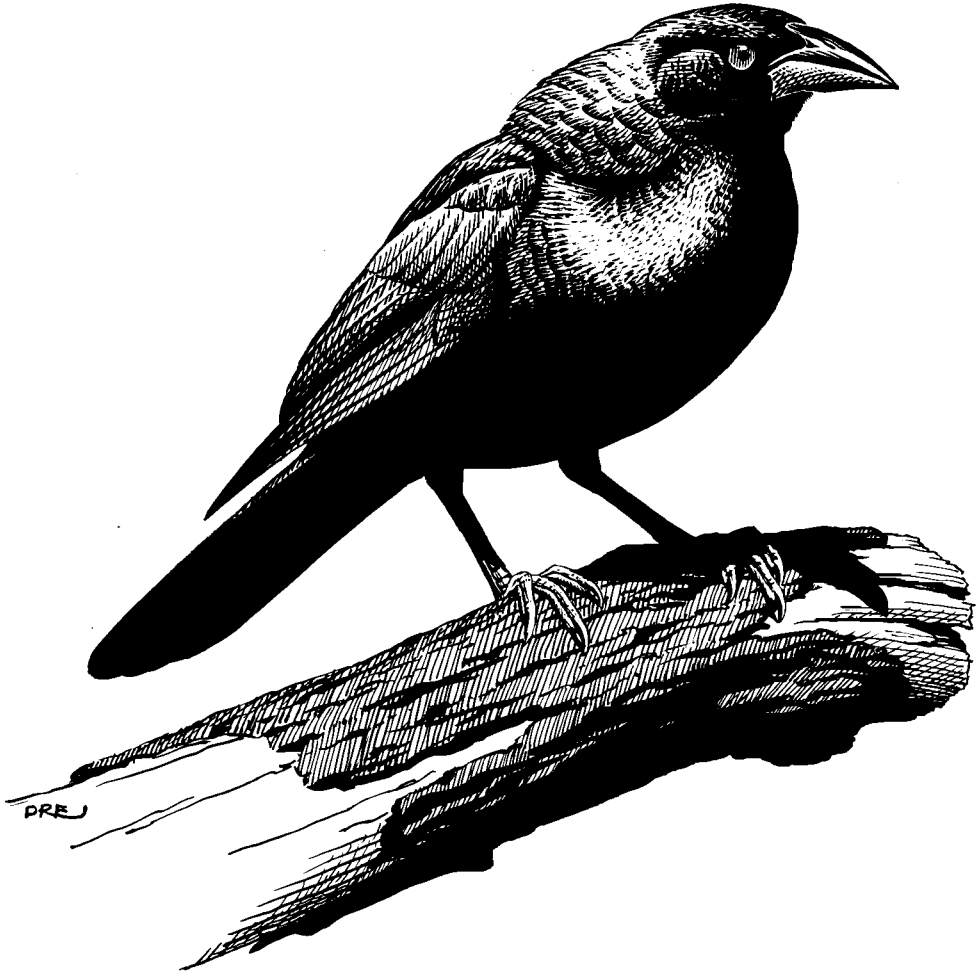


Fig. 51. Male Giant Cowbird.

“birds of a feather flock together.” For some reason, the Giant Cowbirds resented the presence of the male Red-eyed Cowbirds and at times pursued them. The chief occupation of the cowbirds was stone-turning, for which their strong black bills were well adapted. They moved stone after stone, turning over the smaller ones, pushing aside those which were somewhat larger, and merely raising slightly one side of the largest, in order to see what edible matter might be hidden beneath them. The blackbirds and grackles joined in this pursuit, but not so energetically as the cowbirds; for the grackles especially preferred to hunt small creatures lurking in the shoals, where the others rarely

ventured. All four of these black members of the troupial family turned their stones in exactly the same fashion: the head was lowered and the tip of the bill inserted beneath the near edge of the stone and shoved forward, in the line of advance of the bird. As the push was given, the lower mandible was dropped somewhat and the bill held slightly open. Whatever small animals lay concealed beneath the stone were eaten, and the bird proceeded to move another. The Giant Cowbirds occasionally picked up a few spiral snail shells for examination, but usually they found them empty.

#### COURTSHIP

While the female Giant Cowbirds turned stones with great diligence, the larger males strutted among them, seemingly too much taken up with their own importance to indulge in so humble an occupation. Fortunately for the females, they always outnumbered the males by several to one. The male walked with a sort of goose-step and carried himself very stiffly, his chest outswollen and his head drawn back like that of a horse with an over-tight check-rein — a combination which gave him an air of ludicrous pomposity. His long hind toe was conspicuous as he walked and it seemed to impede his movements. Beautiful purplish reflections played over his glossy mantle and breast; his ruby eyes shone like gems in his black head; he was handsome without being in the least graceful, if one may imagine such a combination, and he seemed "swollen with insolence and pride." As he approached with stilted gait, the intently foraging female would often retreat; and then sometimes the would-be suitor forgot his dignity and hopped stiffly after her. Approaching a female, he would plant himself squarely in front of her and draw himself up until he towered above her and seemed to be thrice her height. Arching his neck, he depressed his head until his bill rested among the out-puffed plumage of his breast, and he erected the feathers of his cape until they surrounded his head as an iridescent black ruff, in the midst of which his red eyes brightly gleamed. Sometimes, as though still further to accentuate his height and impress the indifferent female, the male with plumage all fluffed out bobbed up and down in front of her by flexing his legs. But the female's reaction to this display seemed principally to be one of annoyance, and she interrupted her foraging only long enough to rebuke the male with a peck and a sharp note. Sometimes he persisted in his attentions until a clash resulted; then the female fled and with sonorous wing beats he pursued her across the river and out of sight. At these afternoon gatherings, I never saw a male well received by a female.

#### PARASITIC HABITS

Friedmann (1929:357-359) briefly summarized what was known about the breeding habits of the Giant Cowbird. Goeldi in 1894 was apparently the first to publish a description of the eggs and parasitic habits of this species. Throughout its great range, from southern México to northeastern Argentina, this bird appears to parasitize only other members of its own family, the Icteridae, and in particular the oropéndolas and caciques, which nest in colonies and weave long, pensile pouches. Recorded hosts are (Friedmann, *loc. cit.*; Chapman, 1928:152, footnote):

<i>Cacicus cela</i>	<i>Ostinops decumanus</i>
<i>Cacicus persicus</i>	<i>Ostinops cristatus</i>
<i>Cacicus haemorrhus</i>	<i>Zarhynchus wagleri</i>
<i>Gymnostinops montezuma</i>	

Of the behavior of the female Giant Cowbirds at the nest tree of the Montezuma Oropéndolas, their persistence in attempting to enter the nests, their contempt of the half-hearted efforts of the oropéndolas to drive them off and their mutual jealousy, I have written in an earlier chapter (p. 298). In the community of Wagler Oropéndolas

studied by Chapman (1928), the cowbirds were just as conspicuous and just as unwelcome as I found them in the colony of Montezuma Oropéndolas. He states (p. 153) that not alone the oropéndola whose nest is threatened, but other birds in the same group, and also from other groups, join in attacking the female cowbird; while the Parasitic Flycatcher, *Legatus*, "assails at times with more zeal than *Zarhynchus*." Chapman repeatedly saw the cowbirds fight back when attacked by the Wagler Oropéndolas; I never saw a cowbird attempt to face the assault of the bigger Montezuma Oropéndola; but otherwise in the colonies of both species of oropéndola the intruding cowbirds behaved with the same exasperating persistency in attempting to enter the nests, and with the same ultimate disregard of the owners' repeated efforts to drive them away.

The highest colony of the Wagler Oropéndola that I have seen was situated at an altitude of 5400 feet near Vara Blanca in the Costa Rican mountains; and in this small community of eighteen nests there lurked a single Giant Cowbird, which established my record for maximum altitude of the species. At this elevation the cowbird appeared to be migratory like the Wagler Oropéndolas which it followed. I first saw a Giant Cowbird in this region on May 6; it was staying near the oropéndolas' tree, where the earliest nests were finished or nearly so. At the small colony of Yellow-rumped Caciques in Gatún Lake, a single Giant Cowbird was also in attendance.

Giant Cowbirds may lay as many as six eggs in a single nest of *Cacicus persicus*, but most victimized nests of whatever species held only one or two of the parasitic eggs (Friedmann, *loc. cit.*). How many eggs a single female cowbird may lay in one nest, or in a season, is unknown. An egg of the Giant Cowbird from Costa Rica is described by Crandall (1914:338) as spotless white, rough in texture and slightly glossed, measuring 36.1 by 26.0 millimeters. An egg supposedly laid by a Giant Cowbird which a Montezuma Oropéndola threw from her nest in my presence was very pale blue, almost white, with a few scattered scratches of brown; it measured 36.5 by 25.4 millimeters.

Observations made by Goeldi in Brazil indicate that when the nestling cowbird has a youngster of the parasitized species as nest mate, it does not starve the latter by claiming all the food, and the two may grow up together, at least when the foster parent is the oropéndola *Ostinops cristatus*. For a long while I was puzzled because I never saw any young cowbirds in the flocks of Montezuma Oropéndolas that travel around at the end of the nesting season and which contain many young oropéndolas still dependent on their mothers for food. At length, as I was walking up the valley of the Río Morjá on a rainy morning at the end of May, my attention was drawn by oft-repeated, rather nasal cries to a black bird perching high in a wild fig tree on the edge of a banana plantation. I watched a few minutes, and presently the cries redoubled in frequency, while the bird spread and shook its wings. A female Montezuma Oropéndola alighted beside it and placed something in its mouth. Then she flew off over the bananas and the young Giant Cowbird followed. I wondered why I saw these two birds alone, when oropéndolas generally travel in flocks, and why I have never seen young cowbirds in these flocks. Can it be that the other oropéndolas will not tolerate the presence of these intruders and that the foster mother prefers to lead a lonely life along with her foster young rather than desert it?

#### SUMMARY

Giant Cowbirds forage in flocks over open ground, often in company with birds of other kinds. They keep close to the heads of grazing animals to capture insects driven from the herbage, and they alight on the backs of cattle to search for vermin. On the gravelly flood-plains of streams they assiduously turn over small stones with their bills.

Their notes, sparingly used, are spluttering screeches and harsh, nasal whistles.

The male displays to the female on the ground, arching his neck, puffing out the plumage of his breast, and raising the feathers of his cape to form a ruff about his head, at the same time often bobbing up and down by flexing his legs. The female usually is indifferent, or hostile, to this display.

Giant Cowbirds are known to deposit their eggs only in the nests of other species of the Icteridae, especially those of the caciques and oropéndolas which weave swinging pouches. They are reported to lay as many as six eggs in a single nest, but one or two is the usual number.

Apparently a young cowbird may grow up together with a nestling of the host. A female Montezuma Oropéndola attending a cowbird was alone rather than with a flock of oropéndolas, and dependent cowbirds have not been seen in such flocks.

## BOAT-TAILED GRACKLE

### *Cassidix mexicanus*

This big grackle is spread unevenly over a great extent of territory stretching from Chesapeake Bay in the eastern United States to northwestern Perú. The northern and southern races of the species prefer low, wet areas, especially near the seacoasts. Thus the northern subspecies is well known in the southern United States for its fondness of marshes and shallow lakes choked with aquatic vegetation. In Costa Rica, the Peruvian race of the Boat-tailed Grackle appears to be confined to the Pacific coast, where it forages in the mangrove swamps and is quite unknown in the interior. But the nominate race, which occupies the central part of the species' range, from southern Texas to northern Nicaragua, is more enterprising and adaptable. In northern Central America and southern México, the Boat-tailed Grackle spreads over most of the country, and to the local inhabitants it is one of the best known of feathered creatures.

Most other birds of the region are given only general or family names; *chorcha* must suffice for many kinds of orioles, and *carpintero* does service for a great variety of woodpeckers. The familiar grackle not only bears a specific name, but male and female are honored with distinct titles. The big, handsome, yellow-eyed males, clad in sleek black plumage glossed with violet and blue, are called *clarineros* (trumpeters); the much smaller females, soberly attired in shades of brown, are known to everyone as *sanates*. And well may the Boat-tailed Grackles have two names, for more than any other bird of northern Central America, they seek the neighborhood of man. The palm trees of the town plaza are their favorite nesting place; in the evening one sees them streaming in noisy flocks from the surrounding fields, where they forage during the day, to the village shade trees, where they roost. They abound in the coastal towns; and the stirring whistled screech of the clarinero at once recalls to my memory some palm-shaded Caribbean port; but they are scarcely less numerous in the interior, and in Guatemala they frequent the towns of the central plateau up to at least 7000 feet altitude. They are equally at home in the most humid districts of the Atlantic littoral and amid the cacti and thorny scrub of the scorching, semi-desert regions of the interior valleys and of the Pacific plain. But they are never found in the forest.

#### THE COLONY ON THE HILLTOP

I have never stayed longer than necessary in the towns, where Boat-tailed Grackles so often nest, and only at Alsacia plantation did I live on intimate terms with them. The plantation house stood on the upturned end of a sharp spur which juts out from the mountains which form the boundary between Guatemala and Honduras into the level valley of the Río Morjá, a tributary of the Motagua. Here on the hilltop, several hundred feet above the valley floor, a numerous company of grackles established their headquarters in the tall coconut palms that shaded the house. From my arrival in February until the following July, I awoke every morning with their voices in my ears. In the earliest dawn, the clarineros repeated over and over again, in a calm subdued voice, a long-drawn note between a screech and a whistle, which sounded very pleasant and contented, and reminded me of one running up the entire scale on some stringed instrument with one deft stroke. How different from the shrill calls they uttered later in the day, at the height of their amorous zeal!

Then, as the morning grew lighter, with much commotion and clucking on the part of the females and excited calling by the males, they left their sleeping places among





Fig. 52. Male Boat-tailed Grackle.

the coconut fronds and flew down to seek their breakfast. Many alighted on the *Conostegia*, a melastomaceous shrub with small pink flowers that grew abundantly on the grassy hillside below the house. Here they ate the small, black, sweetish berries. Others settled in the cowpen and on the road, where they walked about seeking small, creeping things on the bare ground, or on the lawn to forage in the grass. One morning I watched four sanates pick parasites from a gaunt old cow who stood alone in the pen. One bird alighted on her back and pecked at vermin among the hair. After a slight show of resistance, she allowed a second bird to settle beside her and share the feast. Two more sanates moved about on the bare ground at the beast's feet, and at intervals jumped up to pluck something from her flanks or belly. They clambered over her legs and tail, performing the same service, while the cow stood patiently still.

Many of the grackles, upon leaving their roost, flew directly down into the valley. As the morning wore on the rest melted away, singly or in small flocks, to the shores of the Río Morjá, which wound through the banana plantations half a mile away. Here they foraged along the moist shore or in the shallows, or searched among the piles of driftwood and washed-out banana plants stranded in the shoals. The clarineros walked sedately along the shingly beach and flicked small stones aside with their bills to see what edible animals might be lurking beneath. On hot afternoons they delighted to bathe

in the shallow water at the margin of the stream, shaking wings and tail so vigorously that they sent up a shower of crystal drops to sparkle in the sunlight. One afternoon I saw a sanate approach a clarinero who was bathing and stand as close to him as she could, although there was an abundance of room elsewhere; she seemed to enjoy the shower he was creating. She used him as the Boat-tailed Grackles of the towns sometimes employ the lawn-sprinklers. Finally all the bathers flew up to the boughs of the willow and cecropia trees on the banks, vigorously shook the water from their plumage, and carefully preened their feathers with slender bills.

As the sun sank low and the air grew cooler, the grackles flew up the hill in small flocks, sometimes cackling like a company of Purple Grackles, to congregate again in the coconut palms. On the way many would settle again in the *Conostegia* bushes for a dessert of berries before going to roost. From the time of their arrival until it was nearly dark, our hilltop presented a lively scene. The varied calls and squeaks of the males mingled with the constant chatter of the more numerous females. Many of the birds would settle upon the fronds of a single tree, but they seemed unable to make themselves comfortable and flew out to alight upon another. Often they shifted back and forth a dozen times before at length adjusting themselves for the night. The fresh breeze that generally blew up from the valley at about sunset, and tossed the great fronds of the coconut palms, made it more difficult for the birds to settle down. The long tails of the clarineros flagged back and forth as they perched on the leaves, causing them evident inconvenience. It was a delight to watch their graceful maneuvers in the wind, when they hovered, soared, and poised with dangling legs above the tree tops, as sea gulls play above a windy shore.

On some particularly breezy evenings the clarineros engaged in spectacular if inconsequential sparring matches, meeting face to face and rising well above the tree tops, until the wind took hold of them and twisted them around and they were obliged to forget their opponents and devote all their attention to the maintenance of their own equilibrium. There seemed to be no point to these encounters, which were probably entered in a spirit of fun, the more to enjoy the wind by their vigorous exercise in it.

The sun hung well above the western hills when the grackles began to congregate among the coconut trees; the last red glow was fading from the sky when finally they had all ensconced themselves out of sight among the inner fronds of the palms, and their final sleepy notes gave way to the awakening calls of the Pauraque. But the clarineros, especially at the outset of the breeding season, were light sleepers and often awoke during the night to shatter the monotonous humming of insects with their shrill calls.

At first I was happy to have such active, spirited birds as close neighbors; but before long I began to wish them elsewhere; for like their northern relatives, the Purple Grackles, they ate the eggs of other birds. A number of pairs of tanagers, flycatchers, thrushes and other small birds built their nests on our hilltop, yet few succeeded in rearing their young. The grackles kept all other large birds so well at a distance that I strongly suspect that they themselves were responsible for most of the depredations.

The big male grackle glides downward with wings set, the tips of the primaries separated from each other and distinctly curved upward by the weight of his heavy body, and with his long tail folded together upward so that the feathers lie in a vertical plane, like that of the Purple Grackle, and vibrating from side to side in the breeze. Usually he flies upward with heavy, resonant wing beats, like those of the male Montezuma Oropéndola; but at times he may fly silently. The flight of the female grackle is almost noiseless; although when laboring upward with long fibers for the nest streaming from her bill, her wing beats may be sonorous like the male's, but not so loud. Rarely

she folds her tail feathers together in the manner of the male, but not so completely. In sustained flights on a horizontal or ascending course, both sexes move with perfectly regular and rapid wing beats, neither folding their wings intermittently nor spreading them for gliding. On the ground, the grackles walk rather than hop.

Although I never witnessed a serious dispute between the male Boat-tailed Grackles in the colony at Alsacia, in other regions these birds may be more pugnacious. While travelling by rail through southern México, from the train window I saw two male grackles fighting in earnest. They clinched and rolled on the ground, continuing this battle as long as I could keep them in view.

#### FOOD

Few birds, I imagine, subsist on a greater variety of food than the Boat-tailed Grackle, or display greater ingenuity in procuring nourishment. Everything is grist for their mill. Their diet includes both animal and vegetable products. Much of their food is picked up from the ground, where they extract the larvae of beetles and other insects from among the roots of the grasses and capture small lizards. They are said to hunt in freshly plowed land, following close behind the plowman. They pluck ticks and other vermin from cattle, sometimes alighting on the animal's back for this purpose. They spend much time foraging in the vicinity of water. On bare shingly flats along the shores they turn over small stones by inserting the tip of the bill beneath the nearer edge and pushing forward, then devour the small crustacea, insects, worms or the like that they find beneath. It is chiefly the more powerful males that hunt in this fashion. Often the grackles wade into shallow water, where apparently they capture tadpoles and small fish. Or if the water be deep, they may adopt other modes of fishing. A. W. Anthony (in Griscom, 1932:400) tells how at Lake Atitlán in Guatemala the grackles caught fish as they flew low over the surface of the water, seizing their prey by means of a quick snap and hardly wetting their plumage in the process. At other times, however, these grackles plunged boldly into the lake, like a tern or a kingfisher, immersing themselves to a depth of not more than three or four inches. The overseer of Alsacia plantation told me that once when he exploded dynamite in the river as a means of procuring fish for the table, the grackles fell upon the stunned or dead ones, pecking into such as they could not swallow whole. Sturgis (1928:437) records that the Boat-tailed Grackles frequent the most isolated rocks in Panamá Bay, where doubtless they eat a variety of small marine animals. In Costa Rica, Carriker (1910:831), found these grackles common among the mangroves of the brackish estuaries so numerous along the Pacific coast.

Like other grackles, this species pillages the nests of other birds, taking their eggs or nestlings. At Alsacia I surprised a male Boat-tailed Grackle resting upon a fence post where a pair of Bonaparte Euphonias had built a nest, well concealed in a cranny caused by decay. The roof had been torn from the domed nest and the newly laid eggs had vanished. Although I arrived too late to catch the grackle in the act, the circumstantial evidence pointed strongly to him as the despoiler of the nest. In México, Lamb (1944:245) saw a male grackle seize a female Yellow Warbler which had dashed into the face of the bigger bird in a vain attempt to save her eggs. The warbler was killed, her skull crushed by the grackle's powerful bill.

Of vegetable food, the grackles are fond of ripe bananas and of small, sweet berries, especially those of the melastomaceous shrub *Conostegia*. They greedily eat maize, tearing up the germinating grains from recently planted fields. One Guatemalan farmer told me that his efforts to start a cornfield were frustrated by the grackles until he adopted the expedient of scattering a considerable quantity of grain about the edges of his field. This kept the hungry birds occupied until the planted maize had grown large

enough to withstand their attacks. Yet this same farmer considered that the grackles, by destroying grubs and other insect pests, did on the whole more good than harm on his estate. Later, as the maize crop nears maturity, the grackles renew their depredations in the *milpas*, tearing open the husks to reach the tender, milky grains, which the females at this season feed to their fledglings.

The northern races of this species are equally versatile in procuring food; and the males even prey upon nestlings of their own kind (McIlhenny, 1937:286-291).

#### VOICE

The range and power of the male grackle's voice are wonderful; he lacks only a set song. At one extreme, he utters a little tinkling note, rapidly repeated and very pretty, at the other, calls so loud that they are best heard at a distance. If one may say that a bird with so varied a language has one call which is most characteristic, that call is a single, long-drawn utterance, something between a squeak and a whistle, which rises through the musical scale. Then there is a resonant *tlick tlick tlick*, delivered while the bird is either in flight or at rest, and a spirited, rollicking *tlick-a-lick tlick-a-lick*. There is also a rolling or yodelling call, very vigorous, and quite in contrast with the lazy, screeching note that is like the slow swinging of a gate with rusty hinges. Sometimes while perching the male grackle puffs himself up, swelling out all his feathers and half opening his bill, and slowly expels the air with a low, undulatory sound, such as can be made by whistling through the teeth.

As musicians, the grackles display a good deal of originality. They often invent new calls, which had not previously been heard in the flock, and when they hit upon one which takes their fancy, they repeat it over and over again. One bird took a liking to a pretty phrase, which sounded like *wheet-tóck*, and uttered it constantly for a week or more, until at last, like a popular song, it grew stale and was forgotten. Another clarinero was much taken with a bugle-like call that went *ta-dee ta-dee ta-dee* and was really very martial, especially when heard from a little distance, for it had great carrying power. After delivering a call, the grackles frequently perch with their long, sharp, black bills pointing straight upward, a pose which displays to good advantage the sleek glossiness of their purple necks. This attitude is also assumed on other occasions; and sometimes two splendid birds, perching side by side on a coconut frond, point upward at the same time and hold the pose for a good fraction of a minute, looking very self-conscious. The females, too, sometimes assume this pose; but the trait is not nearly so strongly developed among them as among the males.

Belt (1888:214) describes how the grackles in Nicaragua, after delivering their squeak-like whistle, would stand with feathers compressed and bill pointing straight to the sky. In Louisiana these grackles also assume this same pose. According to McIlhenny (1937:277) several males may stand facing each other on the ground, on the tops of grass or bushes, or occasionally in a small tree; they compress the body plumage, depress the tail, raise the head with the beak pointing straight up, and retain this position for minutes without moving a muscle.

The female grackles are not only smaller but quieter than the males. Their most characteristic utterance is a rapid, clicking sound, a *tlick tlick tlick*, sharper and less sonorous than the corresponding note of the males. They use this while building their nests, quarreling with their neighbors, or flying. Single throaty clucks are also uttered by both sexes. Sometimes a female attempts to deliver the note that I ventured to call the most typical of the male, but hers is a weak, squeaky imitation.

## COURTSHIP

At Alsacia the sanates began to build their nests during the last week of February, and at this time the noise and excitement of the clarineros reached their highest pitch. The colony contained about a hundred birds, and there were at least two or three females for each male. This rough count of birds which were constantly moving about may be compared with the sex ratio in Louisiana, which McIlhenny (1937:291) determined from his banding records and counts of young in the nest to be a little more than two females for each male. The clarineros did not appear to have any particular mates, but formed merely random and temporary unions with the sanates. Although males might share the same territory and were idle, they never seriously quarreled. Sometimes two would stand side by side on the same perch, calling peacefully for several minutes, when of a sudden one would rush at the other and drive him away; but the bird thus threatened never turned to fight and the other forgot his animosity in a moment. The case was quite different with the sanates, who often came to grips in their disputes over their nest sites. In the absence of pugnacity among the males and in their willingness to flee when pursued by their own kind without turning to fight back, as well as in the more serious quarrels which sometimes arise between building females, the Boat-tailed Grackles agree closely with other colonial-nesting Icteridae, including the Montezuma Oropéndolas, Wagler Oropéndolas and Yellow-rumped Caciques.

The clarineros were ardent in courtship. Often one flew down beside a sanate which was feeding or gathering nest material on the ground. He addressed her with wings half-raised and quivering, his tail held level with his body and his head depressed; his contour feathers were all fluffed out, making him appear larger than he was, and with half-opened bill he uttered pleading calls. Sometimes his voice was shrill and insistent, sometimes soft and appealing as the peeps of a lost chick; but no matter what tone he used, the ardent suitor was sure to be ignored by the busy sanate, who went resolutely about her work. At other times he perched beside her in a tree and courted in much the same manner. So long as the sanate ignored him, his interest would die away almost as suddenly as it began.

The nuptial flights of the grackles were aerial displays of the most spectacular sort. They began when a sanate fled the attentions of a clarinero who addressed her on the ground or on a coconut frond, or when he tried to overtake her as she flew about her usual business. As she fled from him, he uttered his shrill nuptial calls and increased his speed to overtake her. She doubled and twisted and dodged and used every stratagem to escape him. Far out over the valley they went, until they were high above the tallest ceiba trees. Closely as he pressed her, she always managed to elude him; and I never saw one of these pursuits end in a capture. The wild chase over, the birds doubled back to the hilltop separately or together, or continued their flight to the river.

Although the clarinero was so spirited in courtship, it was the sanate who decided when she desired his attentions, and this was usually about the middle of the afternoon. Then she vibrated her wings and called with pleading peeps much weaker than his. Sometimes she might continue this for a considerable period without attracting a clarinero, although several were in sight. When a clarinero responded, he flew to her with shrill, ear-piercing cries and quivering wings, and their union was completed in a moment. Then they separated, perched not far apart with wings still violently vibrating, and continued their calls; but their voices were weaker than before and soon died away.

## NEST BUILDING

The nests of the Boat-tailed Grackles are usually aggregated into colonies and are often placed near water, in willow trees or bushes along the banks of lakes or rivers, or

among rushes and reeds at the marshy borders of lagoons. But often they are situated in the shade trees or clumps of bamboos about human habitations, sometimes at a considerable distance from water. At Alsacia all of the grackles built well up on the hill, far above the river. A few of the sanates in this colony placed their nests in orange or lemon trees, or only eight or ten feet above the ground in low, thornless bushes growing in the pastures that surrounded the house. But the majority preferred to nest high up in the coconut palms where they roosted.

I wanted very much to see the nests but at first was uneasy about climbing so high above the ground among the giant fronds of the coconut trees. At the beginning I sent up a boy to look into the nests and report their contents. But after I had watched him clambering in perfect safety among the fronds, I overcame my misgivings and ventured up myself. A man may climb by the aid of these giant leaves as though they were branches, provided of course that he keeps his weight fairly close to the trunk. In the broad, cup-like bases of the lower fronds, fallen flowers and blasted fruits, shreds of decaying sheaths and miscellaneous debris have accumulated and turned to mold; in this, graceful pendent ferns, as well as grasses and various other plants, strike root and form a veritable aerial garden. Among these air-plants hang the green clusters of ripe and ripening fruits, each larger than a man's head, the whole bunch of some two dozen coconuts weighing considerably more than a strong man can lift. Among these lower fronds ants establish their colonies, spiders spin their webs; and one expects to encounter, amid all this debris and decaying vegetable matter, scorpions and cockroaches. Some trees swarm so with stinging ants that it is unhealthful to climb them. Few of the grackles nested among these lowest fronds.

Higher, where hang the young and the half-grown fruits, and from this point to the summit, the trunk and the bases of the fronds are enswathed by their sheaths, which soon dry to form a close fabric of loosely netted brown fibers, of much the texture and aspect of burlap. These sheaths tear and decay away while the fronds to which they belong remain green. Here, in the axils of the younger fronds, against the coarse fabric of the sheaths, many grackles built their nests.

But the place most favored by the sanates for their nests was in the very center of the palm tree's crown, between the two youngest of the expanded leaves, which stood upright face to face, providing between their broad green surfaces a cozy nook where the structure could be hung. The wind sent ripples along the pleated surfaces of these youngest leaves and tossed the older fronds below, the sun at high noon poured down its rays between the upright young leaves. A more attractive site for a bird's nest could scarcely be conceived. The first sanate to build in the coconut palm invariably selected this choice location, and she sometimes allowed another to place her nest between these same fronds, but on the opposite side of the rachises. If any mishap befell one of these nests and left the position vacant, it was most likely to be occupied again, so long as the grackles continued to build. Aside from its sequestered position, the nook between the youngest fronds offered many advantages, not the least of which was its cleanness; for here amid the fresh green leaves the birds were above the ragged sheaths and the debris they harbored — above everything unclean save the droppings of the roosting grackles themselves.

It was only after these most favored sites had all been claimed that the sanates perforce built among the mature fronds lower down. On the broad bases of the latter they found a firm and secure foundation for their nests. Five or six sanates frequently nested at one time in the same coconut palm.

As the sanates built there were frequent quarrels among them. These usually arose

between birds which desired the same nest site, or between those that had begun their nests too close together and were in each other's way as they worked. They menaced each other with open bills and high-pitched, irritated cries, until at length one flew at the other, and the two sparred face to face as they fluttered toward the ground. Then they would separate and fly off to forage or to gather more material for their nests. These quarrels never resulted in injuries to the contestants, but they caused the birds to scatter their nests in different parts of the tree rather than crowd them all in the same place.

Like oropéndolas, the sanates often attempted to steal nest material. Often one bird would grasp the end of a long fiber that dangled from a neighbor's bill. Perching side by side on a coconut frond, the two tugged at the coveted prize, until at last one or the other tore it from her opponent's grasp and flew to her nest with it. Sometimes one or even two birds would pursue a third who had found a particularly desirable piece of material. The sanate who had her fibers rudely torn from her bill never manifested resentment, but soon went off to search for more. The clarineros took no part in building the nests and viewed with indifference the quarrels between the females, from whatever cause they might arise.

The completed nests were large and bulky open cups composed of a variety of ingredients. The foundation was sometimes prepared by piling in the chosen site a quantity of coarse materials such as weed stalks, small grasses torn up by their roots, and miscellaneous vegetable material. Above this the bird wove a roomy cup of coarsely fibrous stuffs picked up from the ground, chief among which were uncleaned strips from the decaying outer leaf-sheaths of the banana plants; but grass stems, bits of rag and string, and fibrous weed stalks made flexible by partial decay, were also employed. The nests built in bushes and dicotyledonous trees were suspended among the finer twigs by fibers twisted firmly around them and woven back into the walls of the cup. In the coconut palms, the nests between the youngest leaves were attached by fibers woven around the ribbon-like leaflets. Those lower in the crown of the palm were attached to the branches of an inflorescence if they happened to touch it; but most of these nests merely rested upon the broad bases of the leaf-stalks, for usually the builders found nothing suitable to which they might bind them. The completed cup was plastered on the interior, to within an inch or so of the rim, with a substantial thickness of fresh cow dung or of mud, and this in turn was lined with finely fibrous material. Those sanates which worked hardest finished their nests in five days, but others less hurried took twice as long. The ample cups measured from 4 to 5 inches in internal diameter and from  $2\frac{3}{4}$  to 4 inches in depth.

#### THE EGGS

The female begins to lay three or four days after finishing her nest. The earliest egg in the colony appeared on March 3, and in the next week many birds started to lay. Usually an egg was deposited each day until the set was completed; rarely two days elapsed between the laying of the first and second eggs in sets of two. Of 49 nests which we were able to reach at Alsacia, 33 contained three eggs each, 15 contained two eggs, and there was a single set of four. Boat-tailed Grackles nesting beyond the tropics, lay somewhat larger sets, ranging from three to five eggs.

The big, glossy eggs of the Boat-tailed Grackle are strikingly marked and usually very beautiful. The ground color varies from bright blue to very pale bluish-gray, on which are dots, blotches and intricate scrawls of brown and black. The blue ground color of some eggs is locally washed with shades of brown or pale lilac. The diversities of pattern are so great that, if all the eggs in a populous colony were mixed together,

each bird might conceivably be able to recognize her own by its distinctive markings. The measurements of 62 eggs in the nests at Alsacia average 33.6 by 23.0 millimeters. The eggs showing the four extremes measured 36.5 by 23.4, 32.9 by 24.6, 31.0 by 22.2 and 34.1 by 21.4 millimeters.

#### INCUBATION

Each sanate incubated alone, without help from a clarinero. But long before the first egg hatched, calamities began to occur. The earliest builders, who had seized upon the most coveted nest sites between the youngest fronds, found that this most desired position had one disadvantage. It was inevitably unstable; for here the nests were supported between two fronds which still grew and bent outward in opposite directions as new leaves pushed up between them at the apex of the palm. The coarse fibers of the outer wall of the nest were, as we have seen, wrapped around the ribbon-like segments of one or both of the supporting fronds. But these formed a quite inadequate foundation; the slender ribbons sagged down under the weight of the heavy, dung-lined structures, and the eggs rolled out even when the whole nest did not fall. The swaying of the fronds in the wind hastened the undoing of the nests. We attempted to save many by tying them securely with cord as close as possible to the original position; but even with this additional support it was difficult to make them remain in their precarious situations, and most came to disaster. Of the many sanates which had built between the youngest fronds, only one to my knowledge succeeded in bringing out her nestlings alive, and then only because we tied up her nest when it began to lean. Yet despite the unfortunate example before her, a sanate would begin a new nest in the top of the palm as soon as the expansion of a fresh frond had prepared another of these deceptive sites. Related birds which attach their nests to monocotyledonous plants with intercalary growing zones often have them overturned by differences in the rate of growth of the supporting leaves or stems on opposite sides; among these are Red-winged Blackbirds (Allen, 1914:96).

The sanates which, from necessity rather than by preference, placed their nests on the broad bases of the stalks of the mature fronds fared somewhat better; yet even among them the loss of eggs and nestlings was enormous. This was to a large degree because the birds continued to roost in the same trees where they nested — an extremely unsatisfactory arrangement. Grackles not actually engaged in incubation settled in the palms for the night and these were always in the majority. The excitement and disorder which prevailed there was so great that I wondered whether the incubating females managed to remain on their eggs. The angry cries which at this time emanated from birds unseen in the crown of the tree were doubtless from sanates trying to protect their nests from intrusion. As the nesting season advanced, the number of grackles which went to roost in the orange and grapefruit trees growing beside the coconut palms increased, possibly as a result of the protests made by the females nesting in the palms. Not only was the safety of the nests jeopardized by the disorder so prevalent each evening, but they and their immediate surroundings were defiled by the droppings of the roosting birds. Some queer things happened as a result of the grackles' disorderly habits. In one of the tallest of the palms was a nest which sheltered two nestlings. When they were nearly ready to take wing, one was found dead among the leaf bases in the vicinity of its nest, while the other in some mysterious manner made its way to a neighboring nest, where there was already a single nestling two days younger than itself.

In the Boat-tailed Grackle the habit of nesting in colonies is imperfectly developed, and perhaps of comparatively recent origin; for conditions such as existed in the colony at Alsacia were a tremendous handicap to the reproduction of the species, and therefore



not likely to survive a long period of evolution. Oropéndolas and caciques, which like the grackles nest in colonies that contain more males than females, arrange the matter much better. At nightfall all of the males, and all of the females whose duties do not keep them in the nest, retire to roost at a considerable distance, leaving the incubating females to pass the night free from unnecessary disturbances. After witnessing the disadvantages with which the sanates must contend while attempting to rear a family in a crowded colony, one understands better why so many kinds of birds select a nesting territory which they zealously defend from the intrusion of all others of their own species.

Only rarely, in nests with two eggs, did both hatch on the same day. More often, one egg hatched each day, so that in sets of three the hatching of all the eggs might require three days; or two might hatch on one day and the third on another day. In a few sets the eggs were marked as laid, and these hatched in the order of laying. The incubation period was measured from the laying of the last egg to the hatching of this eggs. At four nests the incubation period was 13 days; at two other nests, 14 days. McIlhenny (1937:282) found the incubation period to be 14 days in Louisiana.

#### THE NESTLINGS

The newly hatched grackles had pale salmon-colored skin and bore a sparse but long gray down on the head, back, wings and legs. Their eyes were of course tightly closed, but they could already peep weakly, and their bills when opened for food revealed a bright red interior. Their calls of hunger were heeded only by their mothers, for the clarineros were indifferent to this as to every other domestic claim. The only responsibility they assumed was that of guarding the nests. Whenever they saw a man approaching the coconut trees, their sharp *tlick lick, tlick lick* warned the females to flee from their nests, with the result that it was almost impossible to catch sight of them as they incubated or brooded. If we climbed into the crown of a tree which sheltered young grackles, the noise and excitement were immense. Clarineros and sanates, even those whose nests were safe in neighboring trees, circled around and filled the air with excited clucks. There was one particular clarinero, guardian of an isolated palm growing in the corral, who was bolder than all the others. While I rested in the crown of this tree to look at the nestlings, he ventured closer than any of the sanates dared to come and often alighted near the end of the frond against which I leaned; the frond bent perceptibly under his weight and made me instinctively clutch another support. He interrupted his clucks with a little tinkling note rapidly repeated, and at times in his excitement he uttered an indescribably harsh, agonized call, which set the sanates, who were flying in circles around the tree, into faster movement and louder calling. A single female, mother of nestlings in this tree, perched on a frond and relieved her distressed feelings by giving it angry pecks.

No hawk or other big bird dared to fly close to our hilltop. Both clarineros and sanates joined in harrying both the Turkey Vultures and Black Vultures when they circled too near the palms that sheltered the nests or attempted to alight upon them. They pursued the carrion-feeders far down the hillside, striking them repeatedly on the back until they retreated to a satisfactory distance. I am not sure whether they mistook them for hawks or whether the vultures would actually have eaten the nestlings if given the opportunity. But the grackles even attached a Curassow, probably the first they ever saw in their lives, and certainly not a natural enemy; these large gallinaceous birds come into the clearings as seldom as the grackles enter the forest where the Curassow is at home. One morning, while I was in the valley, my attention was drawn by a harsh cry to a male Curassow flying heavily, with labored wing beats, high above the hillside in front of the house. As he approached the top, two clarineros and several

sanates flew out from the palm trees to buffet him. Doubtless already fatigued by his unusual journey, the big bird wavered in his course and lost altitude as his assailants beat down upon him, but he managed to remain in the air until he rounded the brow of the hill and passed from view.

In the Boat-tailed Grackle in Louisiana, McIlhenny (1937:283-285) found that at small colonies containing from 6 to 20 nests there was usually a single guardian male, who was present most of the day and exhibited as much solicitude as the females whenever a man approached the nests; but at large colonies, which might contain from 100 to 250 nests placed close together, no male manifested interest in the welfare of the nestlings when these appeared to be in peril.

At Alsacia there was a nest, in the coveted position between the youngest fronds of one of the smaller palm trees, which as usual had to be supported by tying. It had also been considerably damaged by a high wind, but the two nestlings that it cradled continued to thrive. One morning in this tree I saw a fight between two sanates, who clinched and fluttered to the ground; but I did not pay much attention to their quarrel, for such flurries were of frequent occurrence. The next day, when I climbed into the crown of this palm tree, I found that grass and weed stems had been piled on top of the dilapidated structure, which only yesterday had been the home of two healthy, ten-day-old grackles. Removing the new accumulation, I found the cold, dead bodies of the nestlings beneath it. The intruder had apparently won the fight and must have begun her nest above the living nestlings, trampling or smothering them to death, for they were too vigorous to have died in the night if they had been left unharmed.

The sanates hunted most of the nestlings' food on the ground and often bore it a long distance to the nest. Sometimes they flew from the river, half a mile away, bringing items that they had found along the shore. The nestlings received grubs, obtained from the grass roots, green caterpillars, and sometimes small lizards. Their eyes opened between their third and fifth days, but they continued to be very ugly until they were feathered at the age of two weeks or a little more. When from 16 to 19 days old, they would try to crawl from the nest if disturbed by my visit, but they could not yet fly. The rasping cry of distress, which at this stage of development they uttered when touched, drove the adults to a frenzy. Those young birds which forsook the nest at the age of 19 days could not yet fly but remained climbing around among the broad bases of the coconut fronds for two or three days longer. The full nestling period was from 20 to 23 days. At the time of leaving the nest the young birds of both sexes resembled the adult females, but their breasts were more grayish, their irides were brown instead of bright yellow as in the adults, and their faces and foreheads were still bare of feathers.

The destruction of one of the isolated nests built ten feet above the ground in an *Inga* tree, gave me the opportunity to make an experiment. Although the nest had been cut down, the two vigorous, week-old nestlings were picked up unhurt from the grass. I placed one of these in a nest in a coconut palm which already held three ten-day-old nestlings; it was attended by their mother along with her own offspring. The other fallen nestling was deposited in another nest in the same palm tree, from which the original occupant had vanished a few days earlier. Apparently none of the four females which at the time were building or attending nestlings in this tree, nor any of the other grackles which frequented it, took notice of the foundling, for it died of neglect after a day or two. Each female appears to attend strictly to her own nest and to ignore the nest and offspring of her neighbors.

Soon after leaving the nest, the young grackles began to follow their mother afield as she foraged, before long going even as far as the river, where they would perch on a banana leaf arching over the bank while awaiting her return from her search along the

shore; or else they pursued her along the sandy margin of the stream, begging for food with vibrating wings. In May and June, the young birds became an increasingly conspicuous element in the flock, for despite their numerous failures, the sanates succeeded by persistent efforts in rearing a goodly number of offspring. The youngsters' half-pleading, half-imperious call, *witit witit*, mingled with the whistles and clucks of the older birds. The young males continued to solicit food from mothers smaller than themselves. Once I watched two youngsters, a clarinero and a sanate, alternately beg for

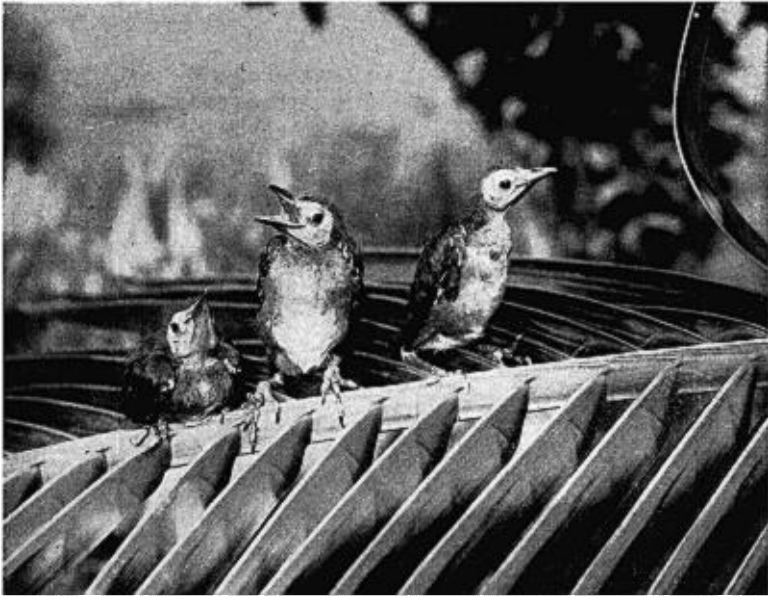


Fig. 53. Nestlings of Boat-tailed Grackle, 18 days old; Alsacia Plantation, Guatemala, April 10, 1932.

and receive food from their mother and help themselves to the ripe banana which she was eating. Sometimes, as the young birds waited for food to be brought to them in the hibiscus hedge beneath the coconut trees, they picked off the leaves and bright red flowers, or they pecked at the unopened buds, seeming to try to find food for themselves before they could distinguish what was edible.

#### LATER BROODS

By the first week of July the nesting season was drawing to a close. Since the grackles had begun to nest at the end of February, they had time to rear two broods. One sanate, who in some unknown manner had lost her tail and got a piece of red tape entangled around her right leg, making her easy to recognize, built a second nest and hatched a second brood after her first had been successfully fledged; but how many birds actually succeeded in raising two broods to the point where the young could shift for themselves, I was not able to determine.

In the night of July 6 the grackles which roosted in the coconut trees were restless, shifting their positions and often crying out in the dark. After this the great majority of them withdrew from the hilltop which had so long been their home. There remained only a few sanates who still had young in the nest, one whose eggs were just hatching,

and two faithful clarineros. The early mornings were strangely silent after the grackles departed.

On the Pacific side of Guatemala, where the dry season begins in late October or early November, two or three months earlier than in the Caribbean region, the Boat-tailed Grackles begin to breed correspondingly earlier. At an altitude of 3300 feet on the Finca Mocá, a great coffee estate situated on the Pacific slope, I found grackles feeding nestlings as early as the first week in January. These birds must have begun to build no later than the middle of December, more than two months before those at Alsacia, which began to build in late February and had no nestlings before mid-March.

#### SUMMARY

In northern Central America, Boat-tailed Grackles are abundant in all sorts of open country, arid as well as humid, from the sea coasts up to about 7000 feet above sea level. They often roost and nest in the town plaza or village shade trees, and they spread by day in flocks over the surrounding cultivated fields.

The diet is exceedingly varied and includes a wide range of both vegetable and animal food. The grackles forage much over the ground and turn over small stones to uncover prey. They alight on cattle to extract ticks and other vermin. They catch small fish, and devour many eggs and nestlings of other birds.

Males have a great variety of songs and calls, some very spirited and stirring. After calling they often pose with the bill pointing straight upward.

The author's studies of reproductive behavior were made at a colony which roosted and nested in the crowns of a group of coconut palms growing about a plantation house on an exposed hilltop at the edge of the Motagua Valley in Guatemala. In this group of about 100 birds there were two or three females to each male.

Mating appeared to be promiscuous, and no lasting attachments were formed between the sexes. Males displayed to females on the ground or in a tree, and they pursued them in spectacular nuptial flights. No female was seen to respond to these solicitations. When a female desired a male, she called with pleading *peeps* and vibrating wings; and one of the nearest usually came and mounted her.

The males avoided encounters by retreating when pursued by another of their sex, and no real fight was witnessed in this community.

In this colony, most of the nests were built in the crowns of the coconut palms, by preference between the youngest expanded fronds—a precarious situation. Only when these most favored sites were all occupied would the females build at the bases of the older fronds, where they had firmer support. Five or six females might nest simultaneously in the same palm.

All the building was done by the females, who quarreled over nest sites and pilfered material from each other. The inside of the deep, cup-shaped nest was plastered with fresh cow dung or mud, within which was a lining of fine fibrous material. The construction of the nest took from five to ten days.

The eggs were laid on consecutive days or more rarely on alternate days. Two-thirds of the nests contained three eggs, nearly one-third held two eggs, and there was a single set of four.

Incubation was carried on by the female alone. Unlike oropéndolas and caciques, the grackles continued to roost in the same trees where they nested, and the excitement and disorder of settling down in the evening caused the loss of many eggs and nestlings. The period of incubation was 13 or 14 days.

Food was brought to the nests only by the females, often from a great distance. But the males were zealous guardians of the colony. The full nestling period was from 20 to

23 days. Young that left the nest earlier than this could hardly fly but clambered among the bases of the coconut fronds for several days more.

At least some females raised two broods.

Early in July the palm trees were suddenly deserted by the majority of the flock, leaving a few females with belated nests and two faithful males.

On the Pacific side of Guatemala, where the dry season begins far earlier than in the Caribbean lowlands, the grackles begin nesting earlier than at this colony in the coconut palms. Some build as early as December.

## GENERAL SUMMARY OF INFORMATION ON THE ICTERIDAE

The American orioles, oropéndolas, caciques, grackles, meadowlarks, cowbirds, and their allies form a heterogeneous family of middle-sized or large passeriform birds containing, according to Mayr (1946:67) 88 species. Restricted to the New World, the family is best represented between the tropics, and there chiefly at lower altitudes; but numerous species breed in both the north and south temperate zones, and one at least (the Rusty Blackbird) nests within the Arctic Circle. Black is conspicuous in the plumage of this family; numerous species are wholly of this color, glossed, perhaps, with iridescent shades of blue, violet or green. In others, the black is relieved by more or less extensive areas of yellow, orange, chestnut or red, often forming a gorgeous attire. Brown-streaked plumage, with breasts of bright yellow or red, is found in the meadowlarks and military starlings. Extra-tropical species are more or less migratory; and in some of these—notably the Bobolink, which performs the longest migration—there are conspicuous seasonal changes in plumage. Pronounced sexual differences in coloration are also found in the northern members of the family. The species that nest between the tropics are mostly non-migratory; the sexes of many, including some of the brightest, are essentially similar in plumage; and seasonal changes in coloration appear not to occur. Even in the single genus *Icterus*, the females of the highly migratory species are far duller than the males, whereas in many non-migratory species the sexes are almost equally brilliant in their yellow and black dress.

Because of its great diversity in social habits, nest-construction, and modes of reproduction, the student of bird-behavior finds this one of the most interesting of all avian families.

The food of the oropéndolas and orioles consists of fruits and insects which they find among the trees. The Chisel-billed Cacique forages among the densest thickets of the humid tropics, forcing open decaying vines and canes by inserting its sharp yellow bill and opening its mandibles. Numerous genera forage over the ground, among them *Cassidix*, *Quiscalus*, *Euphagus*, *Sturnella*, *Dives*, *Psomocolax*, *Tangavius*, *Molothrus*, and *Leistes*. Some, including *Psomocolax*, *Cassidix* and *Dives*, turn over stones with their bills. Many of these ground-feeders walk rather than hop. Grackles and Giant Cowbirds pluck vermin from the skins of cattle. Grackles of various species have an exceedingly varied diet, eating almost anything alive that they can catch and swallow.

Voice is richly developed in the Icteridae, and some of the most delightful of all songsters belong to this family. The Spotted-breasted Oriole, the Giraud Oriole, the Melodious Blackbird and many others are superb musicians. In many tropical species the female has a well developed song but does not quite equal the male in richness of voice. The Yellow-rumped Cacique and the Yellow-tailed Oriole are noteworthy for their varied repertoire and brilliant execution. The various liquid and harsh notes of the oropéndolas are among the unforgettable sounds of tropical America. The Troupial is an accomplished mimic. Flight-songs are regularly delivered by the Bobolink and the Red-breasted Marsh-bird of Argentina.

Courtship displays are striking and varied. There are certain widespread types of display which appear with modifications in diverse genera. One of these is well exemplified by the performance of the male Montezuma Oropéndola, who bows profoundly, raising his wings above his back and at the same time emitting a far-carrying liquid gurgle. The Giant Cowbird takes a pompous pose in front of the female on the ground and raises his ruff. The Red-eyed Cowbird hovers in the air above the female as she rests on the ground.

Nuptial feeding has been observed in the Melodious Blackbird, the Brewer Black-

bird (Williams, 1952:13) and species of *Xanthocephalus*, *Icterus* and *Euphagus* (Ken-deigh, 1952:271). On the whole, it seems to be rather exceptional in the family.

Polygamy is of frequent occurrence in the Icteridae. It is regular in the colonial-nesting *Gymnostinops*, *Zarhynchus*, *Cacicus*, *Cassidix* and *Quiscalus*, and it occurs at times even in such prevailing monogamous species as the Eastern Meadowlark, the Bobolink, and the Red-winged Blackbird. In the Brewer Blackbird, the six-year study of Williams (1952) with banded birds showed that polygyny increased as the ratio of males to females became smaller. In years when the number of breeding males almost equalled that of females, polygyny was exceptional; but when females were twice as numerous as males most of the latter had from two to four mates. Despite this condition, males tended to pair with the same first or "primary" mate year after year, the incidence of "divorce" amounting to only 6.6 per cent of the possible cases among "primary" pairs. Yet he found no evidence that the bond between pairs was maintained during the non-breeding season. The parasitic cowbirds form no regular pairs and appear to be promiscuous or at times polyandrous in their relationships. Monogamy seems to be the rule in *Icterus*, *Dives* and *Amblycercus*.

The nest is most variable in form and position. With the possible exception of the Furnariidae and Tyrannidae, no other family of the New World exhibits such a variety of architecture. The nest may be hung conspicuously from the highest tree tops, as in the oropéndolas, or hidden at the roots of northern meadow grasses, as in the Bobolink. The Icteridae are excellent weavers, and many species construct long, pensile pouches strongly woven of fibrous materials. The pouch-weavers include the genera *Gymnostinops*, *Zarhynchus*, *Xanthornus*, *Cacicus*, *Cassiculus*, *Archiplanus* and *Icterus*. The pouches of the Montezuma Oropéndola are from two to four feet in length. Another type of nest common in the family is a deep woven cup, plastered inside with mud or cow-dung, with an inner lining of vegetable material; such nests are made by *Cassidix*, *Quiscalus*, *Euphagus*, *Dives* and others. Or the nest may be of essentially the same form but without the plastering as in *Trupialis*. The Lesson Oriole suspends its shallow woven pouch beneath a fold in the leaf of a banana or other monocotyledonous plant with giant leaves, passing the supporting fibers through perforations which it makes in the tissue of the leaf. The Meadowlark builds a roofed, oven-shaped nest with the doorway in the side, the Bobolink a shallow, open cup placed on the ground. The Bay-winged Cowbird at times builds a nest, but more often takes possession of the occupied or abandoned nest of another species, preferably the closed nest of a Firewood-gatherer or some other skillful architect, to which it may add a lining on its own account. Finally, the parasitic cowbirds build no nest at all, but drop their eggs into the nests of other birds, which hatch them out and rear the nestlings.

The nest is built nearly always by the female alone, not only in the polygamous species, but also in the monogamous *Icterus*. The male Melodious Blackbird helps his mate to build; and the male Bay-winged Cowbird, when the pair do make a nest, performs most of the work (Friedmann, 1929: 25).

The eggs are white or perhaps more often some shade of greenish-blue or blue, varying from a pale greenish or bluish tinge to beautiful bright blue. Eggs of a deep red color are reported by Hudson (1920: 82) for the Argentine or Shiny Cowbird. Usually the eggs in this family are spotted, blotched or scrawled with shades of red, brown, lilac or black; less often they are immaculate. Because so many of the tropical species of the Icteridae hang their nests high out of reach, not many records of their contents are available. As in other families, the sets are smaller in the Tropical Zone than in the Temperate Zone, the tropical species laying usually two or three eggs, those breeding at higher latitudes often laying sets of from four to six, rarely seven or eight.

Incubation is performed exclusively by the female, so far as known. A female Chisel-billed Cacique and a Melodious Blackbird were both fairly constant sitters, the sessions of the former averaging 53 minutes, of the latter 63 minutes, in the course of a morning. Colonial-nesting, Yellow-rumped Caciques were less patient, remaining in their swinging pouches only from 10 to 30 minutes at a stretch.

Incubation periods reliably reported for this family range from 11 to 14 days. Friedmann (1929: 188) gives the period of the North American Cowbird as 10 days, but Nice (1937: 164) found that with the Song Sparrow as a host it was "normally 11 to 12 days, sometimes longer, but never shorter." (See also Nice, 1953:81-93.)

The nestlings at birth have closed eyes and usually bear sparse down, but in the Chisel-billed Cacique they are quite naked. We need to know a great deal more about this point for the family. The interior of the mouth may at first be largely orange-yellow but in older nestlings it typically is red. The young are, so far as known, brooded by the female only, and in polygamous, colonial-nesting species, including *Gymnostinops*, *Zarhynchus* and *Cassidix*, they are fed by her alone, although the males often help to guard the colony. Exceptional among the polygamous, colonial-nesting Icteridae is the Tricolored Red-wing, in which the males desert their territories during the period of incubation but return to help feed their young (Lack and Emlen, 1939: 225-230). Strangely enough, in the less colonial, usually monogamous, although sometimes polygamous, Red-winged Blackbird, the male often fails to feed his offspring, but merely guards them (Allen, 1914:101). The male Brewer Blackbird may feed the young in two nests simultaneously. Food is brought to the nestlings in the bill or mouth. Injury-feigning is exceptional in this family, but it is recorded in Meadowlarks by Grimes (1936:479).

The nestling periods show a wide range, as we should expect in a family so variable in size and habits. The North American Cowbird leaves the nest of its foster parents at the age of 9 or 10 days; Red-winged Blackbirds depart at 10 or 11 days; Boat-tailed Grackles when from 21 to 23 days old; oropéndolas (*Gymnostinops* and *Zarhynchus*) when from 30 to 37 days old.

Helpers at the nest are unknown in the family.

Adult plumage is acquired, although perhaps not in its full brilliance, in the first prenuptial molt by the male Baltimore Oriole, but not until its second or third year by the Orchard Oriole, which breeds in a transitional attire. Red-winged Blackbirds may also require more than two years to attain fully adult plumage (Allen, 1914: 110). Male Boat-tailed Grackles do not take on the full adult livery until the second fall after hatching, but they do not breed until nearly two years old (McIlhenny, 1937: 274-275, 292). We need much more information on the sequence of plumage changes in the tropical members of the family.

The parasitic habits of members of the Icteridae have engaged the attention of numerous students. Shiny Cowbirds, North American Cowbirds, and Red-eyed Cowbirds drop their eggs into the nests of a wide variety of other birds; the Giant Cowbird appears to confine its attention strictly to the colonial, pouch-weaving members of its own family — the caciques and oropéndolas; the Screaming Cowbird lays its eggs in the nest of a single related, non-parasitic species, the Bay-winged Cowbird. Cowbird nestlings do not evict their nest mates in the fashion of the young European Cuckoo and they sometimes grow up along with their foster brothers; more often, perhaps, the legitimate offspring in the victimized nest cannot compete with the faster growing and more voracious fosterling and are starved to death. The female North American Cowbird often removes an egg from the nest into which she will later slip her own.



## FAMILY PARULIDAE

### PINK-HEADED WARBLER

#### *Ergaticus versicolor*

Color alone is a poor indication of the family in which a bird belongs, yet from limited individual experience we come to associate certain colors and color-schemes with particular groups of birds. It is quite natural that North Americans should think of tanagers as red birds; and when I first came to Central America I was slow in discovering that a very common blue bird was a member of this family. Similarly, in North America we do not associate red plumage with wood warblers; and when I first visited the highlands of Guatemala I did not at once refer to its proper family a little red bird abundant there. The Pink-headed Warbler seems to be an anomaly in a family of birds which, for all the brilliance and variety of their coloring, only exceptionally display red in their plumage; it is attired almost entirely in this color. The bird's head and neck most often appear as though they were pink and had been heavily frosted over; but when the bird turns its tail toward the observer, the faint pink that suffuses the gray changes suddenly to a red deeper than that on the rest of the body. One must look sharply to detect the change, for the restless little warbler is constantly flitting about, and it rarely stays long in a position which reveals the underlying red of the head and neck. This peculiarity of the plumage is responsible for the bird's specific name, *versicolor*. Male and female are closely similar in appearance.

The Pink-headed Warbler is confined to the highlands of Guatemala and Chiapas, where it is found almost exclusively at altitudes so great that frost forms during the months of the northern winter. Its extreme altitudinal range in Guatemala appears to be from about 6000 to 11,000 feet, but it is rare below 8000 feet. In the year I passed on the Sierra de Tecpán in the Department of Chimaltenango, I never saw one of these warblers near the southern foot of the range, which rises from the high plateau at an altitude of about 7000 feet. Yet with the possible exception of some of the humming-birds in their season of greatest abundance, this was the most common species on the upper slopes of the mountains; and it is almost everywhere numerous in the higher parts of western Guatemala. The Pink-headed Warbler dwells on the open, bushy slopes as well as in the humid broad-leaved cloud forests and in the heavy stands of great cypresses (*Cupressus Benthamii*), where its warm red plumage forms a pleasing splash of color amid the prevailing somber green. These warblers live in pairs throughout the year, and except while they are feeding young, it is rare to find more than two together. They never unite in flocks of their own kind, but they sometimes fall in with the mixed bands of small birds which roam through the woods after the end of the breeding season. The pair keep in contact by means of their low, oft-repeated *chip* as they flit restlessly among the low bushes in untiring search of the small insects and larvae on which they subsist.

#### VOICE

In the middle of January, near the summit of the Sierra de Tecpán, I heard the Pink-headed Warbler's song for the first time. The little red songster was in a young cypress tree at the edge of a dense wood, enjoying the bright sunshine which was just beginning to mitigate the chilliness of the early morning air, and he repeated over and over again his clear and cheery song, which reminded me much of the sweet and familiar song of

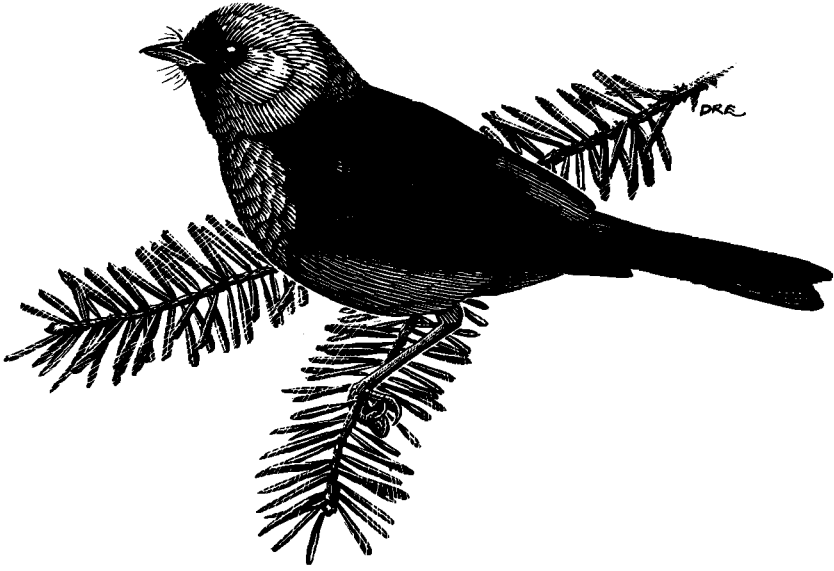


Fig. 54. Pink-headed Warbler.

the Yellow Warbler. It was wonderful how the small voice of so diminutive a creature could enliven the whole grove, making its author the center of interest in the whole mass of vegetation. With all their beauty and variety of form, these woods have a certain gloom when no bird sings. I appreciated the warbler's song all the more because among the cypress forests at this season bird voices were few and weak, except always the perpetual squeaking of the hummingbirds and the raucous calls of the Steller Jays in the clearings.

In February the Pink-headed Warblers sang more freely, and on fine mornings, as the rising sun warmed the thin and frosty mountain air, they filled all the woods and clearings with their bright voices. The male alone sang. The period of song was at its height in March, April and early May, but in the dark and rainy month of June the warblers rapidly fell silent. The call note, heard throughout the year, is a weak *chip*.

#### NEST BUILDING

I found my first nest of the Pink-headed Warbler on the last day of March, when I happened to surprise a bird in the act of carrying material to a half-finished structure. Although far from completion, it was already clear that the nest would be roughly globular, with a round entrance in the side facing out from the low, steep bank on which it was situated. The sides and top of the nest were composed entirely of pine needles, but there was still no floor. Raijón bushes and young pine trees shaded the bank. The nest blended with the fallen pine needles that carpeted the ground and was not at all conspicuous.

From the concealment of a blind I watched the progress of construction. By her plumage, I could not distinguish the female warbler from her mate; but all that I saw led to the conclusion that she built the nest without the help of the male. In the course of  $2\frac{1}{2}$  hours, pine needles were brought to the nest 50 times; but not once did I see both members of the pair holding material at the same time or witness two visits to the nest

in such rapid sequence that it seemed likely that two birds made them. Although pine needles littered the ground all around the nest, the female warbler never used these, but always went off 50 feet or more, flying low beneath the bushes, to gather those which she would add to the structure. On returning with a needle, or a fascicle of them, in her bill, she did not fly directly to the nest, but alighted on a dead branch in front of it and turned completely around in order to survey her surroundings in one sweeping glance. Then she flitted to another perch nearer the nest, and often to a third, on each turning several times from side to side as she examined the vicinity for signs of possible enemies. Convinced at length that she was unobserved, she flew into her little oven with the pine needle; but as she crossed the threshold she often glanced hastily over her left shoulder, as though to make certain that nothing followed her. Once inside, she pushed her burden into place, then went off for more material. Sometimes she flew back into the nest with empty bill to inspect her work or to make some adjustments.

The male rarely accompanied his active mate on her trips to gather material but remained out of sight among the bushes and sang over and over. Sometimes, when the female returned with a needle in her bill, he flew up with her and perched on a twig in front of the nest while she worked inside. His song served to distinguish him from the female, who never sang.

When I emerged from the tent later in the morning, I found that the bare ground still showed through the bottom of the nest. The builder had been placing all the material that she brought in the walls and roof and leaving the floor until last. Later she filled in the bottom with soft, fibrous material and lined it with a great many of the thread-like stalks which bear the spore-capsules of mosses, with the little brown capsules still attached to them.

In addition to this nest, I found two more in May. One was on the bank of an old boundary ditch at the edge of an oak wood, excellently concealed among the fallen pine needles which covered the sides and bottom of the trench. The other was well hidden among the low, tangled growth that covered a nearly vertical slope, between two turns of a cowpath which zig-zagged down a precipitous mountain side that bore scattered bushes and a few trees. Both of these nests were composed chiefly of pine needles, like the first, and were lined with the capsule stalks of mosses in the same manner.

#### THE EGGS

In the nest of which I watched the construction, the first egg was laid about April 10. The other nests, also on the Sierra de Tecpán at an altitude of about 8500 feet, already contained eggs on May 11 and 13. The first set consisted of three eggs, the second of four, and the third of two. The eggs are white or dull white, liberally speckled with light brown, the markings usually aggregated in a wreath about the large end, with a sparse scattering over the remaining surface. The measurements of nine eggs average 17.1 by 13.3 millimeters. Those showing the four extremes measured 17.9 by 13.5, 16.7 by 13.5 and 17.5 by 13.1 millimeters.

#### INCUBATION

I set my blind over the cowpath which passed below the last of the three nests; it was the only place on the steep slope that offered support for a camp stool. Here I spent many hours watching the pair of Pink-headed Warblers. I managed to place a faint paint mark on one of the pair; and this marked bird, which did not sing and was without much doubt the female, alone warmed the eggs. She sat in her domed nest with her tail projecting slightly from the side of the entrance, her body directed obliquely inward,

and her head turned so that she could look out. She was restless and often shifted her position, so that now her right side, now her left, was outward. Her body pulsated continuously and very rapidly, evidently with her breathing. I counted these pulsations and found their rate to be about 115 per minute. She sat for from 13 to 35 minutes at a stretch, and on leaving her eggs she always flew down the steep slope, calling to her



Fig. 55. Nest and two eggs of the Pink-headed Warbler; above Tecpán, Guatemala, May 15, 1933.

mate, whose song I heard through much of the day, coming usually from this direction. Here she must have foraged in his company; but the bushes hid the pair from view and I could not make sure of this. After a recess ranging from 4 to 13 minutes, she returned alone to her nest. When I had watched the warbler through all hours of the day, I found that her average period of sitting was 20.1 minutes, and her average recess 8.3 minutes; whence it was computed that she covered her eggs for 71 per cent of the 13 hours of observation.

Late in the morning the male warbler stood in the doorway of the nest and delivered a caterpillar to his mate. A few minutes later she left the nest; and during her absence he came with a small green insect, alighted in the entrance, and murmured in a low voice. I was surprised that he should have brought this offering to the nest while the female was away, because birds usually seem to know very well where their mate is to be found at any particular moment. After repeating his low murmurs in the doorway, he flew into some bushes in front of the nest, where he hopped around, still carrying the

insect. Soon the female returned and perched near him in the bush. He did not give her what he held, as I had supposed he would do, but preceded her to the nest, where he perched in the entrance and murmured as before. As soon as he had left the entrance, the female returned to her eggs. Then, after hovering a few times in front of the nest, and once standing upon the roof, the male went to the doorway and passed the insect to her.

Again in the afternoon, the male warbler came to the nest while his mate was taking her recess. This time he brought a whole mouthful of insects, and behaved very queerly. Perching on the sill, he bent his head into the nest and called with a fine little twitter. He must have heard the *chip chip* of his mate, who was foraging down the slope, hence how could he expect to find her on the eggs? He went off a little way, then came back to the entrance of the nest and twittered again; he repeated this performance five times in all. He answered the calls of the female, which now sounded plainly from down the hill, yet he did not go to her, but persisted in trying to deliver his insects to the unattended nest. When at length the female had returned to her eggs, he stood on the sill in front of her and delivered his offering as he had done before. By this time I was convinced that he did not bring these insects with the intention of giving them to his mate, but rather in anticipation of the arrival of the nestlings. Because there were still no nestlings to accept the food, the female only incidentally received it. I saw the male warbler come to the nest with insects or caterpillars in his bill four times during the absence of his mate, and only once while she was there. It is most improbable that this resulted from a chance distribution of his visits, for the female spent more than twice as much time on the nest as away from it. This was the first instance of "anticipatory food-bringing" to come to my attention; later I witnessed similar behavior among tanagers, tityras and other birds.

At the first nest, the three eggs hatched after approximately 16 days of incubation.

#### THE NESTLINGS

The Nices (1932:98) tell of a male Black-throated Green Warbler that was so absorbed in his singing that he apparently failed to learn that the nestlings had hatched until the first two left the nest, when he began to bring food to the one that remained behind. I was quite sure that my male Pink-headed Warbler would not be caught napping in this fashion. On May 24, the day after his nestlings were hatched, I again watched this nest from my tent. Very soon after I had hidden myself within it, the male flew up, perched on the sill of the nest, and passed to the brooding mother, one by one, three or four insects that he had brought concealed in his mouth or throat; only the last one was visible in his bill. The female took them all into her own bill, and when her mate had gone arose and called her nestlings with low, soft *chips* until they stretched up their gaping bills, into which she placed the food. Then for a minute she looked at them intently with her head turned sideways, after which she again snuggled down to keep them warm. When the father next came to the nest with food, singing sweetly despite his full mouth, he found the mother absent. He perched in the entrance and called the nestlings with the same fine twitter that he had used to coax the eggs to receive their meal, and when they responded by raising their open mouths he placed the insects into them and departed.

Small green caterpillars formed a large proportion of the food of the nestlings. In the two hours of my watch, the female, who devoted 59 per cent of the time to warming the day-old nestlings, fed them only twice, and then with small portions. The father, who did not brood and could give his whole time to foraging, brought the young eight liberal billfuls. As he approached the nest, he would almost always pause to sing in a

pine tree that grew in front of it, and did very well, considering how full his mouth was. He stuffed the nestlings until they could hardly contain more. Toward the end of my vigil he was obliged to perch on the sill of the nest and twitter and warble to them until they sluggishly responded and rose up to take the food. This act of feeding the nestlings was delightful to witness; for the calls that the parents used to arouse the slumbering infants, especially those of the male, were so harmonious that one might have supposed them to be his song, had he not just sung a far sweeter melody as he flitted up to the nest with the food in his bill. When the little warblers were a few days older they were more alert, and without any coaxing stretched up their gaping bills upon the approach of their parents, who now no longer found it necessary to twitter to them.

The nestling Pink-headed Warblers developed quickly. When they were well feathered, but could fly no more than a few inches, they jumped from the nest as I came near and hopped over the ground with alacrity, until they found shelter among the dense vegetation. I captured and replaced them in the nest, but it was difficult to persuade them to stay. The nestlings in one nest took their final departure at the age of eleven days, whereas those in another nest remained only until they were ten days old. Possibly if I had not touched them they would have stayed a day or two longer.

The young did not at all resemble their parents, for there was no red in their plumage. Their crown was dark chestnut-brown, merging into mahogany on the back. The rump was carrot-colored, like the side, flanks and abdomen. The breast was somewhat darker than the sides. The flight feathers were dusky. The bill was grayish-horn, the iris deep brown, and the feet flesh-colored. These colors are only approximate, because the plumage was of nondescript shades, and I possessed no handbook of colors for direct comparison.

At neither of the two successful nests did I ever see a parent feign injury or make any attempt to lure me off, in the manner of so many ground-nesting birds.

In June the bushy slopes of the Sierra de Tecpán, from 9000 feet up to the summit a thousand feet higher, were full of Pink-headed Warblers; and from all sides came the incessant twittering of fledglings clamoring to be fed. By the middle of the month the brownish plumage of some of the young warblers showed the earliest flecks of red. They continued to call for food and to receive it from indulgent parents, even after they had started to grow red feathers and had acquired considerable skill in catching insects for themselves. Before the end of June, some of the youngsters became independent of their parents, but others, which were probably hatched later, still received parental ministrations until late in July. By September all the young Pink-headed Warblers had acquired the red plumage with the pink-tinged, hoary head and could not with certainty be distinguished from the adults. The warblers now generally went about in pairs, and if a third individual approached it was promptly driven away. I could not make sure whether the youngsters hatched in the last breeding season had paired so soon; but since most of the birds were found in two's, and there were no larger groups, I think it probable that they had already mated. During the wet season the male Pink-headed Warblers rarely sang; but a particularly fine morning in the early part of this season might elicit a few musical strains from them.

#### SUMMARY

Pink-headed Warblers are abundant in the Guatemalan highlands at altitudes where nocturnal frost occurs during the winter months. Their extreme range is from about 6000 to 11,000 feet above sea level. They dwell within humid broad-leaved and coniferous forests and also in open, bushy areas. They remain through the year in pairs, which

never flock with others of their own kind, but which sometimes join mixed flocks of small birds.

The period of song extends from January or February to June. Only males were heard singing.

At 8500 feet above sea level three nests were found in the period from the end of March to mid-May. The oven-shaped structures, composed largely of pine needles and lined with the capsule-stalks of mosses, were placed on the ground on banks or steep slopes amid bushy vegetation. Only the female was seen to build.

The three nests contained, respectively, two, three, and four eggs. Only the female incubated. In 13 hours of watching, the sessions of one female averaged 20.1 minutes, and her recesses averaged 8.3 minutes; she spent 71 per cent of the time in the nest. At one nest the eggs hatched in about 16 days.

A male brought food to the nest four times while his mate was absent and only once while she was incubating. In her absence he presented this food with coaxing notes to the eggs—an example of "anticipatory food-bringing."

The nestlings were brooded by the female and they were fed by both parents. They remained 10 days in one nest and 11 in another, but they had been removed for examination.

The young, whose plumage differs strikingly from that of the adults, began to acquire adult coloration soon after leaving the nest. By mid-June some had flecks of red on their brownish plumage, and by September young and old could no longer be distinguished. Apparently by this time the young had already formed pairs.

## BUFF-RUMPED WARBLER

### *Basileuterus fulvicauda*

The Buff-rumped Warbler is the minstrel of the narrow, shady waterways of Central America and northwestern South America. It is a bird so distinctive in appearance, voice and nidification that it is hardly possible even for the novice in bird-watching to mistake it for any other species within its geographical range. Its upper plumage is dark brownish-olive, except the rump and the basal half of the long tail, which are pale yellowish-buff and contrast sharply with the back and the brownish terminal portion of the tail. There is an indistinct grayish line above each eye, and the under plumage is pale gray. The bill, eyes and feet are dark. The sexes are alike in plumage but are easily distinguished by their songs.

The species ranges from near Tela on the northern coast of Honduras, where I saw a single individual in 1930, southward through Central and South America to southern Ecuador west of the Andes and to Bolivia east of the Andes. It is absent or at least very rare on the coastal plains where the rivers flow sluggishly between low, muddy shores, but it begins to occur in the outer foothills where clear streams run over rocky beds. The single individual that I saw in Honduras was only a hundred feet above sea level, and a bird met in extreme southwestern Ecuador was at no greater elevation. In Costa Rica the species is found in the foothills on both sides of the country and upward to at least 2000 feet on the Caribbean slope and 3500 feet on the southern part of the Pacific slope. The Buff-rumped Warblers of southern Pacific Costa Rica belong to the race *Basileuterus fulvicauda veraguensis*, while those in the northern part of the Pacific slope and the whole Caribbean slope are classified as *B. f. leucopygius*. My studies of nesting have included both of these races, but chiefly the former; and since no noteworthy differences were detected in the behavior of the two races, they may well be considered together. In the eastern foothills of the Ecuadorian Andes I was familiar with the nominate form, *fulvicauda*, which was abundant at 3000 feet above sea level, and in voice and mode of life closely resembled the northern races.

The Buff-rumped Warblers forage chiefly along narrow, shady watercourses, whether rushing or smoothly flowing, or on the tree-lined shores of wider streams. Here they hop and flit along, now to a rock, now to a projecting root, now to a stranded piece of driftwood, now to a stretch of low flat shore, picking up minute animals here and there as they proceed. They may also lightly bounce into the air to snatch up some flying insect. Whenever they stand or perch, they continually flag their long, broad tails up and down with a slow, deliberate rhythm. They may move along a slender fallen branch by rapid, sliding movements of both feet, the same one always in advance; but they do not walk like the water-thrushes and the Oven-bird. Although they spend most of their time along the watercourses, they occasionally wander off through the forest a hundred yards from the nearest stream. They like to forage along woodland roadways, where they hop and flit along, keeping always near the ground. Upon the approach of a human wayfarer, they fly ahead, alight on the ground to hunt again, take wing a second time as the man gains on them, and repeat this until they have gone many yards, very much as a kingfisher will keep ahead of a boat proceeding along a narrow waterway. At length the warbler circles through the undergrowth beside the roadway to pass the man and return to its original feeding ground. Especially in wet weather, when the rivers are swollen and rocks and shore are covered by the rushing flood, the Buff-rumped Warblers desert the streams and hunt on higher ground, sometimes even foraging in the yards



of houses at no great distance from the watercourses, but usually keeping themselves well screened beneath hedges and shrubbery where the earth is bare.

According to Jewel (Stone, 1918) in the Canal Zone the Buff-rumped Warbler "walks like an Oven-bird and feeds along the water's edge like a Water-thrush." Although I have devoted much attention to this point in the Térraba Valley of southern Costa Rica, I have never seen the Buff-rumped Warbler walk in this region. At times I have had one of these warblers and a wintering Oven-bird or water-thrush in view at the same time, and I have been impressed with the great differences in the modes of terrestrial locomotion of these birds—the rapid hopping of the Buff-rumped Warbler; the slow, deliberate pacing of the wintering *Seiurus*. However, if notes made many years ago in an uncritical spirit are to be trusted, the first Buff-rumped Warbler I ever saw, along a rushing mountain stream in the Honduran foothills, "walked with measured steps, tilting its long tail very much like a Northern Water-thrush." Apparently there are geographical or individual differences in the mode of locomotion of this species—a matter worthy of further observations. When it is recalled that most species of the large genus *Basileuterus* are arboreal rather than terrestrial in habit, it is not surprising that *fulvicauda* should be less adapted for terrestrial locomotion than members of the highly specialized warbler genus *Seiurus*.

#### VOICE

The song of the male Buff-rumped Warbler opens with a low, rich warbling that soon swells into a crescendo of loud, jubilant, ringing notes. Although musically simpler

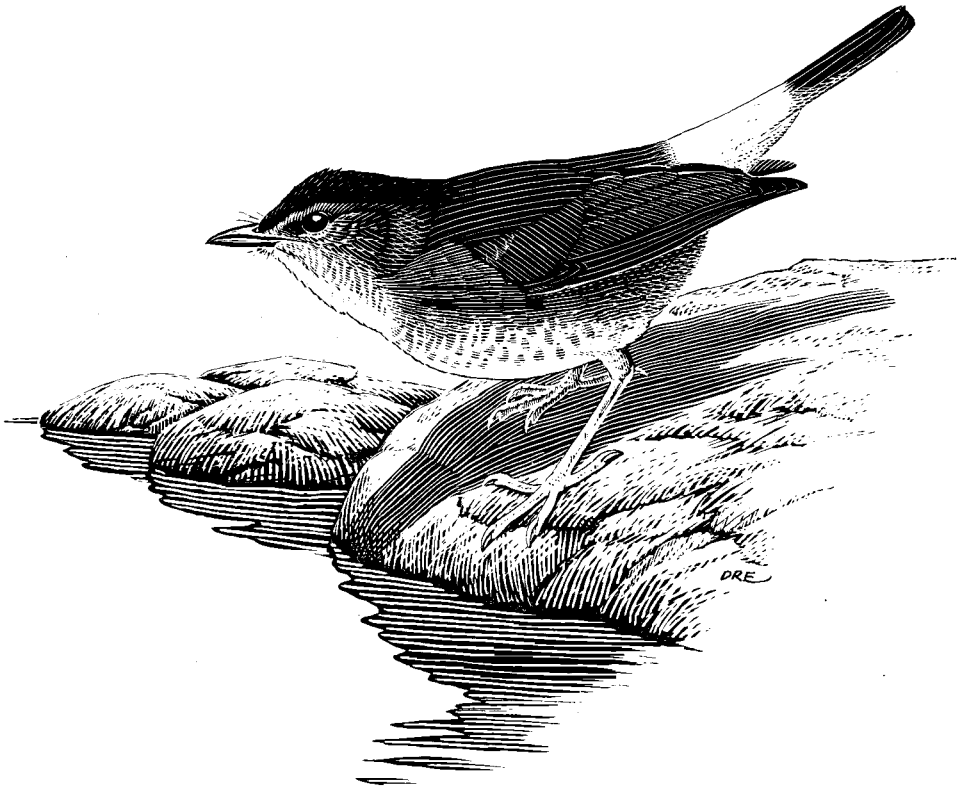


Fig. 56. Buff-rumped Warbler.

than the songs of many wood warblers, this is of such a character that it peals forth above the brawling of mountain torrents, whose noise would drown the voices of most members of the family. Heard above the sounds of rushing waters, which are its almost invariable accompaniment, this simple melody possesses exceptional charm. Unlike the Oven-bird and water-thrushes, and even some of the bush-inhabiting species of *Basileuterus*, the Buff-rumped Warbler does not mount to a high perch to sing, but pours forth his music while standing upon a rock that rises above the current of a shady stream, a log, or a stick of driftwood, or even while on the leaf-strewn floor of the forest or of a riverside thicket. At the beginning of the breeding season, when he sings most freely, he may run his songs together into one continuous flow of melody, with hardly a pause between the last high, ringing note of one verse and the first low, warbled syllable of the next.

Unlike most wood warblers, the female of this species has a remarkably beautiful song—a low, sweet warbling like the opening part of the male's song, but more elaborate and longer continued. It is a rare treat to hear male and female sing responsively, the ringing crescendo of the former serving as a background for the rich, full warble of his mate. As a rule, the female sings far less than the male; but at times, especially in October and November, I have heard her sing as much as or more than he. Possibly the profuse singing of both sexes sometimes heard at this season is associated with the formation of pairs.

Buff-rumped Warblers sing more or less throughout the year, but most freely in the nesting season. Many of these warblers remain mated at all seasons; and even in October and November, when bird music is at its nadir in Central America, male and female may be heard singing responsively. One morning in November, two pairs of Buff-rumped Warblers met under the big flame-of-the-forest tree at the bend of the creek in front of my house. All four sang, raising a delightful chorus. They continued for several minutes to sing against each other, and finally one flew at another; but I saw no fighting. The two pairs had apparently met at the point along the stream where their territories joined; for soon they separated, one pair going upstream, the other down. At the same season, I have also heard two lone males sing in rivalry when they met along a woodland road hardly suitable as a nesting territory. Although some of these warblers appear to remain mated throughout the twelve months, others, which are possibly birds hatched in the last nesting season, are found singly during the latter part of the year.

The call note of the Buff-rumped Warbler is a loud, sharp note, or a rapid series of such notes.

#### NEST BUILDING

My earliest date for the beginning of nest building in the Térraba Valley is March 22, 1944. The oven-shaped nest is placed in a niche or on a shelf on a vertical or steeply sloping bank beside a river or at no great distance from one. If a high bank is not available, a low one may be used. One nest was built on a sloping bank only three feet high, in a small plantation of bananas that occupied a new clearing in the forest, about sixty feet distant from a rivulet. Another was on the bank at the back of a pit dug into the foot of a steep slope covered with low trees and bushes. The front of the pit was open and faced a clean, nearly level pasture with a river at its farther side, about 200 feet away. A third nest was set in a snug niche in a low cut-bank beside a roadway at the entrance to the forest, at a point only sixteen inches above the foot of the bank.

I have watched more or less of the construction of four nests, all of which were built by the male and female working together. On May 3, 1939, I found a pair lining a nest (no. 3), situated among brown dead leaves with which it blended, on gently

sloping ground at the top of a high, vertical bank beside a sluggish, meandering stream. This nest was placed about two yards back from the edge of the bank, beneath tall bushes and low trees draped with creepers. I seated myself on the opposite shore of



Fig. 57. Heavy rain-forest at Esquinas, between Golfito and Palmar in the Pacific lowlands of southern Costa Rica. Habitat of Buff-rumped Warblers, Orange-billed Sparrows, Blue-black Grosbeaks, and Gray-headed and Silver-throated tanagers.

the narrow river to watch; and the warblers continued their occupation, paying little attention to my presence. Indeed, they came to seek material within a few yards of me. They gathered short fibers of various sorts and pieces of decaying thin leaves, chiefly of grasses. All this was found on or near the ground, for these warblers never ascended very high. Early in the morning the male sang loudly while he worked, even when his bill was full of material for the nest, and this served to distinguish him from his usually

silent mate. Later, when he sang less, I could not with certainty differentiate the sexes. In the course of two hours I credited the female with bringing material to the nest 61 times and the male, 28 times; and there were a few times more when I was not at all sure which of the two came to the nest and so did not count the visit. Each took inside and arranged what it had brought, unless it happened to find the mate within, when it passed in the material for the other to place. The male for the most part worked independently of the female and only once flew away from the nest with material in his bill in order to follow her.

Five years later I watched another pair build nest 13 in the same region. On March 30, when the outer shell of the nest was completed and the lining was being applied, the female worked alone. Between 7:18 and 8:34 she labored almost steadily, bringing material 51 times in the 76 minutes. She interrupted her task for only five minutes, when she went out of sight apparently to find food; and she picked up a few morsels as she went about her work. Fallen banana plants near the nest supplied her with both fibers and papery epidermis. She usually collected a good billful of fibers before proceeding to the nest. If the strip of epidermis was too broad, she shook it vigorously until it was reduced to a convenient size. All of her material was added to the inner wall or ceiling; the bottom of the nest was still unlined, and the bare ground could be seen through it. While the female worked, the male appeared only once, hunted food near the nest, then sang a few times and drifted away, without having shown the slightest interest in what his mate was doing. At 8:34 the female warbler brought a final billful of material to the nest, then vanished. Although I waited until 10:00, she did not return. Upon leaving, I set up two twigs in the entrance of the nest, in such a manner that a bird could not go in without upsetting them. These were still upright late in the afternoon, indicating that no work had been done that day after 8:34 a.m.

Returning the next morning at 7:00, I found both male and female warblers near the nest. The male sang once but soon flitted away. The female was actively building, and between 7:00 and 7:34 she took 23 billfuls of material into the nest. Then she was absent for 18 minutes. At 7:52 she returned alone and resumed building, and a minute or two later her mate silently came up and began to help. They continued to work together with no marked interruption for the next 74 minutes, together bringing material 90 times. I did not try to keep count of their separate contributions, for they worked mostly in silence and of course they could not be distinguished by appearance. But the male now took a very substantial part in the work. At 9:06 the female went away for six minutes, and during her absence the male sang repeatedly. But at 9:12 she returned and silent work was resumed, the pair together bringing 41 billfuls of material in the following 45 minutes.

Each of the two, if it found the other in the nest when it arrived with material, would pass its burden to the mate inside. But the female was usually more prompt to relinquish her billful to the male than he to her. When the two met at the nest, they would sometimes murmur very low, sweet notes. By ten o'clock, when I ceased observations, there was a substantial covering of fibrous material over the floor, which at the beginning of the morning had been bare. The lining of the bottom is as a rule the last stage in the construction of the Buff-rumped Warbler's nest.

These two and one other nest of which I watched the construction were in the Tér-raba Valley, where the race *veraguensis* is found. On April 9, 1941, I watched a pair belonging to the Caribbean race *leucopygius* build their nest in a niche in the vertical rocky wall of a shady dell near the Pejivalle River. The cliff, covered with ferns, mosses and liverworts, was seven feet high, and the nest was three feet above its base. This

pair co-operated in nest building in the same manner as in the birds on the opposite side of the cordillera. The female was silent; but the male sang incessantly, even a mouthful of leaves and fibers scarcely causing any diminution in the volume and ringing quality of his song. In two hours in the early morning the female brought material 64 times, the male 36 times. Each, if it found the mate inside, passed its billful through the doorway for the other to arrange, but if the nest was empty, it went in to place its own contribution.



Fig. 58. Nest of Buff-rumped Warbler with two eggs; El General, Costa Rica, August, 1936.

A nest found when newly begun appeared to be finished 13 days later; but this was the earliest nest of all that I have recorded, and perhaps for this reason it was built more leisurely than most.

The completed nest is a bulky domed or oven-shaped structure with thick, substantial walls and roof and a round doorway facing out from the bank where it is situated. The walls and roof are composed of coarse rootlets, dry grass blades, strips and shreds of banana leaf, leaf skeletons, short lengths of herbaceous vines, and weed stems. The lining in the bottom, which is the last part of the nest to be applied, is composed of fine shredded fibers and bits of light-colored leaf skeletons. This seems at times to form a separate, thick-walled cup set within the oven-shaped structure that houses it.

## THE EGGS

In seven nests, the first egg was laid between two and eight days after the structure appeared to be completed. The earliest eggs of which I have record were laid on April 3, 1940, and April 7, 1944. In six nests, the eggs were laid on consecutive days. They are usually deposited early in the morning; six eggs were laid before 7:00 a.m. and at least three of these before 6:10 a.m. The two eggs of which I timed the laying most closely were deposited between 5:35 and 6:08 a.m. and between 6:15 and 6:45 a.m.

Each of the 24 nests of this species that I have found in Costa Rica contained two eggs. The eggs are glossy white, marked about the blunt end with a usually heavy wreath of brown or reddish-brown blotches and spots, sometimes also with spots of pale lilac, and they are thinly dotted over the remaining surface with the same colors. The measurements of 20 eggs average 20.7 by 14.9 millimeters. Those showing the four extremes measured 22.2 by 15.5 and 19.4 by 14.3 millimeters.

The distribution according to the month of laying of 23 nests in the valley of El General, 2000 to 3000 feet above sea level, is as follows: April, 9; May, 11; June, 1; July, 1; August, 1.

## INCUBATION

Incubation is carried on by the female alone. At nest 13, incubation began with the laying of the second egg; but on the day this was deposited the female did not sit with the constancy which she afterward displayed. At this nest the second egg was laid before 6:00 a.m. on April 8, 1944. When I returned at 8:05 I found the eggs warm. I at once entered the blind, but the female did not come to the nest until 8:47. Then she covered the eggs for 43 minutes, leaving when she heard her mate sing for the first time in a long while. She stayed away 27 minutes, then returned and sat 12 minutes more. After leaving spontaneously, she was absent 55 minutes, returning at 11:04, when I ended my three-hour watch. As I returned at 2:05 in the afternoon the warbler flew from the nest and did not come back until 3:36. Then she remained sitting constantly until my departure at 5:05; she seemed to have settled on the nest for the night. During the six hours, she incubated only 145 minutes. This was only 40 per cent of the time and very much less than she spent on the eggs after she had warmed up to her task.

I watched this nest again from 6:00 a.m. to 12:28 p.m. on April 19, after the female warbler had been incubating 11 days. In this period of 6½ hours she took four sessions of 40+, 88, 90 and 78 minutes. Her recesses were 24, 31 and 37 minutes, respectively. Using as the basis of computation her three completed sessions and three recesses, she spent 73.6 per cent of the time on the nest. She always approached her nest by hopping for several yards over the bare ground of the gulley in front of it, picking up food here and there as she advanced. As she passed through the doorway she gave a *chip chip chip*. Then she turned to settle on the eggs, facing outward.

Early in the morning the male warbler came, stood on a fallen banana stem four or five feet in front of the nest, voiced low monosyllables and spread both wings, bringing them forward and downward in an attractive posture. He held in his bill a small morsel which he worked between his mandibles, dropped to the ground, recovered and finally swallowed. Then he went away without having gone to the nest. But in less than ten minutes he returned, approaching slowly by hopping over the ground, went directly to the nest and fed his mate while standing in the doorway, tail outward. The transfer of food was accompanied by low, murmuring notes. Then he flew off, and in the next five hours I neither saw nor heard him.

We have considered this nest out of chronological sequence for the sake of the observations made on the day the second egg was laid. I made a somewhat fuller study of

incubation at nest 3, in which the set of eggs was completed on May 10, 1939. I watched this nest during six hours of the morning of May 15, while seated without concealment on the opposite bank of the narrow stream which the nest faced. The female took five sessions on the nest, ranging from 32 to 58 minutes in length and averaging 43 minutes. Her four recesses that I timed varied from 24 to 40 minutes, with an average of 33 minutes. She devoted only 56.6 per cent of the time to incubation. Although I could not distinguish the sexes by appearance, the male identified himself by singing during each of his mate's sessions in the nest. On her return to the nest after a recess, he accompanied her to its vicinity four times out of five. Once he flew to the entrance of the nest while she was sitting within, but so far as I saw did not feed her. Most of the time he stayed out of sight and hearing.

Later I studied this nest for six hours more, divided between the mornings of May 22 and 23, when the period of incubation was drawing to an end. The five sessions that I timed in full lasted 21, 97, 68+, 5, 20, and 21 minutes, giving an average of 38.8 minutes—distinctly less than the average of this bird's sessions on the fifth morning after she began to incubate. It is to be noted, too, that her sessions had become much more variable in length. Her shortest turn on the nest, lasting only 5 minutes, was terminated when the male called her off to receive food that he had brought. Her six recesses ranged from 8 to 30 minutes, averaging 18.5 minutes. She devoted 67.7 per cent of the time to warming her eggs, considerably better than her record of a week earlier, but not so good as that of the Buff-rumped Warbler studied in 1944.

The male warbler now brought food to the vicinity of the nest more often than he had done on May 15, but for some reason he refrained from taking it to his mate while she incubated. In three hours on the morning of May 22 he thrice appeared with a laden bill. Once with low soft notes and quivering wings he called the female from the nest and fed her while the two perched side by side on a stick projecting a few inches above the smooth surface of the stream. Twice more he came with his mouth full, perched on a dead branch above the water in front of the nest, and finally swallowed what he had brought, once after he had held it for five minutes. He sang with his mouth full, at first *sotto voce*, but finally reaching the height of his ringing crescendo. On the following morning, he twice came with food in the course of three hours. Once he started toward the nest, but paused in front of it, alternately advancing and receding short distances, finally swallowing what he held and departing. When he next appeared with food, he went no nearer the nest than the shore below it, where after some hesitation he swallowed his billful and flew away. I thought that perhaps my presence on the opposite bank prevented his taking the food to the nest; but if this be true, it was not personal fear of me, but fear of disclosing to me the position of the nest, which inhibited his approach to it. He often rested quietly in front of me at only half the distance which separated me from the nest. The female was not afraid of revealing her nest to me.

The first fracture in the shell may be detected from 15 to 20 hours before the eggs hatch. The incubation period is long for a warbler. At four nests it was 16 days, counting from the laying to the hatching of the last egg; at four other nests it was 17 days; and at two nests it was 19 days—surprisingly long. One of the nests with the 19-day incubation period was situated in a roadside bank where the female was subject to frequent interruption from people passing by; only one of her eggs hatched. The following year there was another nest in the same position; the roadway was now less often used; and a single egg hatched after 17 days of incubation. But the other nest where incubation required 19 days was in a sequestered location; and I cannot account for this long period unless the female was slow in starting to incubate in earnest. At several nests I tried to determine the length of the incubation period in hours. At nest 14, the second

egg was laid before 6:55 on the morning of May 21, 1944, and hatched between 1:00 and 5:50 p.m. on June 6, giving a period between 16 days and 6 hours and 16 days and 13 hours. At nest 16, the second egg was laid between 5:35 and 6:45 a.m. on May 18, 1945, and hatched between 5:30 and 7:00 a.m. on June 4, giving a period between 16 days, 22 hours and 45 minutes and 17 days, 1 hour and 25 minutes, or 17 days  $\pm$  80 minutes.

I have never seen a Buff-rumped Warbler feign injury or give any sort of distraction display when driven from her nest.

#### THE NESTLINGS

At two nests I studied the events attending the hatching of the nestlings and leading up to food-bringing by the male parent. At nest 3 both eggs were pipped on the afternoon of May 25, and at dawn next morning I resumed my watch of this nest, this time from a blind. At 6:22, while the female was absent, the male went to the doorway of the nest with food in his bill. Although the eggs were still unhatched, he murmured low, soft notes, as though coaxing nestlings to eat; just as I had seen a male Pink-headed Warbler offer food to eggs years earlier. He withdrew several feet, then returned and repeated the act, but finally flew off with his morsel. A little later he returned with a billful of small insects and stood before the nest, murmuring as on his last visit. The female was now within and refused to receive his offering, so again it was carried away. Her cold reception of her mate confirmed a suspicion that I had already begun to entertain that when the male warbler came with food he hesitated to take it to the nest while the female sat, because she did not respond.

At 9:03 that same morning, the female warbler, who had been sitting restlessly, flew from the nest with a piece of shell in her bill, advising me that an egg had hatched. She voiced two sharp notes as she departed, flying over her mate, who was at the moment resting on a bough above the bank in front of the nest. Soon he followed her upstream. In the next three hours, the female warbler ate two more pieces of shell while sitting in the nest, indicating that the second egg had also hatched. She fed the nestlings six or seven times, in the intervals between brooding, and she twice more received food from her mate, while they stood side by side on driftwood by the bank. But throughout this period the male did not again visit the nest, and to all appearances he remained in ignorance of the important event that had occurred there.

Shortly after-noon, while the female warbler was away, the male returned to the stream in front of the nest and caught tiny insects from the air until his mouth was stuffed with them. Then he remained along the shore, awaiting his mate's return. When at length she flew downstream and came to rest on the end of a stick projecting a few inches above the water, he promptly flew to her side and, quivering his wings, uttered low, soft notes. But she could not take the proffered food, for her mouth was already quite full with what she had been gathering for the nestlings. Going to the nest, she fed them through the doorway, then entered to brood. When she had settled down, the male came to the doorway (for the first time since seven o'clock that morning), and passed many insects to her. This was at 12:25 p.m.

Whether on this visit the male warbler learned that the nestlings had hatched I could not tell. It is not likely that he saw them. But what he did without any doubt discover was that his mate was now eager for food at the nest, and he was at last free to bring it to her, as for several days at least he had apparently been eager to do. In the next hour he brought eight brimming billfuls of insects and delivered them to her while she sat. Some of this food was passed on to the nestlings; but since it was far more than they could use, their mother ate the surplus, and she was soon so stuffed that she could



hardly swallow more. During this hour she brooded continuously, whereas in the hour preceding the male's discovery of her new requirements she left the nest twice to hunt food, remaining absent for a total of twenty minutes. The change in the male's behavior after his revealing visit to the nest was sharply marked. In the preceding seven hours he had appeared with food only four times, and only twice had he gone to the nest with it. At 12:25 his rate of food-bringing abruptly increased fourteen fold. It seems that male birds, when they take no share in incubation, are at times so eager to have something to occupy them, that when the nestlings first hatch they bring to the nest far more food than is necessary. Later, when the novelty of the occupation wears off, they adjust the amount of food they bring to the demand for it.

I also watched nest 13 on the morning the eggs hatched. At daybreak on April 24 both eggs were pipped. At 6:40 I entered the blind to wait for their hatching. Although I had heard the male singing at 7:50, I did not see him until 8:35, when he came to the nearest point on the shore of the stream, his bill laden with food. His mate was then taking a recess from her eggs; and he delayed here, murmuring softly, until she flew up beside him on the fallen branch, begged with quivering wings and low notes, received the insects, and then continued to the nest, hopping slowly over the ground and hunting as she went, in her customary manner. At 8:51 the male gave his mate a green insect while she sat, and at 10:10 he brought a whole mouthful of insects to her in the nest. A minute later she departed; and going to the nest I found the bird in one of the eggs in the act of pushing off the cap of the severed shell.

At 10:34 the female warbler returned, delayed for two minutes to preen on a log directly in front of the blind, where I might have touched her with my feet, then continued to the nest. For less than a minute she stood in her doorway contemplating the nestling; then she entered to brood it, but almost at once rose up again, poked down into the bottom of the nest with her bill and repeated this over and over, seeming to pluck at something. She lifted a piece of shell slightly and dropped it again. Finally, at 10:40, she gobbled down half of the shell, then continued to brood. At 11:02 she began to eat the other piece, dropped it through the doorway, stretched out her head to retrieve it from the foundation of the nest where it rested, and swallowed it.

Meanwhile, at 11:00, the male had appeared on the brink of the stream with food in his mouth. He called with very low, soft notes—*wit wit wit*—and continued to snatch insects from the air until mouth and bill could hold no more. How he managed to open his bill to take another without dropping a large part of his load, I could not understand. Proceeding slowly over the ground, he reached the nest at 11:07 with a brimming load of small insects. With low, soft murmurs the female took the food from him, then rose up and offered it to the nestling beneath her, continuing to present it while the male stood in the doorway looking in. Thus he had his first view of his progeny. He lingered in the entranceway two or three minutes, flagging his tail up and down, producing still more insects from his throat, and passing them to his mate as she needed them. Then he flew away.

In the next hour, while the female continued constantly in the nest, her mate brought food to the doorway six times. It should be remembered that in the preceding 4½ hours, before he saw the nestling at 11:07, he fed the female only four times in my presence, on the nest and off. Thus the sight of the nestling caused a more than sixfold increase in his rate of bringing food. The mother patiently offered to the nestling the insects her mate brought, but the nestling's capacity was far too limited for them all, and she ate a large share herself—so much, in fact, that she could stay in the nest for two hours and seven minutes (127 minutes) without interruption. In ten hours of watching, I had not previously seen her incubate for longer than 91 minutes continuously. When at length

she left the nest, at 12:43 p.m., the male was again approaching with food; but on seeing her go he followed and fed her while the two stood side by side on a log floating in the backwater of the creek.

The newly hatched Buff-rumped Warblers bear scanty gray natal down quite insufficient to conceal their pink skins, and their eyes are tightly closed. The interior of the mouth is yellow. Although fed by both parents, they are brooded by the female alone. At the age of ten days they are clothed with feathers, but if undisturbed they linger in the nest several days longer. From one nest they left, apparently spontaneously, at the age of 12 days, from another nest at 13 days, and from two more nests at 14 days. In each of these nests two fledglings were reared; but a nestling that grew up alone stayed in the nest for 15 days. Upon leaving the nest the young birds hide in the dense vegetation and are extremely hard to find. When at last they become active and conspicuous, they are difficult to distinguish from the adults. Long before the end of the year, I can detect no differences between the youngsters a few months old and their parents.

Before the end of June most of the nests are empty. I have only two records of nests occupied at later dates; one of these contained eggs on July 6 and the other on August 7. Since the Buff-rumped Warblers begin to build in March, they would have time to rear two or even three broods before the end of August. But from my failure to find late nests near the sites of successful early ones, I suspect that this warbler, like most members of the family, rears but a single brood each year, and that those individuals which were incubating in July and August had been unsuccessful in their earlier attempts.

#### SUMMARY

Buff-rumped Warblers forage chiefly along streams in the foothills and lower mountains up to about 3500 feet above sea level in Costa Rica. They hunt for their invertebrate food over the ground, rocks and fallen logs, hopping and flitting along rather than walking and rarely rising ten feet into the air. They remain mated throughout the year.

Both sexes sing, the male profusely with a loud, ringing crescendo that rises above the babble of rushing water; the female on rare occasions answers him with a warble very different from his song. They sing throughout the year, but most freely in the breeding season.

In El General the nesting season extends from March to August. Both sexes build the oven-shaped nest, which is placed on a shelf or in a niche on a bank or steep slope, often close to or beside a river.

Two eggs are laid early on consecutive mornings. Only the female incubates, taking sessions up to 1½ hours in length and keeping the eggs covered from 56 to 74 per cent of the day. The period of incubation is 16, 17, or, exceptionally, 19 days.

From time to time during incubation the male brings food which he delivers to his mate on or near the nest. One male brought food to the eggs shortly before they hatched.

The nestlings are brooded by the female and are fed by both parents, the male beginning to attend them within a few hours of hatching. They remain in the nest 13 or 14 days, more rarely 12 or 15 days.

Upon leaving the nest the young warblers remain in dense vegetation, where they are extremely difficult to see. When at last they become more active and conspicuous, they can no longer be distinguished from the adults, having acquired a plumage essentially like that of the adults in the postjuvinal molt.

Apparently a single brood is reared each year.

## SLATE-THROATED REDSTART<sup>1</sup>

### *Myioborus miniatus*

The Slate-throated Redstart is the more common and widely distributed of the two species of *Myioborus* which occur in Costa Rica. The subspecies *Myioborus miniatus aurantiacus* is confined to this republic, but closely similar races are widespread in the mountains of northern and western South America and northward to México. In Costa Rica, the Slate-throated Redstart is found only at middle altitudes. Carriker (1910: 800) gives its altitudinal range as 2000 to 7000 feet above sea level. It must be very rare at 2000 feet; for on the Caribbean slope I have never met it below 3000 feet, and seldom even at this altitude. On the Pacific slope, where I have spent much time, I have not encountered the bird below 3700 feet.

In contrast with the Guatemalan race (*hellmayri*) of the Slate-throated Redstart the breast and belly of this form are cadmium yellow instead of orange-red. Most of its head, its back, wings, most of the tail, throat and the sides of its breast are dark slate-color. The center of the crown is chestnut, and the outer tail feathers are broadly tipped with white. The male and female are colored so nearly alike that it is usually not possible to recognize any difference in their plumage.

In the vicinity of Vara Blanca, on the northern slope of the Cordillera Central of Costa Rica, I found this yellow-bellied race very numerous between 5000 and 6000 feet above sea level. Here they dwelt in the humid, moss-draped cloud-forest, but they usually avoided the darker depths and were most often seen along its bushy edges, whence they ventured forth among the scattered trees and shrubs of the adjoining fields and pastures. Yet they rarely wandered far from the woodland and the heavier second-growth thickets. They remained mated through the year. In this they differed sharply from Slate-throated Redstarts of the Guatemalan highlands, which habitually lived singly during that long portion of the year when they were not engaged in nesting. In the eastern foothills of the Ecuadorian Andes, in August and September when they were apparently not nesting, I found the pale-bellied race of the Slate-throated Redstart living in pairs or alone.

#### FOOD

This race hunts among the branches of the trees less constantly than does *hellmayri* of Guatemala; it forages far more frequently among the bushes along the margin of the forest, often quite near the ground, where it sometimes alights to pick up an insect. It rarely ascends to the tops of the higher trees. It has the same sprightly, active ways as the other redstarts, and it catches much of its insect food on the wing, making short sallies out from the bushes, frequently doubling and twisting through the air in an intricate course. It is, as a rule, somewhat less spectacular in its movements than *hellmayri* and the American Redstart, probably because it forages so much among low bushes, often in close, tangled vegetation, rather than in the more open crowns of trees. Sometimes, as they flit about in search of insects, they spread fanwise the feathers of their tail, displaying the two white plumes on either side in contrast to their dark central tail-feathers and upper plumage. Like the Guatemalan race, this form sometimes forages over the bark of trees. One April morning at dawn, I watched a male redstart ascend the clean, smooth trunk of a medium-sized tree, searching for insects as he went. He clung to the bark, then flitted up a short distance and clung again, repeating this

<sup>1</sup>This and the following life history are adapted from accounts first published in the Wilson Bulletin, 57, 1945:217-242.

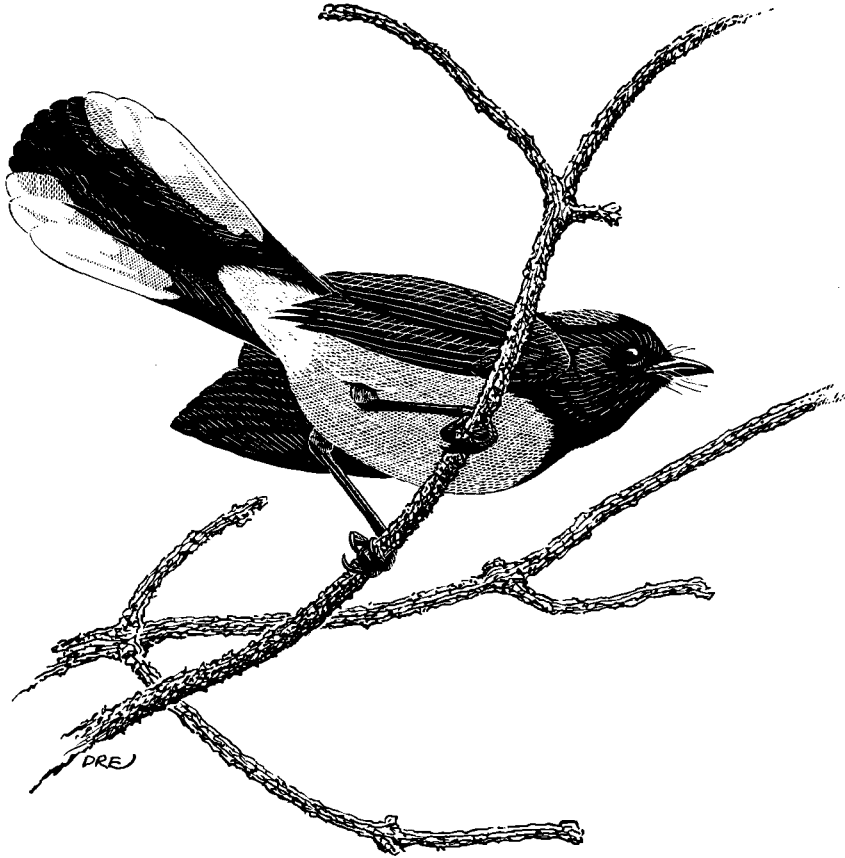


Fig. 59. Slate-throated Redstart.

until he reached the branches above. Here he flitted about, his wings drooping when not in use, his tail prettily spread, and sang his sweet, homely song.

The redstarts' almost exclusively insect diet is from time to time varied with the little white protein bodies which they pluck from the brown, hairy cushions at the bases of the long petioles of the great leaves of the *Cecropia* trees. These ovoid corpuscles, the size of a mustard seed, are the chief food of the azteca ants that make their homes in the hollow stems and branches of the tree; but when the ants are absent, as is often true at higher altitudes in the subtropical zone, they accumulate in numbers and are eaten by small birds — wintering warblers of several kinds, small finches, honeycreepers and ovenbirds, as well as redstarts.

#### VOICE

The simple song of *aurantiacus* is pleasant, but neither strong nor ringing in tone—*chee chee chee chee chee chee*, the notes rising slightly in pitch toward the end. Its notes are far less full and rich than those of the race *hellmayri* and than those of the Collared Redstart or the Painted Redstart; its phrasing is less varied than that of the Collared Redstart and the American Redstart. But the male does not restrict his singing to the season of courtship and nesting; he is heard in pleasant weather in every month of

the year, although more rarely during the gloomy period from October to January. The call of this redstart is a weak *chip*.

#### NEST BUILDING

In 1938, I found the first nest of this redstart on March 30, when it was already nearly completed. It was situated in a niche six feet above the base of a cut-bank eight feet high, beside a muddy mountain road along which many people passed. The little pocket in the clay wall was just big enough to contain the nest, and the site was further shielded from the elements by an overhang of root-bound earth at the top of the bank. Yet the nest, composed principally of straws, dry grass-blades and fibrous rootlets, was a roofed structure, with a round doorway in the side facing out from the bank; and moreover, the roof had been made very thick. It may have served to shield the interior of the nest from falling particles of earth if not from the rain. The side walls were still thin, and one could see the earth of the bank through the right side of the nest. The floor of the nest, as is usual in such structures, had been left until the last; and when I first looked in, the earthen bottom of the niche had not been covered over. It was to the covering and lining of the bottom that the builder devoted most attention while I watched on the morning of March 30.

Since the redstart was too cautious to go to her nest while I stood in the roadway, in order to watch her at work I was obliged to screen myself within the border of the high grass in the pasture below the road. Later, when she had become somewhat accustomed to her observer, I moved closer and stood behind a small cypress tree that had been planted beside the road. I watched for two hours, from eight to ten o'clock, in which period the female warbler brought material to the nest 54 times. She picked up straws, grass blades and other fine bits of vegetation from the road and the slope above the bank, and sometimes tried to pull exposed slender rootlets from the bank, but usually without success. Later in the morning, when she had begun to line the nest, she brought, from the woods that began a short distance back from the top of the bank, sheafs of fine brown fibers, of whose origin I remained in ignorance. She also visited a thick stump, overgrown with epiphytic bushes, ferns and mosses, which stood at the edge of the road close beside me, vanishing into its cavities and fern-shaded recesses, to re-appear with her bill full of thread-like rootlets. She was usually cautious in approaching her nest and perched upon some fallen brush beside the bank to look about her before she entered.

At this nest the male redstart did not help with the work of building. Most of the time while his mate worked, he remained among the bushes on the slope above the nest, where he hunted insects and often sang. From time to time he came to perch upon a slender dead stem that projected from the bank a few feet from the nest. Here he sometimes sang, but mostly rested in silence. At times he hovered in front of the nest to look in; and once, while his mate was within arranging the material that she had brought, he came to stand upon the sill of the doorway. The female evidently did not approve of this visit, for she opened her bill in a threatening attitude.

On April 1, I found another nest being built in a very different sort of position. It was on the ground on a very steep slope in a bean patch overgrown with low weeds, about thirty feet from the edge of the forest. It occupied a slight depression in the slope, and the sill of the entrance was just level with the ground in front. The fronds of a small fern, growing above the nest, bent prettily over the domed roof; it was screened in front by a seedling *Cecropia* tree, and on the sides by tufts of grass. The slender trunk of a fallen tree, bridging the concavity in the hillside, stretched above the nest, helping to conceal and shelter it. The nest itself resembled the first that I found; it was entirely enclosed except for the round doorway in the side facing down the slope. The walls,

roof, and cupped bottom were all quite thick; they were composed of soft, fibrous vegetable materials, with some decaying grass blades intermixed. The nest was already nearly finished.

The male and female redstarts were building this nest together. Since I could not distinguish them by appearance, and since the male sang very little, and not at all while he worked, I was not able to determine the relative part taken by each sex in building. The two made no attempt to come and go together, as tanagers of many kinds do; but each went its own way independently of the other. Yet despite this lack of co-ordination in their movements, on 10 occasions in the course of the hour and a half between 9:00 and 10:30, I had proof that both birds worked at the nest, since I saw the second fly up to it with material in its bill, before the first, which had already added its contribution to the structure, had left the clearing. From this it was evident that both male and female took substantial parts in the labor of building. This was the first time that I had seen a male wood warbler of any kind build a nest.

Among other things, the birds upon several occasions brought billfuls of the brown scales of a fern to their nest. I saw one of them pull these scales from the bases of the great, thick, spine-studded petioles of the huge, spreading fronds of a tall tree-fern that grew at the edge of the neighboring forest. While I watched these redstarts build their nest, I sat at the base of a tree on the slope above them, in plain view and at no great distance. At first, the birds, upon arriving with material in their bills, flitted about in the offing and hesitated to approach their nest, but soon they grew accustomed to my presence and went about their labors without fear.

The third nest at which I watched building was situated quite differently from the first two. A small fallen log, densely covered with slender aroids, ferns, mosses, and other epiphytic growths, lay in a pasture about 10 feet from the edge of the forest. The nest was built upon the log, where it fitted snugly into a nook beneath the stems and roots of the epiphytes; it was completely covered over by a thick layer of moss. The round entrance was screened by a bromeliad and the foliage of several small epiphytic shrubs. On the morning of April 5, after the cessation of the rain, I watched this nest from 9:15 to 10:15. It appeared to be finished, but the industrious builder continued to augment the already ample lining. In the course of the hour, she took material to the nest 15 times. Her mate flitted about in the vicinity, catching insects and often singing; but I saw nothing to suggest that he helped to build.

Two days earlier, I had watched yet another nest, whose builder, shier than most of her kind, would not go to her work in my presence. Here, too, I saw nothing to suggest that the male would have helped his mate to build. Quite a number of times I saw one of the pair flitting about with material in its bill, hesitating to approach the nest, but never two birds together with material. (When both members of a pair of birds build the nest, yet do not often come to it together, sometimes the best way to prove that they both work is to delay their approach to the structure by standing near it and preventing the deposit of material until both have arrived with laden bills.)

The following day, I spent a short while at a fourth nest, also without finding any evidence that the male helped to build. The male redstart that took so large a share in the construction of the nest in the bean field was evidently exceptional in his species, as he was among wood warblers in general. I wanted very much to see whether he would take an abnormal part of the subsequent duties of the nest, but unhappily it was prematurely destroyed.

The male Buff-rumped Warbler regularly takes a large share in building. But nest construction by male wood warblers has been rarely recorded in print; and aside from the single Slate-throated Redstart and the Buff-rumped Warblers, I have never myself

seen a male at work. It is possible that at the other redstart nests I watched, the male helped to build at other stages of construction, but I do not think this is likely.

We have already called attention to a considerable variation in the redstarts' nest sites: niches in cut banks; a slight depression on a very steep slope among sheltering vegetation; a fallen log amid low, dense epiphytic growth. But a cranny in a bank appeared to be the most favored location; 11 of the 14 nests found in 1938 were so situated. The cottage that I occupied at Vara Blanca stood amid pastures which covered the back of a narrow ridge falling away steeply on three sides to wooded ravines or gorges. On the western side of the pasture, a footpath followed along the side of the ridge for a distance of about a quarter of a mile. Along much of its length, this path had been cut into the steep slope, making a bank, in places three or four feet high, that faced the bushy border of the woods across the path and had the grassy hillside rising behind it. This low bank, in places covered by grasses creeping down from above, in others overgrown with ferns and small native herbs, was a favorite nesting site of the Slate-throated Redstarts. In this one long bank eight of their nests were built between the end of March and late May. Most were well screened by surrounding vegetation. They were well separated, no two close together, although one was only 29 feet from an occupied nest of the Collared Redstart.

Although I did not have the good fortune to witness the very beginning of nest building in any instance, from the examination of completed nests I learned something about the earliest stages of construction. After the selection of the nest site, the redstart's first task was to carry into the cavity fairly large dead leaves to serve as a foundation for the nest. These leaves included the foliage of dicotyledonous plants and bamboos, and fragments of the fronds of ferns. Some measured as much as six inches in length. Often a number was strewn in front of the nest site, whether intentionally or by accident I cannot say. From the ground in front of one of the nests, I picked up a double handful of dead leaves which obviously had not merely fallen from neighboring trees. I found a number of niches in banks, such as might have been selected by the redstarts for their nests, which contained a small accumulation of dead leaves, mixed at times with some straws and the like, all of which appeared to have been quite recently placed there. Apparently the redstarts had prepared to build in these crannies, but afterward abandoned them in favor of other sites that pleased them better. Some of the pockets that contained completed nests were lined all around with dry bamboo leaves; in others, this lining was confined to the sides and bottom. The Collared Redstart likewise builds its nest upon a foundation of broad dead leaves.

The nest beside the main trail, which I had watched as the bird built on March 30, was found lying in the roadway on the following day. On April 2, this bird had a half-finished nest only four inches from the site of her first. By the afternoon of April 3, the new structure appeared to be finished, after three (or at most four) days of work—only to meet the same fate as its predecessor. Another nest, found on April 2 when newly begun, appeared complete by April 5. A late nest was found in an early stage of construction on May 19 and seemed to be finished on May 23. Accordingly, the redstarts build their roofed nests in from three to five days.

#### THE EGGS

Despite the speed with which these rather bulky nests were constructed, about a week elapsed between the completion of the work and the laying of the first egg. This long period between the end of active building and the appearance of the first egg was noted at all seven of the early nests for which information is available. But a late nest (evi-

dently a replacement), found under construction on May 19, was completed about May 23 and contained the first egg on May 25 (see table 12).

The redstarts at Vara Blanca quite generally began to build their nests in the last days of March or the beginning of April. The earliest egg was found on April 7 (nest 7). In nine nests, the first egg was laid in the week from April 7 to 13, inclusive. (Nest 10 is included in this number, from the calculated date of laying.) The three nests found with eggs in May were probably all replacements of earlier nests that had been lost. This close synchronization in the time of laying is surprising in a bird that dwells throughout the year in a region without marked seasonal variations in climate; yet it is paralleled, in my experience, in several other kinds of tropical birds. At Vara Blanca I kept only rough notes on the weather, and took records of maximum and minimum temperatures with a Six's thermometer that was probably none too accurate. During my residence there, from July, 1937, to August, 1938, the only pronounced seasonal difference in weather occurred in the period from February to August, 1938, when the rain storms were less protracted and severe than they had been during the preceding seven months. But during April, May and June, when the great majority of the birds were nesting, there was much cloudiness and rain, and a dearth of sunshine.

The eggs were laid early in the morning — I have four records of eggs laid before 7:30 a.m. — and at intervals of one day. Eleven nests contained each three eggs or nestlings; two contained two eggs each. The eggs were white or dull white, speckled and blotched with some shade of brown, ranging from bright brown to chocolate. The pigmentation was heaviest in a wreath about the point of greatest transverse diameter, or in a cap covering the larger end. The remaining surface was more lightly spotted with the same color, the heaviness of the pigmentation varying considerably in different sets. The measurements of 20 eggs average 17.5 by 13.4 millimeters. The eggs showing the four extremes measured 18.3 by 13.9, 16.7 by 13.5, and 17.5 by 13.1 millimeters. Six eggs showed the minimum diameter of 13.1 millimeters.

#### INCUBATION

Incubation apparently began with the laying of the last egg of the set. The fact that in every instance for which information is available the eggs in the same set all hatched within an interval of approximately 24 hours, suggests that the redstarts incubated little before their sets were complete. The nest that I most wanted to watch during the period of incubation—that which the male had helped to build—was prematurely destroyed; and the others seemed less important to study during this period than those of some other species of birds that then claimed my attention. It is almost certain that the female incubates without help from her mate, as in all other wood warblers for which I have information.

The incubation period varied from 13 to 15 days. Three eggs in one nest hatched 13 days after the set was completed and incubation presumably began; three eggs in one nest hatched in 14 days; nine eggs in four nests hatched in 15 days. The eggs of the non-migratory Central American warblers seem generally to require a few days more of incubation than those of the migratory species that breed in temperate North America. I have one record for the Collared Redstart, 15 days; one for the Pink-headed Warbler, 16 days; ten records for the Buff-rumped Warbler, 16, 17, or abnormally 19 days. The eggs of North American warblers frequently hatch after only 11 or 12 days of incubation.

#### THE NESTLINGS

The newly hatched redstarts were pink-skinned and blind, and they had the usual sparse passerine down. At the age of 9 or 10 days, they were well clothed with feath-



ers, and after the age of 10 or 11 days, they were no longer brooded during the night. They left the nest when from 12 to 14 days of age. Six nestlings in three nests left at the age of 12 days; two in one nest, at the age of 14 days. I handled none of these nestlings after they began to become feathered, and the departure of all was probably spontaneous. At one nest (no. 11), however, I removed two nine-day-old nestlings for examination of their under plumage. As I lifted one from the nest, the other tried to jump out. When I had completed my notes on the plumage, I returned both nestlings and persuaded them to remain at home, at least until I was out of sight. But the following day the nest was empty. The nestling period of these youngsters that had been handled was accordingly only 10 days, as compared with the 12 to 14 days of undisturbed young redstarts.

Table 12

Synoptic History of 14 Nests of the Slate-throated Redstart at Vara Blanca de Sarapiquí,  
Costa Rica, 5300-5600 feet, March-June, 1938

- Nest 1—Building March 30; destroyed by man, March 31.  
 Nest 1a—Building 4 inches from nest 1, April 2; apparently completed, April 3; met same fate as nest 1, April 6.  
 Nest 2—Building April 1; 3 eggs laid April 8, 9, and (presumably) 10; eggs broken and eaten, April 16.  
 Nest 3—Begun about April 2; apparently completed April 5; 3 eggs laid April 12, 13, and 14; 3 nestlings April 28; all dead in nest May 4.  
 Nest 3a—Found completed, resting on nest 3, June 7; apparently never contained eggs.  
 Nest 4—Nearly completed, April 4; 3 eggs laid April 12, 13, and 14; eggs broken and eaten, April 28.  
 Nest 5—Nearly completed, April 4; 3 eggs laid April 12, 13, and 14; 3 nestlings, April 27; nestlings disappeared, May 4, 5.  
 Nest 6—Apparently completed, April 2; 3 eggs laid April 8, 9, and 10; 2 nestlings, April 25; nestlings departed May 9.  
 Nest 7—Found with 1 egg, April 7; second egg laid April 8; 2 nestlings, April 23; nestlings departed, May 5.  
 Nest 8—Apparently completed, April 6; 3 eggs laid April 13, 14, and (presumably) 15; eggs disappeared, April 18.  
 Nest 9—Apparently completed, April 7; 3 eggs laid April 13 to 15; 3 nestlings hatched April 30; nestlings departed May 12.  
 Nest 10—Found with 3 nestlings a few days old, April 27. Subsequent history unknown.  
 Nest 11—Found with 2 eggs, May 4; 2 nestlings hatched May 16; nestlings departed May 26 (had been removed for examination).  
 Nest 12—Found with 3 eggs, May 4; 1 nestling hatched May 13 (other 2 eggs infertile); nestling departed May 25.  
 Nest 13—Found with 3 nestlings in pin-feathers, May 8; nestlings well feathered, May 16.  
 Nest 14—Building May 19; nest completed, May 23; 3 eggs laid May 25, 26, and 27; 2 nestlings hatched June 11; nestlings disappeared June 18 (near site of nest 2 and probably belonged to the same pair).

#### REPRODUCTIVE SUCCESS

Tables 12 and 13 give data for the 14 redstart nests whose histories are adequately known, including two replacements at the sites of earlier nests that had been despoiled. Of the 31 eggs laid, 10, or 32 per cent produced fledglings; of the 11 nests that contained these eggs, 5, or 45 per cent produced at least one fledgling. In my experience, this is about average success in reproduction among Central American birds—rather better than one would expect in the lowlands but not so good as might be found at still higher latitudes. I continued field-work in the same locality until the middle of August but found no evidence of a second brood. The one nest whose dates suggest a second brood (no. 14) was near the site of an earlier nest from which the eggs had been lost.

Wood warblers in general appear to raise only one brood in a year; in this the species of the Central American highlands agree, so far as we know, with those that breed in the North Temperate Zone.

Table 13  
Reproductive Success of the Slate-throated Redstart\*

Nest	Number laid	Eggs			Nestlings	
		De- stroyed	Not hatched	Hatched	Died or lost	Left nest
1	0	....	....	....	....	....
1a	0	....	....	....	....	....
2	3	3	....	....	....	....
3	3	0	0	3	3	0
3a	0	....	....	....	....	....
4	3	3	....	....	....	....
5	3	0	0	3	3	0
6	3	0	1	2	0	2
7	2	0	0	2	0	2
8	3	3	....	....	....	....
9	3	0	0	3	0	3
11	2	0	0	2	0	2
12	3	0	2	1	0	1
14	3	0	1	2	2	0
Totals	31	9	4	18	8	10
per cent	100	29	13	58	26	32
Totals, by nests	11	3	3	8	3	5
per cent	100	27	27	73	27	45

\* Based on the nests listed in Table 12; nests 10 and 13, whose history is unknown, are omitted.

#### INJURY FEIGNING

Sometimes, when they were interrupted while incubating their eggs or brooding their nestlings, the Slate-throated Redstarts would feign injury in front of the nest. Since I passed almost every day, and often several times a day, along the path beside which most of these nests were situated, I enjoyed an excellent opportunity to witness these displays and to learn something of the circumstances under which they took place. Other things being equal, whether or not a bird will feign injury often depends upon whether it finds a suitably clear area in which to perform; for although it has been claimed that birds are hysterical, or half-crazed, or otherwise not in full control of their faculties when they behave in this manner, they are usually sufficiently in possession of their wits not to beat their wings and flap about amid dense vegetation, where there is danger of their becoming entangled and falling an easy prey to their enemies. Since all these redstarts had, in the clear pathway in front of their nests, a suitable stage upon which to act, variations in behavior might be attributed to individual differences among the birds rather than to the varying nature of the surrounding area.

Of the eight Slate-throated Redstarts that nested in the bank beside the path, three were never seen to make any special display upon leaving the nest. Two of these successfully reared fledglings, but the third lost her eggs when they were on the point of hatching. The remaining five redstarts varied considerably as to the stage of the nesting at which they displayed. The female of nest 6 feigned injury soon after she began to incubate, but not thereafter, although she successfully raised her nestlings. The owner of nest 8 gave an excellent performance the day after she began to incubate. Two days later she lost her eggs. The redstart of nest 11 displayed nine days before her eggs hatched. At nest 7, the female feigned injury only on the day her eggs hatched. At nest 3,

the performance was witnessed three days before hatching, on the day the eggs hatched, and when the nestlings were two days old. Even in a single day, the same bird did not consistently feign injury when driven from the nest. Possibly this depended upon how long she had been sitting before she was interrupted (see Pickwell, in Bent, 1942:349).

Usually the Slate-throated Redstarts sat bravely, permitting me to approach very close to them before they fled from the nest. Some would allow me almost to touch them; others would sit steadfast and return my gaze with eyes only a hand's-breadth from my own. But a closer approach would cause them to dart past me and fly toward the neighboring woods. There was no relationship between the closeness of the bird's sitting and her display upon leaving; some of the redstarts that would allow me to come within a few inches of touching them never feigned injury. Those birds that attempted to lure me from the nest by the distraction display usually dropped from their nests into the pathway almost at my feet, where they vibrated their relaxed wings and moved slowly, as though injured, toward the bushes on the farther side. Others would flit directly from the nest to the vegetation at the edge of the neighboring forest, where they raised and fluttered their wings, depressed their tail, and hopped mincingly from stem to stem, always keeping near the ground. Sometimes, after passing from view amidst the foliage, they would return to the edge and continue to perform where they caught my eye. Such behavior certainly seemed purposive and not merely a substitute reaction.

*The fledglings.*—When they left the nest, the young redstarts wore a plumage very much duller than that of the adults. The head was dingy black, with no chestnut on the crown. The upper plumage, throat and chest were dark slate-color. The lower breast and belly were buff. The outer tail feathers, so far as they could be seen, were white as in the adults. This body plumage was worn only for a brief period, for soon after beginning to fly the young birds started to acquire the colors of the adults. The last remaining mark of immaturity was the crown; but by mid-July some individuals displayed chestnut feathers on their heads. Soon there was little difference between the adults and the young of the year. By October the young birds, now indistinguishable from their elders, appeared to have mated; for most Slate-throated Redstarts of this subspecies that I saw then were in pairs.

#### SUPPLEMENTARY DATA ON THE RACE

##### *Myioborus miniatus hellmayri*

The subspecies *hellmayri*, which has orange-red underparts, is confined to the western highlands of Guatemala and extreme southwestern El Salvador. In Guatemala, I met this form in many localities, and in 1933 I found its nest on the Sierra de Tecpán, Department of Chimaltenango, at an altitude of about 8500 feet. It was seen at points ranging from 2000 to 9500 feet above sea level, although at both of these extremes of elevation it is rare. It is particularly abundant in the heavy, humid forests at middle altitudes on the Pacific slope, from 5000 to 7000 feet above sea level, as, for example, on the wooded flanks of the Volcán Zunil opposite Santa María de Jesús, where in July and August, 1934, I found it among the most conspicuous members of the avifauna.

This race of the Slate-throated Redstart catches a large part of its insect food on the wing. It flits airily amid the foliage, or with consummate deftness weaves an intricate course among the branches, to reach some insect it has seen in a distant part of the tree; or it darts swiftly in pursuit of some creature that has taken flight, twisting, turning and doubling in the air with amazing skill. In its quieter intervals of hopping and jumping among the branches it often droops its wings and spreads its tail, displaying the broad white tips of the outer feathers.

Except during the few months when it breeds, *hellmayri* strictly avoids the company of its own kind, but attaches itself to the large mixed flocks of wood warblers and other small birds that roam through the highland forests, in each of which a single Slate-throated Redstart is usually to be seen. Here it is conspicuous by reason of its spectacular flight, its flaming breast, and its habit of continually spreading its tail. As the breeding season approaches, the males attract still further attention by their song. Although simple in phrasing, it is loud, clear and ringing—the most forceful of all the songs of the warblers I heard on the Sierra de Tecpán, except only that of the Painted Redstart.

*Nest and eggs.*—On the afternoon of May 13, 1933, while climbing a steep, wooded slope on the Sierra de Tecpán, beneath fine, old, epiphyte-laden trees, I stumbled over a decaying log and frightened a small, blackish-backed bird from its nest. It flew off so rapidly that I saw it only imperfectly and could not identify it. The nest was situated on the uphill side of a large depression in the ground made by the uprooting of the great tree whose massive trunk lay mouldering on the slope below. The tree must have fallen some years earlier, for the sides of the hollow were already well covered with ferns and mosses, among which the nest was concealed. The structure consisted of a cup-shaped lower portion and a domed roof. The entrance, in the side facing out from the bank, was not round like that of the nests of other forms of *Myioborus* that I found in later years in Costa Rica, but it was very much wider than high. The lower cup was composed of dead leaves and fibers, thickly lined with fine fibrous material; but the substantial roof, which seemed to have been added as a separate unit, consisted largely of pine needles, with a few dead leaves of dicotyledonous plants intermixed.

The three beautiful eggs which rested in the bottom of the nest were white, heavily speckled with reddish brown, especially on the thicker end; they measured 17.5 by 13.5, 17.5 by 13.5 and 17.5 by 13.1 millimeters. The tip of the pendent frond of a small fern, rooted higher on the bank, hung prettily in front of the entrance and partly screened the eggs.

Dickey and van Rossem (1938:506) describe a nest of this redstart found in El Salvador, May 17, 1927, which "was in a crevice in a vertical road bank, the site being about three feet above the road level. It was simply a ball of bright green moss which entirely filled the cavity, and the outer surface of the nest was flush with the face of the bank. The entrance was a small hole in the side. The lining was of rather wide strips of what appeared to be soft inner bark. A sheltering curtain of ferns hung down over the nest entrance, and the site was discovered only by watching the parents as they carried food to the young."

*Incubation.*—After I found the nest, I waited many minutes for the bird to return, but it seemed reluctant to show itself in my presence and I left. Returning on the following day, I was delighted to find a Slate-throated Redstart sitting in the domed nest. The bird allowed me to approach almost within reach before she jumped out and flew down the slope, skimming low above the ground. I set up my tent in the depression, not two yards from the nest, for there was no other level spot in the vicinity. I seated myself inside, and looked out through the window for the redstart's return. Promptly re-appearing, the bird fluttered back and forth in front of the nest, apparently not sure whether it would be quite safe to go to it in the presence of the strange brown object that had so suddenly sprung up there. Many times the redstart approached the nest and seemed to be on the point of entering but retreated before quite reaching the goal. Finally, ten minutes after I entered the blind, the bird was warming her eggs once more.

The next step was to mark one of the pair of redstarts, in order to distinguish male from female with certainty. After the bird's departure from the nest, I stuck upright

in the middle of the doorway a fine twig bearing a wad of cotton soaked in white enamel. Once more the bird flew back and forth in front of the nest; sometimes it alighted on a dead branch which projected from the bank just outside the blind, proving thereby that it had already lost all distrust of this strange object. Before many minutes had passed, the bird returned to the nest and attempted to slip into it between the little paintbrush and one corner of the wide entrance. In doing so, it brushed lightly against the paint-soaked cotton. This seemed to annoy the bird greatly; it slipped out immediately and at once began to preen the feathers on the left side of the orange breast, where a small spot of white marred their uniform brightness. The mark was hardly conspicuous enough to satisfy me, and the redstart was doing her best to make it less so; accordingly I left the brush in place so that the bird might make contact with it once more. Although it remained there for more than half an hour, the bird did not go near, and finally disappeared into the forest with another redstart, assumed to be the male of the pair. Since it was now after five o'clock in the afternoon, I removed the paintbrush and went away, leaving the blind in place for the morrow.

The following morning, May 15, in the early dawn, I slipped into the blind without disturbing the redstart and passed the greater part of the day watching the nest. The marked bird, evidently the female, alone warmed the eggs. On returning at the end of a recess, she always flew back and forth a number of times in front of the nest, and often she made several false starts to enter it. Her hesitation in going to the nest was probably not caused by the presence of the blind, for in these maneuvers she often came very close to it and many times perched on a dead branch just outside, not two feet from my eyes. Thereby I enjoyed ample opportunity to recognize the faint paint mark on her left side, and I did so at every return to the nest except three.

The female redstart sat sideways in the nest, with her long tail projecting from one corner of the wide entrance and her head constantly turned outward so that she could view her surroundings. Her bright orange-red breast and belly were concealed beneath her and quite invisible, as were the white ends of her outer tail feathers, which were folded under the uniformly dark central feathers; in the nest, she was far less conspicuous than one who had seen her only on the wing would suppose to be possible. During the night and in rainy weather, she sat with her left wing toward the outside; but during clear days she always sat facing in the opposite direction, with her right wing outward. Most of the time she rested nearly motionless, seldom turning her head or adjusting the eggs beneath her; but she was ever alert to slight sounds and looked about to discover their origin. Some minutes before leaving the nest she would become restless, move her head actively, swallow, gape, and shift the eggs; these movements would lead at length to her flying off. As she flew down the mountainside, she invariably called, with sharp, metallic monosyllables very similar to the call of the Cardinal.

I devoted a total of twelve hours to watching this Slate-throated Redstart incubate. From 5:40 a.m. to 2:26 p.m. on May 15, I kept watch during weather which was largely cloudy but rainless; while from 2:55 to 6:00 p.m. on May 17 I studied her behavior in a steady, fairly hard rain. Taking the two records together, 11 sessions on the eggs ranged from 26 to 49 minutes, with an average of 37.6 minutes; 12 recesses ranged from 10 to 37 minutes, with an average of 18.2 minutes. She devoted 67.4 per cent of the twelve hours to incubation. I have not included in this record a session of only 18 minutes which was prematurely terminated when a jaguarundi cat passed stealthily only two yards in front of the nest and frightened the redstart from her eggs.

It is of interest to compare the redstart's behavior while incubating in clear weather and in the rain. On the rainy afternoon of May 17, I timed two sessions of 42 and 49 minutes, respectively, and two recesses of 37 and 35 minutes. Her sessions during the

rain were not significantly longer than those she took in clear weather; for early in the rainless afternoon of May 15 she sat continuously for periods of 47, 38, and 45 minutes, whereas early in the morning she had incubated once for 38 minutes. But her three longest recesses on May 15 were only 22, 16, and 16 minutes; and the average of ten recesses in rainless weather was only 14.6 minutes. Thus the rain had greatly increased the time she devoted to finding food but did not correspondingly increase her periods of warming the eggs. This was doubtless because during a hard rain there are few insects on the wing; and since she subsisted largely on flying insects, she found it far more difficult to satisfy her hunger.

The male redstart usually remained at a considerable distance from the nest. His song, when I could hear it at all, sounded from afar in the woods. Twice, however, he accompanied his mate as she returned to her eggs, calling, and singing *ch'ree ch'ree ch'ree ch'ree* in a clear, melodious voice. The female, after she had settled in the nest, answered him with a low murmur. After singing and catching insects for a few minutes in the vicinity of the nest, he flitted off among the trees, and his song grew faint in the distance. Even on these rare visits to the vicinity of the nest, he did not approach it closely.

Among the brightly colored species of North American wood warblers, the female is usually duller in plumage than the male and incubates the eggs without his assistance. In many species of tropical warblers, male and female are equally brilliant in plumage; and I thought that perhaps, for this reason, they might share in the duty of incubation. But neither the male Pink-headed Warbler, nor the Hartlaub Warbler, nor the Slate-throated Redstart, ever sat upon the nest. My experience with warblers has been duplicated with tanagers, finches, honeycreepers, orioles and other families. With few exceptions, all the members of the same family of birds follow the same general plan of incubating the eggs, and species of which the sexes are alike in color behave very much the same as species in which the sexes are greatly different. Contrary to the statements of theorists of the last century, the color of the plumage is of very minor importance in determining whether one or both sexes shall sit on the eggs.

*The nestlings.*—Each day the female Slate-throated Redstart allowed me to come a little closer to her when I visited the nest, until finally I could bend down my head and look in at her from the distance of a foot, before she slipped out and fluttered away, “feigning injury.” On May 22, this reaction was much stronger than before. Upon jumping from the nest at my near approach, she alighted on the ground only two yards away from me, relaxed and vibrated her wings, and moved as though in great distress. When I took a few steps toward her, she fluttered off ahead of me and alighted on the ground again to repeat the act. She did this a number of times, until I had followed her a good distance from the nest, when of a sudden she “recovered” and flew rapidly down the mountainside. Returning then to her nest, I found one little nestling, with red skin scarcely concealed by sparse gray down. It was remarkable how erect it stood, like a sentinel at his post, as it held up its widely gaping mouth for food. Then, exhausted by the momentary effort, it fell over and lay in the bottom of the nest. The occupants of the other two eggs were tapping at their shells. They hatched the following day, May 23.

The male redstart, as we have seen, did not show much attention to his mate while she incubated; and while I watched, he never went to look into the nest. As a result, he had not become familiar with its position and experienced considerable difficulty in finding it when he first began to feed the nestlings. Just how he learned that they had hatched I do not know, for I did not replace my tent and watch again before this nest until the first-hatched nestling was three days old, the other two a day younger. Even then the male wasted much time in locating his young. He would come, singing, with his bill full

of insects and fly to the wrong part of the bank. Here he would search vainly for the nest, returning again and again to look for it, seeming to be surprised at not finding it where it never had been. Sometimes he spent many minutes exploring various portions of the mossy sides of the depression before he at last encountered the nest. On three occasions he abandoned the quest and flew away, still carrying the food intended for the nestlings. Even after he had fed them several times in my presence, he seemed unsure of their exact location. During the three hours of my watch that morning, his ability to find the nest improved rapidly, until at last he was able to go directly to it as his mate did. She fed the three nestlings 10 times, in the intervals of keeping them warm; but he gave them food only 5 times, and 3 times carried away the food that he had brought.

The male redstart was not at all afraid of my tent, for he flew all around it while searching for his nestlings; but it is possible that the sudden appearance of so large an object less than six feet from the nest confused him. The tent did not in the least disturb the female, although eight days had passed since she had last seen it.

One of the nestling redstarts vanished when only a few days old, and only two lived to leave the nest. They took their departure on June 2 and 3, respectively, at the age of about 11 days, when they were scarcely able to fly and could only hop rapidly over the ground. Since I had removed them from the nest to examine their plumage, it is likely that they left somewhat prematurely.

By late July, before their parents had ceased to give them food, young Slate-throated Redstarts had molted into a plumage difficult to distinguish from that of the adults. As soon as the young were able to take care of themselves, the families broke up.

In the separation of male and female after the close of the breeding season, the race *hellmayri* differs strikingly from *aurantiacus* and from the Collared Redstart. Although the males of *hellmayri* now sang far less than they did during the fine weather of April and May, they sang occasionally on pleasant days through most of the rainy season, which extended from mid-May to mid-October. In this period, I heard their song far more often than that of any other wood warbler on the Sierra de Tecpán; but it was not so loud and clear as it had been during the nesting season. If two males happened to come together in the same mixed flock, they sang spiritedly, and finally one would drive the other out of the flock.

#### SUMMARY

In Costa Rica, Slate-throated Redstarts of the race *aurantiacus* are found in humid forests at middle altitudes, chiefly between 3000 and 7000 feet, and are abundant around 5500 feet. They frequent the edges rather than the depths of the heavy forest and wander into adjacent clearings with scattered trees and bushes. They hunt their insect food chiefly among the lower vegetation, more rarely in the tree tops. Sometimes they search over the bark of trees or weave an intricate course through the air as they snatch up flying insects. They live in pairs throughout the year.

The song, simple but pleasing, is delivered in pleasant weather in all months, but chiefly from February to September.

At Vara Blanca, nest building began at the end of March, and in the next two months 14 nests were found. The oven-shaped nest was most often placed in a niche in a cut bank, but other sites were among clustered epiphytes on a fallen log in a pasture and in a slight depression on a steep, weed-covered slope. At one nest the male took an active part in building; but this was unusual, for at several other nests he was not seen to help. The nests were constructed in from three to five days.

About a week elapses between the completion of the nest and the beginning of laying. The set consists of two or three eggs laid on consecutive days. In nine nests, the first

egg was laid between April 7 and 13. In three nests, probably built after an earlier brood had been lost, the eggs were laid in May. Apparently these redstarts raise a single brood each year.

Incubation begins with the laying of the last egg of the set. The incubation period was 13 days at one nest, 14 days at one nest, and 15 days at four nests.

The newly hatched young are blind and bear sparse down. At the age of 9 or 10 days they are well clothed with feathers, and after they are 10 or 11 days old they are no longer brooded. They leave the nest when from 12 to 14 days old.

When driven from eggs or young, the female sometimes gives a distraction display. But there is much variability in this behavior, and three were never seen to perform.

Of the 31 eggs laid in the nests that were most carefully followed, 10, or 32 per cent, produced fledglings. Of the 11 nests that contained these eggs, 5, or 45 per cent, produced each at least one fledgling.

On leaving the nest the young redstarts wear a plumage much duller than that of the parents, but by July some have acquired the adult colors. By October the young birds, now indistinguishable from the adults, appear to have mated.

In the highlands of western Guatemala, Slate-throated Redstarts of the race *hellmayri* range from 2000 to 9500 feet above sea level and are abundant in heavy, humid forests at middle altitudes on the Pacific slope. More active than the Costa Rican form of the species, these warblers catch a large share of their food as they make the most intricate aerial maneuvers. They also differ from the Costa Rican redstarts in living singly rather than in pairs when not breeding. A single redstart attaches itself to one of the large mixed flocks of small birds that wanders through the mountain forests.

The male's simple song is loud, clear and ringing. Although they sing most freely in April and May, their song is heard on pleasant days in the wet season, which extends from mid-May to mid-October. If two males happen to come together in a mixed flock, they sing spiritedly against each other until one drives the other out of the flock.

A single nest was found near Tecpán, at about 8500 feet above sea level, on May 13, 1933. The roofed structure with a wide doorway in the side was concealed among mosses and ferns on the sloping side of a depression left by the uprooting of a great tree in the mountain forest.

The nest contained three eggs, which were incubated by the female alone. In 12 hours of observation her sessions ranged from 26 to 49 minutes and average 37.6 minutes and her recesses ranged from 10 to 37 minutes and averaged 18.2 minutes. She covered her eggs 67.4 per cent of the time. While rain fell, making it more difficult to find food, her recesses were considerably longer than in rainless weather, but her sessions on the eggs were not correspondingly increased. When driven from the nest, she sometimes gave a distraction display.

The nestlings were brooded by their mother and fed by both parents. But the male, who was not seen to visit the nest in the course of incubation, was unfamiliar with its position even on the third day after the first nestling hatched. He spent much time searching for the nest and sometimes abandoned the quest, carrying away undelivered the food that he had brought for his offspring.

The two surviving nestlings left the nest when about 11 days old, but their departure was probably hastened by earlier removal for examination.

By late July the young redstarts had changed their dull plumage for a dress scarcely distinguishable from that of the parents who still attended them. As soon as the young could take care of themselves the families broke up, and thereafter the redstarts were nearly always found singly.



## COLLARED REDSTART

### *Myioborus torquatus*

The charming Collared Redstart is confined to the mossy, humid forests of the southern highlands of Central America, in Costa Rica and western Panamá. It is the biggest and to my mind the prettiest of the Central American members of this attractive genus. Its upper plumage is black or blackish, and it has the chestnut crown-patch characteristic of the group. Its forehead, face, throat and all the under parts are bright yellow, with a black band or collar extending across the breast, joining the black of the upper plumage. Its long tail is black, with snowy white outer feathers. Its bill and eyes are black. The sexes are alike.

Carriker (1910:799) states that in Costa Rica the Collared Redstart ranges from about 3500 feet above sea level up to timberline on the high volcanoes. Hence it extends considerably higher than the Slate-throated Redstart, although the ranges of the two species overlap in a wide belt. I found it very abundant on the storm-beaten northern slopes of the Cordillera Central between 5000 and 8000 feet above sea level. Although essentially a sylvan bird, it frequents the bushy woodland edges and such openings as are made by roadways or the fall of some giant tree rather than the dark depths of the unbroken mountain forest. Sprightly, graceful, and restlessly active, it hunts its insect food at all levels from the tree tops to the ground, yet is most often seen at no great height. It searches over the bark of trees far more seldom than does the Slate-throated Redstart, but like it frequently catches insects on the wing. Sometimes, in the lower parts of their altitudinal range, Collared Redstarts will be found following the army ants in company with a variety of other small woodland birds. They concentrate chiefly upon the capture of such winged fugitives from the ant horde as they can snatch up in the air; and their bright colors and active habits make them the most conspicuous figures in all the motley feathered flock.

Unlike the American Redstart, Painted Redstart and the Guatemalan form of the Slate-throated Redstart, the Collared Redstart rarely lives alone during the winter months. After the separation of the young birds from their parents, which usually occurs in August or September, Collared Redstarts are most often seen in pairs. Yet even in November and December, it is not rare to find from three to five birds keeping company. Whether these are family groups that have failed to disperse at an earlier date or unrelated birds that have banded together for companionship in the wettest, stormiest and gloomiest period of the year, I do not know.

In the wilder portions of the Costa Rican highlands, where few men dwell, most of the birds are as fearless of the human presence as one will find them anywhere save on uninhabited oceanic islands. But the Collared Redstart is the most friendly of all. Sometimes, while I watched them, one of these warblers would alight on a branch so close in front of me that I might have reached out and touched it. One afternoon, while I squatted beside a Wood Wren's nest in a bushy opening in the forest, I was surrounded by a family of Collared Redstarts, consisting of parents and young already in the adult dress. Of a sudden, one of the young birds flew up to me and stood on the crown of my hat. Possibly it had espied an insect crawling over my headgear, or possibly it merely decided that this would be a pleasant place to stand. While I remained motionless, it lingered upon my head for several seconds, then flitted off again. At their nests, too, I found the Collared Redstarts almost fearless of me. Because of its trustful ways, the



Fig. 60. Collared Redstart.

Costa Rican mountaineers sometimes call this bird *el amigo del hombre*—the friend of man.

#### VOICE

Not only is the Collared Redstart the brightest in plumage of the Central American forms of *Myioborus* that I know well, it is also the most gifted songster. Its delightful song is long-continued, full and mellow in tone, varied in phrasing, and easily distinguished from the simpler music of the other redstarts that I have heard. It is both longer and more powerful than the simple notes of the Slate-throated Redstart of Costa Rica. It is far longer and more varied than the songs of the Guatemalan form of the Slate-throated Redstart and the Painted Redstart; and although it perhaps equals the former in richness of tone, it falls somewhat short—if memory is to be trusted—of the latter's strong, full voice. The Collared Redstart is a notable songster among all the wood warblers. In my year at Vara Blanca, I heard it very rarely from July to February; during this period it sang far less than its neighbor, the Slate-throated Redstart. But in March, as the breeding season approached, it entered its period of full song and was a joy to hear.

The call-note of the Collared Redstart is a sharp monosyllable, *pit*, similar to the *chip* of the Slate-throated Redstart, but distinctly sharper.

#### NEST BUILDING

At Vara Blanca, on the northern slope of the Cordillera Central of Costa Rica, the Collared Redstarts, although by no means rare between 5000 and 6000 feet above sea level, were far less abundant than the Slate-throated Redstarts. In 1938, I found 14 nests of the latter, but only two completed nests of the former. Since the two species

placed their nests in similar situations, and they were accordingly equally easy to find, the number of nests discovered is probably a good index of the relative abundance of the two kinds of redstarts in this area.

The first Collared Redstart's nest was found on April 3 when already nearly completed. It was situated in a deep recess in a vertical cut-bank beside a little-used pathway. Above the bank was a pasture with scattered trees and clumps of low, spiny palms; below the path was forest with tangled undergrowth, falling away into a ravine. The bank was 4 feet high; the niche which sheltered the nest, 40 inches above its foot. The nest was a roofed structure with a round entrance in the side facing out from the bank. It resembled the nests of the Slate-throated Redstarts, but had a thinner roof. The foundation was composed of dry bamboo leaves, others of which lay loosely in front of the doorway. The chief material of the structure was fine vegetable fibers, which in the floor and lower part of the walls were matted together to form a thick, soft fabric. The liverworts, mosses and low herbage on the walls and about the entrance of the niche in the bank quite screened the nest from the casual glance. Two feet distant, in a more shallow cranny in this bank, was an old nest of the same kind, possibly the preceding year's nest of the same pair. Twenty-nine feet to the north a Slate-throated Redstart was building her nest in the same bank.

I sat without concealment in the path north of the Slate-throated Redstart's nest, hoping to watch both kinds of warbler build at the same time. The Collared Redstart, whose nest was 70 feet away, went ahead with her work as though I had not been there; but the Slate-throated Redstart, whose nest was only 40 feet distant from me, feared to approach it. I made trial of various positions and learned that the Collared Redstart was not afraid of me even when I sat as close as 14 feet from her nest; but the Slate-throated Redstart continued to be shy when I was 15 yards from hers. This agreed with my earlier experience that the Slate-throated Redstart is consistently less confiding than the Collared Redstart. Since I could find no position that gave a satisfactory view of both nests, yet was not so near that of the more wary bird that my presence disturbed her, I sat with my back to the Slate-throated Redstart and gave my attention wholly to her trustful neighbor.

At eight o'clock, when I began to watch the Collared Redstart at her building, a fine drizzle was falling from the clouds that swept low above the open pasture and drifted through the tops of the trees in the neighboring forest, whence fell larger drops of moisture that had condensed on the foliage. From time to time the precipitation increased to the intensity of a light shower; and by 9:45 the rain had become hard enough to drive me to shelter. Yet despite the unfavorable weather, the redstart kept steadily at her work. In the 105 minutes of my watch, she brought 34 billfuls of material to her nest. She found all this material in the woods down the slope, and she would arrive at the bushy edge of the woodland with her bill laden with an ample bundle of fine, light-colored bast fibers, or the brown scales from a fern frond. Then, after a moment's pause here, she would flit across the path and come to rest on top of the bank near her nest. Here she delayed a few seconds more, then flew out and hovered, facing the bank, until she had located her nest, whereupon she darted into it. In the deep niche she was invisible to me while she worked. Upon emerging, she sometimes flew up to rest a few moments on top of the bank; but at other times she flew directly down into the woods.

The male redstart often followed his mate on her trips to and from the nest. Sometimes he waited at the edge of the woods while she went into the niche, but frequently he crossed the path and rested on the herbage at the top of the bank while she arranged the material. Occasionally he sang here; but more often I heard his beautiful song coming out of the woods, where I could not see him. The yellow of his breast, immediately

below the black pectoral band, was purer than that of the female. He never brought any material in his bill.

Although I watched from a point only five yards from the nest while sitting in the pathway without the slightest concealment, the Collared Redstarts appeared to be perfectly indifferent to my presence. When I was ready to go, I rose and stood in the path only seven feet from the nest, directly in front of it. While I waited in this position, the female arrived at the edge of the woods with her bill full of the big, brown ramentum scales of a fern, almost the color of her own crown. After a little hesitation, she flew into her nest to deposit her burden.

Two other nests of the Collared Redstart were found in April in the neighboring pasture. The first was newly begun when discovered on April 6 in the midst of the odorous calingero grass (*Melinis minutiflora*) on a steep slope. The bird had chosen as her nest site a little hollow in the hillside, beside a large clod of earth, and beneath the overhanging stems of the grass growing higher up the slope. Her first step in building was to lay as a foundation a number of dry bamboo leaves, which she carried up from the edge of the woods about a hundred feet down the hillside. This nest was still not quite completed by April 18, and four days later I found it partly destroyed.

On April 24, I found another redstart building, beneath a decaying log, amid fallen brush in the pasture, also about a hundred feet from the edge of the forest. This nest was placed upon the sunken remains of another of the same kind, which raised it a few inches above the earth. A number of dead leaves of dicotyledonous plants, brought by the redstart, littered the ground in front of the nest. As in the Slate-throated Redstart, the first step in building appears to be the laying of a foundation of broad, dry leaves, and many are dropped a few inches short of the nest site. This nest appeared to be completed by April 26, contained one egg on April 30, and two—the full set—on May 1. On May 8, I found that the nest had been torn from its nook beneath the log, and the eggs had vanished. An examination of the ruins revealed that the structure had been composed of fine, light-colored bast fibers, shreds of plant epidermis, long, black fibrous roots, and large, brown scales from the fronds of tree-ferns—all in considerable quantities.

#### THE EGGS

On April 4, the day after I watched in the rain while she carried material into the deep recess in the bank, the female redstart continued to add to the lining of her nest, but it appeared to be practically completed. Still, the first egg was not laid until April 10; and two more followed on the succeeding days. The three eggs were white, sprinkled all over with light brown; but the dots of color were most concentrated in a wreath about the large end. The eggs measured 19.1 by 13.5, 19.1 by 13.5, and 18.7 by 13.5 millimeters. Two eggs in another set found later were similar in coloration but somewhat shorter, both measuring 18.3 by 13.5 millimeters.

#### INCUBATION

The female redstart began to incubate on April 12, the day her set of three eggs was completed. She was already much attached to her nest and would not fly out when I stood directly in front of it. Four days later she sat so closely that I might have caught her in the niche had I cared to do so. If I slowly advanced a hand toward the entrance, she would slip past it just in time to avoid being trapped; but by a swift movement she might have been held prisoner. She would allow me to look in at her with my face only a few inches from the front of the recess in the bank.

Despite the redstart's great fearlessness, to study her mode of incubation I decided to watch from a blind; for I wished to feel quite certain that the activities of the pair

were in no wise constrained by my presence. Seated in my brown wigwam placed in the pathway a short distance from the nest, I made a continuous record of events there from 5:30 to 10:50 on the morning of April 23, 11 days after incubation had begun. The female alone incubated the eggs, and she was extraordinarily regular in her comings and goings. The 8 sessions in the nest which I timed varied only from 27 to 30 minutes, with an average of 28.5 minutes. The eight recesses from incubation ranged from 7 to 13 minutes, with an average of 9.8. The redstart covered her eggs for 74.4 per cent of the 5 hours during which I watched. She always sat sideways in the nest, usually with her left side outward. Her long tail projected through the doorway at one side, while her head was turned to look out through the opposite extremity of the opening.

While I watched, the male did not once come near the nest, nor even show himself in the pathway. From time to time, but not very often, I heard his song coming out of the forest down the slope; and doubtless his mate found him there when she took her recesses. I only once saw him accompany her as she returned to the nest, and then only as far as the edge of the woods.

On the morning of April 24, the female redstart sat, as was her custom, until I put my hand to the entrance of the niche. Then she slipped past it, fell to the ground at my feet, slightly lifted the tips of her wings and waved them as though helpless. She crept over the ground to the edge of the woods, still with quivering wings, then hopped slowly about low among the bushes, continuing to vibrate her uplifted wings. This was the first time that she had feigned injury in my presence—12 days after she had begun to incubate. On the next two days she behaved in the same fashion when I made her leave the nest in order that I might see whether the eggs had hatched. The eggs were pipped on April 26, and they hatched the following day. The female redstart again gave an excellent display of injury feigning on April 30; but after that I saw no further repetition of the performance. Her use of this display was restricted to the period extending from three days before to three days after the eggs hatched.

The three eggs hatched on April 27. Since the last had been laid, and incubation begun, on April 12, the incubation period was 15 days.

#### THE YOUNG

The nestling redstarts had the pink skin and sparse natal down of other newly hatched wood warblers. On April 30, I found one of the three-day-old nestlings lying dead in the niche a few inches in front of the nest. It appeared to be well fed and probably had been accidentally brushed out of the nest by its mother as she departed—a mishap by no means rare among small birds. By May 7, when ten days old, the two surviving redstarts were well feathered. They were brooded by their mother on the night of May 6, and again on the night of May 8, but for some unexplained reason not on the night of May 7. When I visited the brooding redstart at dawn on May 9, I found her awake, but with her head turned back to the right and covered by the loosely ruffed-out downy feathers of her back, leaving exposed her left cheek with its open eye.

On May 10, the two surviving nestlings left their protected niche in the bank, at the age of 13 days. I had not touched them after they began to grow feathers, and I believe that their departure was spontaneous. They bore little resemblance to their parents, for their entire upper plumage, head, throat and breast were dark slate-color, with no trace of chestnut on the crown, and no yellow on the forehead, face, or throat. But this juvenal plumage was worn for a very short while. By the end of May, young birds of the year were far on the road to the acquisition of the adult colors. (Since I had seen no indication of nesting until late March, it is unlikely that these birds had been hatched before the middle of April, at the earliest). In the first stages of the postjuvenal molt, the fore-

head, lores, lower cheeks, and throat were pale yellow flecked with gray, over an area of irregular outline. There was a broad gray band across the chest; and the lower breast and belly were yellow, brightest on the flanks, fading to whitish in the center of the abdomen. These changes were evident before chestnut feathers were visible on the crown. The wings and tail when full grown resembled those of adults. By the middle of June, before they parted company with their parents, the young birds were difficult to distinguish from their elders. Since by August most of the Collared Redstarts were in pairs, it seems likely that the young of the year found mates very soon after becoming independent.

#### SUMMARY

Collared Redstarts live in the mossy mountain forests of southern Central America, from about 3500 feet up to timberline, and are fairly abundant between 5000 and 8000 feet above sea-level. They frequent the edges of the forest and openings in its midst and hunt their food at all levels from the ground to the tree tops, but chiefly at middle heights. They remain mated through the year and are found in pairs or family groups of from three to five. They are exceptionally fearless of man.

Males have a beautiful, varied song, which they deliver chiefly from March to June, rarely in other months.

At Vara Blanca, Costa Rica, three nests were found in April. These oven-shaped structures were placed in a deep niche in a vertical bank, in a little hollow in a steep, grassy hillside, and beneath a decaying log in a pasture. Only the female was seen to build.

One nest contained two eggs and another three. Laying began four and six days after the nest's completion and the eggs were deposited on consecutive days. At one nest only the female incubated, during 5 hours and 20 minutes of observation, taking sessions which averaged 28.5 minutes and recesses which averaged 9.8 minutes; she covered her eggs 74.4 per cent of the time. At this nest the period of incubation was 15 days.

The female gave distraction displays in the period from three days before the eggs hatched to three days after they hatched.

The nestling period was 13 days.

Young hatched in April begin to acquire the colors of the adults, the sexes of which are alike, by the end of May, and by mid-June they are difficult to distinguish from their parents, which they still accompany. By August young birds seemed to have paired.

## HARTLAUB WARBLER

### *Vermivora superciliosa*

Next to the Pink-headed Warbler, the most abundant member of the wood warbler family in the Sierra de Tecpán was the Hartlaub Warbler, a species that ranges from México to northern Nicaragua. This warbler is also confined to the upper altitudes, and although it has been reported from points all the way from 4000 to 10,500 feet above sea level, it is rarely seen below 6000 feet. I found the Hartlaub Warbler not uncommon in the oak woods on the plateau of Tecpán, at 7000 feet, whence it extended upward to the summit of the range at 10,000 feet. It is an attractive little bird with upper plumage generally grayish, variegated by a patch of olive-green on the center of the back and the shoulders. There is a broad white line over each eye, bordered below by blackish cheeks and sides of the neck. The throat and chest are bright yellow, which merges into gray on the abdomen. The more richly colored individuals of both sexes bear a short, broad, transverse bar of chestnut on the breast; yet on others which breed, this bar is merely suggested by a faint tinge of chestnut. Because of this individual variation, in some pairs male and female are alike in appearance whereas in others they are readily distinguished.

More arboreal than the Pink-headed Warbler, the Hartlaub Warbler usually forages in the crowns of the forest trees, where it flits through the foliage in the active manner characteristic of its family. During the greater part of the year these birds live in small flocks, which are joined by numbers of Townsend Warblers, Hermit Warblers and other species which come down from the north, as well as by single individuals of such resident species as the Slate-throated Redstart and the Great Pewee. The large and motley groups thus formed roam through the woods in amicable companionship.

So long as they remain in flocks, the Hartlaub Warblers rarely sing. But at the beginning of February, I noticed that some had separated from their companions and were then repeating persistently their dry, chaffy trill, which seemed more like the buzzing of an insect than the song of a wood warbler.

#### THE NEST

On April 28, 1933, I found my first nest of this species. While wandering through the second-growth oak woods on the Sierra de Tecpán, I saw a Hartlaub Warbler whose nervous flitting about told me plainly that she wished to return to her nest but that she feared to do so in my presence. I drew off a short distance and stood quietly until she disappeared into a deep ditch not far off. Then I jumped down into the dry ditch and walked along its leaf-strewn bottom until the bird darted out from the steep bank by my side, thus revealing her nest. The nest was an open cup, the thick outer wall of which was composed entirely of green moss; it was well lined with fine fibrous material. The bird had apparently cleared a little niche for its reception among the dead leaves which covered the bank, and some of these big leaves, caught up among the stems of the sparse vegetation, formed an adequate roof for the cup and concealed it very well.

In the highlands of Guatemala, the boundary of a field is sometimes marked by digging a ditch instead of erecting a fence. The ditch is more enduring, and no material is required for its construction. If the trench encloses a pasture, it is made deep and broad so that the cattle and horses cannot cross it. The Hartlaub Warbler's nest was on the side of such a boundary ditch. Acting upon the hint which this bird gave me, I followed along a number of old ditches that had sides well covered with fallen leaves



Fig. 61. Hartlaub Warbler.

and vegetation and found two more nests in the course of the same morning. Both were in positions similar to that of the first, both constructed of green moss, and both naturally roofed over by the fallen leaves. The linings of these nests, composed of fine grass stems, tawny down and hair, were thinner than that of the first, and much green moss was visible in the interior of the cups. One of the nests measured on the inside  $2\frac{3}{8}$  inches in diameter by  $1\frac{3}{8}$  in depth, another,  $1\frac{3}{4}$  by  $1\frac{1}{2}$  inches.

#### THE EGGS

When found on April 28, the three nests contained their full sets of three, three and two eggs, respectively. In the second nest they appeared fresh; in the third they were well incubated. The eggs were pure white; seven were immaculate, but one had a sprinkling of faint brownish dots on the thick end. The measurements of the eight eggs average 16.3 by 12.7 millimeters. Those showing the four extremes measured 17.5 by 13.1 and 15.5 by 11.5 millimeters.



## INCUBATION

To study the mode of incubation, I first chose nest 3 because it was the most conveniently situated for watching. In as much as I was not at first sure that I could distinguish the sexes by their appearance, I attempted to mark one of them with paint. To this end, I wrapped a little wad of cotton about the end of a twig, soaked it with vermilion enamel, and stuck it upright in the rim of the nest where I hoped that the



Fig. 62. Nest and two eggs of Hartlaub Warbler; above Tecpán, Guatemala, May 15, 1933.

warbler would rub against it as she returned to her eggs. A few minutes after I had set up the paint brush and retired into the blind on the other side of the ditch, one of the pair, evidently the female, flew up to the nest. After a little hesitancy she alighted on the rim beside the strange vermilion object and gave it a few tugs with her bill, which became stained with the sticky enamel that oozed from it. Then she flew to a perch, against which she wiped her bill to clean it. In a few minutes she returned and repeated the attempt to remove the paint brush. Her persistence appeared to have no limits; and in the course of half an hour she returned a dozen times or more, at each visit giving the wad of cotton only a tug or two, then retiring for a breathing spell before renewing the attack. She moved all around the offending object, yet such was her daintiness of touch that not a speck of vermilion could be detected on her neat plumage. At length I shifted the paint brush into the bowl of the nest; and here after a few more attempts she succeeded in drawing it forth and flew out of sight with it. Then I tried suspending

a similar paint brush just above the nest; but the warbler insisted on tugging at this, too. After nearly an hour she remained immaculate; and fearing that she might swallow more of the paint than was good for her, I abandoned the attempt to mark her. All this time she worked alone to free her nest of the foreign body. Her mate did not appear either to aid or to watch her.

Next morning at the first light I stole into the blind close in front of the nest. The warbler sat quietly on her eggs until the rays of the rising sun struck through the trees and fell on the dry leaves that carpeted the woodland floor. Then she rose up, stretched her wings, and flew off for breakfast. At the end of 7 minutes she returned. I continued my watch for 6 hours, in which time the warbler took 12 sessions ranging from 5 to 37 minutes and averaging 18.8 minutes; an equal number of recesses varied from 2 to 13 minutes in length and averaged 8.1 minutes. She spent 70 per cent of the time on the nest. Although I could not always distinguish the sex of the bird which darted rapidly in and out of the nest, I saw nothing to indicate that the male incubated. Sometimes I heard his song in the distance; but the bird that sat in the nest was never heard to sing, and it was without much doubt the female. Rarely while sitting she voiced a few low, sharp notes. Before leaving she would often stretch her wings above her back. Later in the morning she often closed her eyes, as though sleeping; but her naps, if such they were, lasted less than a minute.

Early in the morning the male came with an insect. As he approached the nest the female turned her head inward and crouched down into the bottom. The male delayed a minute on the rim, then flew away still bearing his intended gift. The female seemed to resent his presence, and after her cold reception he did not repeat his visit in the course of my watch.

Later I watched nest 2, when the three eggs in it were near the point of hatching. The female of this nest was so tame that she remained on her eggs while I set up the blind three yards in front of her. The chestnut bar on her breast was as heavy as that on many males, but I could distinguish her by certain irregularities in the outline of her white superciliary stripes. This female was more regular in her movements than her neighbor of nest 3. In  $5\frac{1}{2}$  hours of the chilly morning of May 9, she took 9 sessions ranging from 14 to 28 minutes in length and averaging 23 minutes; the 9 recesses varied from 7 to 24 minutes and averaged 11.8 minutes. Her longest recess of 24 minutes was the first of the morning; thereafter she was not absent for more than 13 minutes at a stretch. Returning from her first excursion she incubated for 14 minutes; and after her second absence of 7 minutes she sat for 16 minutes. Thereafter her sessions were more regular, 7 of them varying only from 20 to 28 minutes. She devoted 66.1 per cent of the morning to incubation. Her mate did not approach the nest all morning, but I heard him sing much more than the male of the other nest. The female sometimes left the eggs in response to her mate's calls, which she answered either before or after flying off.

The female at nest 3 was a co-operative subject for photography. On the day when her two eggs were pipped she sat very steadfast, allowing me to approach within a yard before she jumped from the nest. Less than ten minutes after I had set up the camera on its tripod and retired into the blind, she returned to her eggs. After the first exposure she grew bolder and would dart into the nest while I focused the camera only three or four feet in front of it, my head beneath the black cloth. By the time I was again settled in the blind with my hand on the thread that released the shutter, she was waiting to have her portrait taken once more.

The three eggs which were already present in nest 2 when I found it on April 28 all hatched on May 11, giving 13 days as a minimum for the incubation period. Possibly it was a few days longer.

## THE NESTLINGS

When the two nestlings in nest 3 were four days old their eyes were opening and their pin feathers sprouting. Their mother covered them closely and did not leave when I set up the blind only eight feet in front of her. The male was now making regular visits to the nest; and after I had seen him well I found it easy to distinguish him from the



Fig. 63. Female Hartlaub Warbler on nest; above Tecpán, Guatemala, May 3, 1933.

female. He wore a conspicuous chestnut bar across his yellow breast, whereas in the corresponding position on the breast of the female there was only a faint tinge of this color. (At nest 2, however, the female's breast had a conspicuous chestnut bar.) The superciliary stripes of the male were pure white, those of the female slightly grayish; yet it was necessary to see the two birds side by side to notice the difference in shade.

Male and female took almost equal shares in feeding the nestlings, but the female alone brooded them. Between 6:00 and 8:10 a.m. the two four-day-old nestlings were fed 12 times by their mother, 10 times by their father, and twice more when I did not see the parent well enough to identify it—a total of 24 times. The mother brooded 6 times, for 6, 8, 7, 1, 7, and 13 minutes—a total of 42 minutes out of 130.

The first time that the male came with food he perched upon an oak twig above the nest and called, whereupon his mate, who was brooding, flew away. He then dropped down, delivered the insect, cleaned the nest, and departed. The next time he came with a small larva. The female stayed on the nest and tried to take it from him; but he would not give it to her; so she rose up, exposing the nestlings, and he put the food into the gaping mouth of one of them. Two minutes later he returned with something else. This time he was more trusting and gave it to his partner, who delivered it to one of the young beneath her. I heard him sing only three times in the course of the morning. He was

either an unusually silent male warbler, or he went off beyond hearing when he sang.

The female warbler was sensitive to the movements of the nestlings she brooded, and whenever they became restless beneath her she rose up in the nest to allow them to adjust themselves. Her last turn at brooding was the longest—13 minutes; and on this occasion one of the nestlings, becoming hungry, pushed its head from beneath her yellow breast and raised its gaping mouth. The mother looked down at it, several times placed her empty bill in its mouth, and then flew off to seek something wherewith to appease its hunger.

I had left the blind and was on my way down the hillside when I remembered that I had not replaced the fern leaf which screened the nest, and which I had pushed aside for the period of my vigil. Returning to the nest from the rear, I surprised the female as she was brooding and was on top of her before she knew it. Slipping from the nest, she alighted in the bottom of the ditch three or four yards from me, where for a few seconds she relaxed and quivered her wings; she then flew up to a perch. This was the only time I saw her feign injury, and it was not a particularly convincing performance.

I also watched nest 2 from 6:35 to 9:05 on the morning of May 14, when the three nestlings were three days old. Here also both parents fed them, the male 8 times, the female 6. The mother alone brooded, for periods of 22, 9, 13, 16, 7, and 11 minutes, or a total of 78 minutes out of 150—approximately half the time. When the male arrived with food and found the female covering the nestlings he gave it to her, and she then rose up to pass it to one of the nestlings beneath her. Usually each parent brought several insects or larvae at each visit to the nest and divided them between the nestlings.

In the first nest the eggs were destroyed before they hatched; the nestlings vanished from the other two when they were a week or less of age; hence I could not learn the length of the nestling period.

The Hartlaub Warblers on the Sierra de Tecpán apparently raised only a single brood. By the beginning of June the young were on the wing; and their parents led them to join in small flocks of their kind, which foraged through the woods that were now almost constantly wet.

#### SUMMARY

The Hartlaub Warbler is a highland species, ranging in Guatemala from about 4000 to 10,500 feet above sea level, but it is rare below 6000 feet. A bird of the tree tops, when not breeding it lives in small flocks, which associate with a variety of other small arboreal birds.

Males which had separated from the flocks in February began to sing a dry, chaffy trill that resembled the buzzing of an insect.

All three nests found at 8500 feet were on the steep sides of ditches. The open cups, composed largely of green moss, were deeply embedded among fallen leaves that formed a roof above them.

On April 28 these three nests contained sets of three, three, and two eggs, respectively. At two nests, only the female incubated. In six hours one female took sessions averaging 18.8 minutes and recesses averaging 8.1 minutes, and she sat for 70 per cent of the time. In 5½ hours another female took sessions averaging 23 minutes and recesses averaging 11.8 minutes, and she sat for 66 per cent of the time.

One male brought an insect to his incubating mate, who did not take it.

The nestlings were brooded by their mother and fed by both parents. All were lost before they were fledged.

## GENERAL SUMMARY OF INFORMATION ON THE PARULIDAE

The wood warblers are a compact family of small birds containing, according to Mayr (1946:67), 109 species. They are essentially confined to the New World, and many migratory species nest in temperate North America. In the tropics their headquarters is in the mountainous regions. The plumage is extremely varied, with intricate color patterns in the genus *Dendroica* and somewhat simpler patterns but larger areas of bright color in *Myioborus* and *Basileuterus*. Yellow is the prevalent bright color; but orange, blue, red and chestnut are present in many species. In the highlands of México and Guatemala there is a genus (*Ergaticus*) in which the plumage is almost wholly bright red. Those warblers which breed beyond the tropics and which are for the most part highly migratory usually show pronounced sexual differences in plumage; and when this is true, marked seasonal changes in the coloration of the males may occur. But among the non-migratory warblers of the tropics, the sexes are on the whole alike in plumage, and even the most brilliant of them wear the same bright hues throughout the year.

The food of the warblers consists almost wholly of insects, which these active birds capture while they flit and hop ceaselessly through the foliage of trees and bushes, or which they dart out for on the wing. Some members of the family (*Geothlypis*, *Chamaethlypis*) forage in grassland; not a few hunt over the ground, or along the banks of streams, some (*Seiurus*) walking, others (*Basileuterus fulvicauda*) hopping along. The Black-and-White Warbler creeps over the trunks and limbs of trees, seeking the small creatures that lurk in crevices of the bark. Fruit does not enter largely into the diet of the wood warblers; but the hardy Myrtle and Audubon warblers eat many small berries during the fall and winter; and Tennessee Warblers are fond of grapes and bananas.

Voice is well developed in this family. The voices of most are not strong nor are their phrases especially varied, but the songs are so persistently repeated that they make up in quantity what they lack in brilliance. Some, however, have rich, strong voices all out of proportion to their size. Among the best musicians that I have heard in this family are the Painted Redstart, Collared Redstart, and Ground-chat. The Yellow-breasted Chat is something of a mimic, but of the call notes rather than the songs of other birds; his repertoire is amazing but contains far more harsh notes than sweet. Flight-songs have been recorded for the Yellow-breasted Chat, Oven-bird, Louisiana Water-thrush, Worm-eating Warbler, Yellow-throat, and Tolmie Warbler. In their winter homes, the migratory species do not often sing, but many, perhaps all, species deliver a few songs before their departure in the spring. In this family, song is largely restricted to the male sex; but the female Buff-rumped Warbler delivers a beautiful, rich warble, very different from the ringing crescendo of her mate, to which it responds.

Nuptial feeding is recorded by Lack (1940:177) for five species of wood warblers: Yellow Warbler, Bay-breasted Warbler, Black-throated Blue Warbler, Pine Warbler, and Prothonotary Warbler. Schrantz (1943:376) gives additional instances of feeding of the female by the male Yellow Warbler; and Sturm (1945:197) saw male American Redstarts bring food repeatedly to their incubating mates. From Sturm's description of the behavior of his Redstarts, I suspect that the male brought food in anticipation of the nestlings rather than as an intended offering to his incubating partner. The male Pink-headed Warbler who repeatedly brought food to the nest in my presence seemed to desire to feed the still unhatched nestlings rather than his mate, who at times incidentally received the food. When a male Hartlaub Warbler brought a morsel to the nest where his mate incubated, she would not accept it. The male Buff-rumped Warbler

occasionally feeds his mate in the period of incubation, both on and off the nest, some males of this species seem afraid to approach the nest while the female incubates.

Polygamy rarely occurs in the family; but in the Oven-bird Hann (1937:155) found two instances of males with two mates and later (1940) a case of polyandry.

The nest may be placed in trees at a good height, in bushes, on the ground, or in niches in banks and ledges of rock. Rarely, as in the Prothonotary Warbler, it is built in a cavity in a tree or stump or in a cranny in a man-made edifice. Usually the wood warbler's nest is a simple, cup-shaped structure, but in *Myioborus*, *Basileuterus*, *Ergaticus* and *Seiurus aurocapillus* it is a roofed, oven-shaped construction with a round doorway in the side, placed in a niche in a bank or cliff, on a steep slope, or, in the last-mentioned species, on level ground. The Parula Warblers place their nests amid swinging tufts of beard-lichen (*Usnea*) or Spanish "moss" (*Tillandsia*), or in bunches of green moss on trees.

The nest is built by the female, usually without help from her mate. But the male Buff-rumped Warbler seems regularly to take a large share in the work of building; and one Slate-throated Redstart helped his mate regularly, although in several other pairs of this species that I watched the male failed to bring anything to the nest. In the Black-throated Green Warbler the male apparently helps to build only on the first day, if at all (Pitelka, 1940:5). Nest building by males has also been observed in the Prothonotary Warbler by Walkinshaw (1941:4) and in the Black-throated Blue Warbler by Harding (1931:513, 516). Yet in most species which have been watched while building, the female worked unaided.

The eggs of wood warblers are usually white or cream or are lightly tinted with green, blue or pink, rarely with deeper green, and in nearly all species they are more or less heavily spotted or blotched with shades of brown, chestnut, lilac or black, the markings as a rule heaviest on the large end, where they form a cap or wreath. Very rarely warblers lay unmarked eggs, among them the Swainson, Bachman, and Hartlaub warblers. The eggs of the last, although usually immaculate white, are at times faintly speckled.

In Costa Rica the Buff-rumped Warbler appears regularly to lay two eggs in a set, but even within the tropics the sets of most species of warblers average larger. The Striped-crowned Warbler lays three or four eggs in Trinidad (Belcher and Smooker, 1937:522). Species of *Myioborus* in Central America lay two or three, more commonly the larger number; the Pink-headed Warbler of the Guatemalan highlands lays from two to four. Northern warblers lay larger sets; three, four or five are recorded for most species, and rarely six; four is perhaps the most usual number for the species breeding in the United States and Canada.

Incubation is performed only by the female, so far as our information goes. The rhythm of coming and going varies considerably with the species and even within the species. In some the average session on the eggs was found to be less than half an hour; among these are the American Redstart (Sturm, 1945:196, table 1; Kendeigh, 1945:162, table 1; Baker, 1944:86), the Black-throated Blue, Chestnut-sided, and Blackburnian warblers (Kendeigh, *loc. cit.*), Hartlaub Warbler, Pink-headed Warbler, and Collared Redstart. Average sessions of from half an hour to an hour were recorded for the Black-throated Green Warbler (Nice and Nice, 1932:95), Slate-throated Redstart, and one Buff-rumped Warbler. Another Buff-rumped Warbler took sessions which averaged 85 minutes in six hours of observation. The absences from the nest of some incubating warblers are surprisingly short. In many hours of watching at a nest of the American Redstart, Sturm found that the female took recesses from her eggs ranging from 1 to 11 minutes and averaging 3.3 minutes. Baker and Kendeigh recorded only

slightly longer absences for this species. Average recesses of under ten minutes were found for the Black-throated Blue Warbler and Chestnut-sided Warbler by Kendeigh and for the Pink-headed Warbler and Collared Redstart by me. The Buff-rumped Warblers which sat for long periods also took long recesses which averaged half an hour or more. Most of the warblers of which we have studies covered their eggs between 60 and 80 per cent of the daylight hours; but a few were far more constant in incubation, the Redstart studied by Sturm sitting on some days as much as 93 per cent of the time; the Oven-birds studied by Hann (1937:216, table 2) incubated at times for 90 per cent or a little more of the hours of daylight.

Incubation periods ranging from 11 to 12 or, exceptionally, 14 days have been recorded by various authors for several North American species of *Dendroica*, *Geothlypis*, *Oporornis*, *Setophaga*, *Seiurus*, and *Protonotaria*. Kendeigh (1945:163) considers 12 days the normal incubation period for a number of warblers which he studied in the state of New York. Central American Warblers have distinctly longer incubation periods that range from 13 (rarely) or 14 to 16 days for species of *Myioborus*, *Ergaticus* and *Basileuterus*, and not infrequently 17 days is required in the last. Possibly the longer period of incubation for this group of warblers is associated with the fact that all build oven-shaped nests, whereas the North American warblers, with the exception of *Seiurus* and *Protonotaria*, use open nests. (Among the tanagers, the species which build closed nests have longer incubation periods.) Possibly also the shorter incubation periods of the northern species are associated with a general acceleration of their reproductive processes correlated with the shorter breeding season.

The nestlings when newly hatched are blind, bear sparse natal down, and have the interior of the mouth yellow. They are in all species for which we have information fed by both parents, which carry the food in their bills, but the young are brooded by the female alone. Although some male warblers may be slow in beginning to bring food (see Nice and Nice, 1932:98), usually they begin to attend the nestlings very soon after they hatch. The parents of many species, both tree- and ground-nesting, feign injury in a spectacular manner when their eggs or young appear to be in danger; but I have failed to witness such displays at numerous nests of the Buff-rumped Warbler.

The nestling period for North American species is usually between 8 and 10 days, and rarely is 11 days. Even the hole-nesting Prothonotary Warbler remains in the nest no longer than this. The Central American warblers studied by me had distinctly longer nestling periods, as they had longer incubation periods. Pink-headed Warbler nestlings that had been handled left when 11 days old. Undisturbed nestlings of two species of *Myioborus* departed at ages varying from 12 to 14 days. The nestling period of the Buff-rumped Warbler ranges from 12 to 15 days.

Helpers at the nest are rarely found among the wood warblers. Both the Central American and the North American representatives of this family, with rare exceptions, rear only a single brood each year, and long before the following breeding season the families break up. Hence opportunities for the young of an early brood to feed a subsequent brood rarely occur. At times adult warblers give food to young of other species. Kendeigh (1945:147) saw a pair of Black-and-White Warblers feed a fledgling Oven-bird. Rea and his companions (1945:262) watched a Black-and-White Warbler take food to a nestful of Worm-eating Warblers in the face of strong opposition from the parents. De Garis (1936:423) found a nest of the Kentucky Warbler to which a second male, apparently an abnormal individual, brought food for the incubating female, although occasionally he was chased by another male who sang better and appeared to be her mate.

The acquisition of the adult plumage is strikingly different in the migratory and

non-migratory members of this family. Young males of the migratory species go south in the immature plumage, pass the winter in that plumage, and then take on the bright nuptial attire before returning to their breeding grounds in the north. In the non-migratory Central American species of *Myioborus*, *Basileuterus* and *Ergaticus*, the sexes of which are alike, the young of both sexes acquire a plumage essentially like that of the adult soon after leaving the nest.



## FAMILY COEREBIDAE

### BLUE HONEYCREEPER

#### *Cyanerpes cyaneus*

The honeycreepers are a family of small song birds restricted to tropical America. In splendor of coloration they rival the tanagers, to which they are related. Bright shades of blue and green predominate in the plumage of the males; but in some species yellow is the most prominent color; and in certain of the curious highland members of the family there is a blackish or lead-colored dress. In the species of which the male is most brilliantly clad, the female is far more modestly attired.

One of the most brilliant members of this family is the Blue Honeycreeper. It is a very small bird, about four and a half inches in length, including the long, slender, slightly downcurved, black bill. The male is chiefly deep sapphire blue, which color covers all of his under parts, his rump, cheeks and hindhead. His crown is turquoise blue, a very bright shade which contrasts elegantly with the darker blue of his body plumage. A streak passing from the base of the bill through the eye, the hindneck, the back, the tail, and the greater part of each wing are black. The inner vanes of some of the remiges and under wing coverts are in part light yellow, which flashes out brightly when the bird takes flight but is invisible while he is at rest. The eye is dark, and the feet are bright red or flesh-color. The female, of the same size as the male, is rather bright olive-green above; her under plumage is pale greenish, fading to white on the throat and the middle of the abdomen and marked with darker streaks on the breast. There is a faint light line above her eye. The yellow on the inner surface of her greenish wings is far paler and less conspicuous than in the male. Her feet, too, are much less brilliant than those of the male, varying from pale flesh-color to grayish.

The Blue Honeycreeper enjoys a wide range that extends from southern México to Ecuador and southern Brazil. In Central America it is at home in the more humid and heavily wooded regions on both sides of the cordillera from sea level up to about 3500 feet. Dickey and van Rossem (1938:478) found it even at 4500 feet on the Volcán de San Salvador, about the lower edge of the cloud forest; I have never met it so high. It forages through the tops of the forest trees, but perhaps more frequently at the edge of the forest, in tall second-growth woodland, and in all sorts of open country where the trees are not too low nor too distant from each other. I never anywhere found this honeycreeper more abundant than among the shade trees of the coffee plantations on the Pacific slope of Guatemala, in the departments of Quezaltenango and Suchitepéquez, between 2500 and 3500 feet above sea level. Although common enough here in June and July, in December and January these little birds swarmed in incredible numbers, both through the coffee groves planted with *Inga* trees as shade and those canopied by the original forest which had merely been thinned by felling some of the trees. Through the bright December days the honeycreepers' sharp nasal call was heard almost ceaselessly as one roamed through these beautiful plantations. On the Pacific slope of southern Costa Rica, at the same elevation, the Blue Honeycreepers are abundant throughout the year, but they are never so multitudinous as I found them in Guatemala. Possibly in the latter country these honeycreepers perform seasonal migrations. Dickey and van Rossem discovered that in El Salvador the species nests and winters in distinct but not very widely separated parts of the country. In midwinter it swarms, in flocks



Fig. 64. Blue Honeycreepers; male above, female below.

containing from a score to a hundred individuals, in the southeastern lowlands; but in the breeding season they found it only in a more elevated region to the westward.

Except while nesting, the Blue Honeycreepers roam restlessly through the tree tops in small flocks, which in El General rarely contain more than twelve or fifteen individuals among which males in full breeding plumage are always a minority. Their flight is rapid and direct; and as they fly overhead the pale yellow on the underside of the males' wings is conspicuous. They bathe among the wet foliage during or immediately after a shower, flapping around among crowded, drop-laden leaves until thoroughly drenched, then preening and putting their plumage in order. I have often watched them perform their ablutions in this fashion in the madre de cacao (*Gliricidia sepium*) trees in front of my house.

#### FOOD

Although the rather long and very slender, curved bill of the Blue Honeycreeper suggests a highly specialized mode of foraging, actually it is, for a small bird, remarkably versatile in its feeding habits. It probes blossoms of the most diverse kinds, perch-

ing or clinging beside them rather than hovering on wing before them in the manner of hummingbirds. It apparently uses its long, slender, protrusible, white tongue to suck up the nectar or possibly to capture small insects that hide in the heart of the flower. The blossoms of *Inga*, *Calliandra* and other Leguminosae with clustered, protruding, white or red stamens are often visited; the powder-puff flowers of the introduced eucalyptus are equally attractive to the honeycreepers; and fragrant white orange blossoms frequently claim their attention. To reach the depths of the long, tubular, white flowers of the banana, they hang head downward beside them. They hunt small insects among the foliage and finer twigs, hopping or sometimes almost seeming to creep along the smaller branches, whence perhaps their name is derived. Often they forage very much in the manner of a wood warbler. They like to alight upon the very tip of the great, arching banana leaves and bend over or even hang head downward to look for insects or spiders that might be hiding in the fold beneath the midrib. They frequently catch tiny insects on the wing, darting out a few yards from some lofty perch, and like hummingbirds using to good advantage their slender bills, which seem so poorly adapted to flycatching. They may hover momentarily while they pluck an insect from a portion of the foliage otherwise difficult to reach, but they can not hang stationary on beating wings for long periods as can the hummingbirds.

As recorded by Todd and Carriker (1922:463) and other writers, Blue Honeycreepers are very fond of small berries and soft fruits of many kinds. When the spherical pods of the epiphytic species of *Clusia* open, spreading their pointed, leathery valves like the petals of a flower, and exposing a multitude of small seeds each enclosed in a bright red aril, the honeycreepers feast upon the soft, sweetish pulp, and carry quantities of it to their nestlings. When more succulent fruits are rare, they visit the dangling catkins of the cecropia trees and tear off portions of the crowded green achenes. In October, they flock into the clearings to visit the thorny *Xanthoxylum* trees, which at this season ripen their seeds. The little reddish pod, warty with projecting oil glands, now turns brown and splits into two valves, allowing the single black and shining seed to slip out and stand above it upon a short, thread-like stalk. Each rough, bony seed, only an eighth of an inch in diameter, is covered by a very thin, soft aril, rich in oil. Apparently it is the oily outer covering which attracts the birds; for they could hardly digest away the hard seed coat in order to derive nourishment from the germ that it encloses. These fruits are borne in large, pyramidal panicles containing hundreds together and attract birds of many kinds, but none more than the Blue Honeycreepers.

The Blue Honeycreepers are exceedingly fond of ripe bananas and plantains, and they have long been regular visitors to my feeding shelf where these fruits are daily displayed for them. Although they come throughout the year, they flock to the table in greatest numbers in October, November and December. At first the honeycreepers were somewhat distrustful of the far larger Song Tanagers, which were the most numerous attendants at the table. The tanagers paid no attention at all to the little honeycreepers; but as often happens with small people, the azure-crowned birds felt sure that unfair advantage would be taken of their diminutive size, and they opened their slender, curved bills as a threat to the relatively giant tanagers, although they still were being ignored by them. A colorful sight it was!

In late October, 1944, a fortnight of scarcely interrupted rain and gloomy weather brought birds of a dozen kinds, both residents and winter visitants, flocking to the table in greater numbers than ever before. Two or three large bananas would be consumed in about half an hour; they went so rapidly that before the bad weather came to an end the supply was exhausted and ripe plantains were substituted for them. Aside from the

wintering Tennessee Warblers, the Blue Honeycreepers gathered about the table in greatest numbers. Constantly in motion, they were as difficult to count as a flock of chickens; but there would certainly be a dozen at once feasting on the board or awaiting their turn among the branches of the guava tree above it. When the 15-inch-square board was crowded to capacity with a multicolored assemblage of tanagers, finches, orioles, wood warblers, and honeycreepers, one Blue Honeycreeper would sometimes alight upon the back of another of its own kind, although I never saw one take this familiarity with a bird of another species. If two honeycreepers elbowed each other too closely, they would stop eating, and facing each other, hold their slender bills pointing almost straight upward, at the same time voicing their fine, nasal notes. After a few seconds of this they would lower their heads and resume their meal; or one might make a jab at its rival and drive it away. Sometimes one of either sex pursued another for a few inches, but there was never any actual fighting. Rarely one honeycreeper would become greedy and try to keep the others off the board, but it was never successful for long. If it was not promptly swamped by eight or ten of its own kind, a bigger bird would soon arrive and call its puny bluff. When the table was less crowded, such manifestations of belligerency were rare; but occasionally two female honeycreepers, facing each other across the banana which both were eating, would posture with head tilted high, remain motionless in this attitude for several seconds, then as likely as not resume their feast.

Dickey and van Rossem (1938:480) record that in El Salvador Blue Honeycreepers "came in numbers to a clump of orange trees, much of the fruit of which had been drilled by woodpeckers (*Centurus santacruzi*). These openings in the fruit brought swarms of insects, which, in turn, may have been the main attraction for the honeycreepers, rather than the fruit itself."

#### VOICE

No honeycreeper with which I am familiar ranks as a songster of even the second class; and the Blue Honeycreeper has far less to offer to the ear than to the eye. The most common note is a thin, weak, nasal utterance delivered in various keys and sometimes sounding like *chaa*. Some honeycreepers that I heard in the Caribbean lowlands of Honduras gave a call which in tone reminded me of the nasal *dee dee* of the Black-capped Chickadee; but I have not detected this resemblance among the birds of southern Costa Rica. At times the thin, nasal call is suggestive of that of the gnatcatchers, but it is not quite so thin and wiry-sharp.

Like many another bird with a poorly developed voice, the male Blue Honeycreeper has a dawn-song which he rarely if ever utters after sunrise. In the dim light of day-break, the honeycreeper begins to sing among the foliage of a tree top, apparently that in which he has roosted. Here, unseen in the dark shadows of the clustered foliage, he pours forth his modest refrain in an uninterrupted flow. When the light has grown stronger, he may make short excursions to neighboring trees, singing briefly in each, then returning to his original position. Toward the end of his singing, he may interrupt his performance long enough to refresh himself with a few sips of nectar from conveniently situated flowers.

The Blue Honeycreeper's dawn-song is of the utmost simplicity, lacking in all musical quality. It consists merely of the monotonous reiteration of a single note, a clear but weak *tsip*, repeated at intervals of a second or two, with the interjection, after every two or three of these clear notes, of the bird's usual, rather nasal, mewing call. *Tsip tsip chaa, tsip tsip chaa, tsip tsip tsip chaa* . . . and so on, interminably, for twenty minutes

or so, with occasional brief intermissions. Toward the end of the period of singing, the clear notes may be repeated a greater number of times without interruption by the nasal call. I have heard this quaint performance only before sunrise in April, May and June. In its simplicity, its long duration, and the rareness or absence of repetition during the hours of full daylight, it greatly resembles the dawn-songs of many flycatchers. In character, it is more like the songs of hummingbirds than those of true song birds.

#### CONFLICTS

As in most of the far-ranging birds of the tropical treetops, it is difficult to learn much about the territorial relations of the Blue Honeycreepers. I have often watched them engage in disputes, but I have never been able to discover the causes of these disagreements, whether territory, mates, or other motives more obscure. Invariably the contestants have been two individuals of the same sex, and more often they were females than males. Other honeycreepers of one or both sexes might be interested onlookers, or the two might settle their difference in solitude. Always the opposing parties have limited their hostilities to posturing and vocal utterances; and although as the dispute ends one bird may chase its antagonist, I have never seen the least physical violence. Often a motley crowd of small birds of other species gathers around to witness the polemics.

One June I watched two female honeycreepers dispute in the underwood of light forest while a single male looked on. Perching low among the undergrowth, only a few feet above the ground, the two greenish females faced each other, a few inches apart, bowed up and down, pivoted from side to side, and uttered their nasal *chaa* in each other's faces. They did not constantly maintain the same position, but flitted about each other, always, however, remaining close together, and each keeping her head toward her vocal antagonist. This altercation continued monotonously, without change of procedure, for many minutes, while the sound of it attracted other birds, including two hummingbirds of different species and a Chestnut-tailed Automolus, which for a while looked on from very close at hand. Once the two antagonists descended almost to the ground among the branches of a fallen tree, and here I judged, from the altered character of the sounds, that they engaged in some sort of a scuffle. But if so, it was brief and inconsequential; and the birds soon rose into the bushes to continue as at first. All this while the male remained perching a few feet away from the contestants, for all that one could see a perfectly distinterested spectator. Toward the end of the logomachy a second male approached, but the first drove him unresistingly away. When this odd conflict had gone on for, I judged, more than a quarter of an hour, one of the females began to feel herself out-talked, or out-faced, and started to back away. Soon she fled, while the victress went off with the male—evidently the splendid prize for which these two plainly attired females contended. But on other occasions two males looked on while the females, evidently their mates, argued; so apparently these disputes are not always waged merely for the possession of a male.

Late one afternoon, as I rode my horse homeward through cultivated country, my attention was drawn by a more spectacular engagement between two female Blue Honeycreepers. Hovering face to face in the air on fast-beating wings, almost like hummingbirds, they rose up and up. Then they dropped down to perch close together on a banana leaf, where, again facing each other, they bowed as they turned from side to side and voiced their nasal *chaa*. Two males looked on from convenient perches. Soon one of the contestants was out-stared, or out-bowed, lost courage, and fled, to be

pursued by her adversary, while one of the males followed. They passed rapidly from view down the hillside.

A "fight" between two males in breeding plumage, unattended by others of their kind, was carried on in much the same manner. I found them late one afternoon in December in the top of a low tree standing in a thicket, my attention having been drawn to them by their oft-repeated *chaa*. Facing each other on perches only a few inches apart, they turned ceaselessly from side to side, flitted out their wings, and endlessly reiterated their *chaa*, which reminded me of a call of the Yellow-green Vireo. After many minutes of *chaaing*, they both changed their tune to the clear little *tsip* which enters so prominently into their dawn-song, but they continued to turn and flit out their wings as before. Finally they began to mix the *chaa* with the *tsip*, always gesticulating in the same fashion. A number of birds of other kinds—Tennessee Warblers, Blue Tanagers and a tiny Northern Tyranniscus—looked on from close at hand, showing a real interest in the contest; but no other honeycreeper came in sight. Finally the spectators withdrew to seek their sleeping places, for night was falling; but still the two honeycreepers continued to face each other and call and turn. At last, when the light was dim, one darted at the other, and both suddenly vanished from my view in the foliage. Their talking contest had lasted at least half an hour. Why they should have been disputing in early December, months before they would nest, I cannot surmise.

In the foregoing contests, I was unable to detect any essential disparity between the disputants, or to decide how victory was won. But in a dispute between two female Blue Honeycreepers which I watched under particularly favorable circumstances at the end of February, 1943, I believed that I discovered the basis of superiority of the contestant who won the engagement. I found them in a mandarin tree in the pasture in front of my house, at 9:30 in the morning, when the argument was already well begun. The two females faced each other on neighboring twigs of a low branch, about four feet above the ground. Each turned rapidly from side to side, flitting her wings and twitching her tail, repeating over and over the nasal *chaa*. The bird on the left perched slightly lower than her adversary a few inches away. Her breast was more strongly streaked, and she delivered her nasal note about three times to the other's two.

For a full half-hour, this performance continued in precisely the same fashion. Then, at ten o'clock, Left took a rapid lunge at Right, scarcely if at all touching her with the tip of her long, slender bill. Now Left changed the character of her utterance, delivering, at measured intervals, a low, sharp, clear monosyllable instead of the nasal *chaa*. Right remained silent for a while, merely turning her body, flitting her wings and twitching her tail like her opponent; but soon she began to utter a similar clear note, weaker than that of Left, and far less frequently repeated. At 10:10 Right shifted, after another interval of silence, from the clear note back to the nasal note which I had first heard. Left continued her clear monosyllable and displayed more energy in her movements. Right seemed to be becoming tired or bored, stretched her wings, and flitted from twig to twig, but always remained close to the other bird, who consistently turned to face her, continuing her rapid movements of body, wings and tail, and never ceasing to utter her clear note. Right answered with an occasional *chaa*.

At 10:28 Right was changing her perch more often and posturing less. Of a sudden, both birds flew to the far side of the mandarin tree, then to a small guava tree behind it. Here they separated. Both, so far as I could make out, delivered a few more of the nasal notes, then vanished. Although this contest was not abruptly terminated by a pursuit, as others I have watched, it seemed clear that Left had won. By calling more frequently and continuing her calling and posturing after the other tired, she had displayed energy

and endurance superior to those of her opponent. These are qualities of no little importance in the struggle for existence and the rearing of a family of young birds; and without the necessity of resorting to force, the victress had proved that she possessed them in a higher degree than the vanquished. It might almost be said that she had won a moral victory, since there had been no physical violence. The advantage of a merely vocal and demonstrative contest over actual fighting is that the contestant which happens to be slightly weaker comes off uninjured and fit to reproduce its kind. Although it might be somewhat inferior to the victor in certain points, it may still possess many qualities worthy of perpetuation in the species. Thus even from the purely physical consideration of the survival of the species, the formal contests so widespread among birds are preferable to fighting. Few species can afford needlessly to sacrifice their individuals.

#### NEST BUILDING

In the basin of El General, the flocks of Blue Honeycreepers separate into pairs in February. My earliest date for the beginning of nest building is March 23, 1937; but this nest was never finished. The earliest nest that was actually completed and used was found on April 16, 1944, when well begun. April, May and June are the principal months when the honeycreepers breed in this region. The eight nests of the Blue Honeycreeper that I have found were situated in trees or bushes growing in pastures or gardens, or at the edge of tall thickets. Two were above streams. In height these nests ranged from 10 to about 45 feet above the ground. They were placed in crotches or trifurcations at the end of slender branches, or else they were attached to petioles amid clustering foliage that concealed them.

I have seen something of the building of six nests, and always I found the female attended by her mate, who took no active part in the work. The first step in the construction of the little open cup is to wrap a liberal amount of cobweb around the bases of the diverging twigs which are intended for its support. The female honeycreeper collects the spiders' silk in the tip of her slender bill and carefully applies it to the bark of the twigs. The first Blue Honeycreeper that I found starting a nest abandoned her work when a pair of Blue Tanagers stole her cobweb for their own structure.

After she has applied the cobweb necessary to hold the nest in place, the female honeycreeper gathers very fine, stiff material, often tugging valiantly at the wiry fibrous roots of orchids or of other epiphytic plants, while her mate perches close by idly watching her strenuous efforts, voicing from time to time his nasal *chaa*, but never offering to help. If other birds have nests in the vicinity, she may visit them in the absence of the owners and try to pull from them such of the finer ingredients as meet her needs. Sometimes this thieving propensity leads her into trouble. One Blue Honeycreeper that was building in a ceiba tree in a pasture visited in turn nests of a Boat-billed Flycatcher, a Bellicose Elaenia and a Blue Tanager, finding little in them that she could use. But when she approached a nest of the Neotropic Kingbird the owners pursued her hotly; and she fled at top speed, crying shrilly, with her mate rushing along beside her.

The female honeycreeper seems to build most actively late in the morning or early in the afternoon; at least, these are the periods of the day when I have been most successful in watching her at work. At best, her visits to the nest are rather widely spaced, doubtless because gathering the fine, stiff fibers that enter so largely into its construction is strenuous labor for so small a bird. One honeycreeper brought material to her nest 13 times between 11:30 a.m. and 12:30 p.m. Another came 14 times between 11:00 and 12:00; and a third 11 times between 10:55 and 11:50; but in the last 20

minutes of my vigil she did not work. A fourth honeycreeper, building somewhat earlier in the day, brought 14 billfuls of material to her nest between 8:45 and 9:30 a.m. A fifth visited the nest 6 times in the half-hour between 2:00 and 2:30 p.m. After relatively brief periods of work, the birds stay away from the nest so long that the watcher grows tired of waiting for their return.

The brilliant male nearly always follows his mate back and forth while she builds, watching her gather material, then resting near the nest while she arranges it there. With bill and vigorous movements of the whole body the female tucks in the fibers and gives the nest shape, while the male idly preens his splendid plumage, voices his nasal *chaa*, or at considerable intervals gives the slight, clear note that forms a part of his dawn-song. The moment she darts from the nest, he flies away in close pursuit of her.

The completed nest of the Blue Honeycreeper of Central America (*Cyanerpes cyaneus carneipes*) is a small hemispherical cup, with side walls so thin that much light passes through their meshes. The bottom is thicker and less pervious to light. The nest is composed of fine fibers, thin fibrous rootlets from epiphytic plants, and slender branches from the inflorescence of grasses. Usually it is light in color. It is attached to the supporting twigs by cobweb and by passing some of the fibers around them. One nest measured  $2\frac{3}{4}$  inches in diameter by  $1\frac{3}{8}$  inches in height. Its internal diameter was 2 inches and its depth was 1 inch.

In the Guianas and Trinidad, the nominate race of the Blue Honeycreeper builds a nest amazingly different from that of the Central American form. Beebe (1917:241, fig. 75) writes as follows of a nest found in British Guiana: "The nest was a fairy network suspended over the water, as thin and evanescent as the shadow of an oriole's purse, and the eggs were the strangest of all eggs in the world—they were black. The home of the honeycreepers was delicately caught in the base of a great heartleaf of a water arum, the mucka-mucka, beloved of hoatzins, and it swung in every breath of air barely four feet above the surface of the river's edge. It was exceedingly thin-walled, every detail of the eggs and the setting bird being plainly visible. And yet it was most durable and quite impossible to tear or even appreciably alter in shape, for it was composed of fine, but very strong thread-like rootlets, all of a uniform dark brown or black color. The small round opening was at the top, obliquely facing one side. The nest itself was 17 cm. high, and 8 cm. across, while the nest hollow within measured 4 cm. in diameter by 7 cm. deep."

On June 5, 1937, while I dwelt in Rivas in the valley of El General, Efraim Flores came to me in great elation to announce that he had found the nest of the Blue Honeycreeper for which we had long been fruitlessly hunting, and for whose discovery I held out a reward of a colon. When, in answer to my questions, he described it as a small open cup light in color and containing white eggs, I told him that he was surely mistaken in the identity of the bird; for I recalled the foregoing account of the Blue Honeycreeper's nest found in British Guiana and I doubted whether representatives of a single species of bird, even in the most widely separated portions of their range, built nests or laid eggs so fundamentally different in appearance. But when I saw clearly for myself the attendants of the delicate, shallow little cup and when in subsequent years I discovered seven additional nests of the Blue Honeycreeper all essentially alike in shallow form, light shade of their materials, and the white eggs they held, I concluded that Efraim had been right, and Dr. Beebe had made some mistake in identification. But since additional evidence has become available, I am constrained to reverse my former judgment and to admit that both Dr. Beebe and Efraim made correct identifications.



Belcher and Smooker (1937:517-518) found a nest of the nominate race in Trinidad and another, apparently of this same race, in Venezuela. Both were built above water, the first attached to some vines on a dead stump and the second to a double fork of a small mangrove tree; both were constructed of black fibers like horsehair in appearance, and in form they were essentially similar to that described by Beebe. The Venezuelan nest measured 15 cm. from top to bottom and 8 cm. from the lower rim of the opening to the bottom of the nest; the greatest inner diameter was 7 cm. So, too, the Penards (1910:476-477) ascribe to the Hyacinthine Honeycreeper a nest which closely agrees with the foregoing in form, materials and dimensions, and they state (p. 475) that the Blue Honeycreeper resembles its congener in nidification.

#### THE EGGS

My earliest date for eggs in Costa Rica is April 19, 1944. In one nest the first egg was laid six days after I found the female honeycreeper starting to build. In three nests the eggs were laid on consecutive days, and in two of these nests the second was laid before 6:30 in the morning. Five nests which I could reach or look into with a mirror, or in which I could see the nestlings when they stretched up their heads for food, contained each two eggs or nestlings. The eggs of the Central American Blue Honeycreeper are white, with little gloss, and are speckled with bright brown, heavily in a wreath about the large end, and sparingly elsewhere. Two in a nest which could be reached measured 19.1 by 13.5 millimeters.

In their eggs, the two races of the Blue Honeycreeper, *cyaneus* and *carneipes*, differ just as strikingly as in the form of their nests, as already indicated. Beebe (1917:241-242) describes his set of two found in British Guiana as "astonishingly black or purple-black. Closer examination showed faint traces of the pale lavender ground color, distinctly revealed at the small end, and in irregular streaks and minute interstices as far as the middle of the shell. They measured 20.5 x 14 and 20 x 14 mm., and were quite fresh." Likewise, Belcher and Smooker (1937:517-518) describe their set of two from Trinidad: "The eggs are smooth-shelled and glossless, in shape elongated ovals; the ground colour is almost hidden, but appears to be of a deep purplish-buff; over this is a nearly uniform blotching and clouding of blackish-brown, so dense that it is no great exaggeration to describe the egg as black. Measurements: 21.9 x 14.2 and 21.9 x 13.9 mm." The egg they found in Venezuela was "cloudy purplish-black" and measured 21 x 14.5 mm. The eggs ascribed by Gundlach (1893:128) to the Cuban race of the Blue Honeycreeper (*ramsdeni*) are so much smaller (14 x 10 mm.) than those of the other races that I am not sure that they have been attributed to the proper species. In appearance these eggs resembled those of the Central American form far more closely than those of the nominate race in the Guianas and Trinidad. Gundlach fails to describe the form of the nest; but one may infer from this omission that it was of the open type so common among passeriform birds.

The blackish shell of the Guianan Blue Honeycreepers matches the color of the black nest that contains them and undoubtedly renders their detection by egg eaters more difficult. Such dark coloration would be of no particular advantage to eggs in the lighter-colored, more open nests built by the Central American Blue Honeycreepers. In this species we have a remarkable example of a bird which has evolved diverse forms of nidification and related differences in the coloration of its eggs in different portions of its range while remaining so uniform in size and appearance that the populations which build the two kinds of nests could hardly be distinguished in the field.

While this book was in press, Eisenmann (1952:362-363) published a review of the long and rather involved history of the only black eggs known to be laid by any bird in the world. He believes that the pensile nests with black eggs have been erroneously attributed to the Blue Honeycreeper—an opinion which merits the serious attention of anyone interested in this problem.

The distribution according to the month of laying of 7 nests in the valley of El General, 2000 to 3000 feet above sea-level, is as follows: April, 1; May, 5; June, 1.

#### INCUBATION

Incubation is carried on by the female alone. I devoted most of the morning of May 17, 1939, to watching a nest situated among the foliage clustered at the end of a slender ascending branch of an *Inga* tree, eighteen feet above the water of a small stream flowing between pastures and open fields. In 5½ hours the female honeycreeper took 8 sessions on the eggs, ranging in length from 16 to 53 minutes, and averaging 28.6 minutes. Her 7 absences lasted from 9 to 22 minutes, and averaged 13.9 minutes. She spent 67.3 per cent of the morning on her eggs. Her sessions lengthened to a pronounced degree as the morning advanced, while her recesses did so less markedly. Her longest recess, lasting 22 minutes, preceded her longest session of 53 minutes, which was terminated at 11:09 a.m., while a light rain fell. The early morning had been brilliantly clear. The male honeycreeper usually accompanied his mate as she flew to the nest, then flew away while she settled on her eggs.

At the end of April, 1943, a Blue Honeycreeper built a nest in a calabash tree in front of my house in El General; but before completion it was pulled apart and destroyed by other birds seeking material for their nests. In the middle of April of the following year, a Blue Honeycreeper, possibly the same individual, built in almost the same place. This time she was successful in completing her nest and hatching her eggs; but the nestlings vanished along with their nest before they were two days old, carried off, I believe, by toucans. I could watch this nest while resting on my front porch. On April 20, the day her second egg was laid, I repeatedly saw the female on the nest but made no continuous watch to learn what proportion of the time she devoted to incubation. But I watched her constantly from 5:15 to 11:26 a.m. on April 25, a mild bright morning, which became cloudy at about 11 o'clock, and from 11:30 a.m. to 1:12 p.m. on April 29, while clouds gathered heavily overhead, veiling the bright sun that had shone during the morning. In the 7 hours of fair or rainless weather, I timed 11 sessions of the female honeycreeper that ranged in length from 12 to 44 minutes and averaged 27.7 minutes; an equal number of recesses were from 6 to 19 minutes in length and averaged 11.2 minutes. She covered her eggs 71.3 per cent of the 7 hours.

When I began to watch this nest at 1:00 p.m. on April 26, the sun was beating down hotly between thickly gathering clouds. The female honeycreeper was absent, but she returned to her eggs at 1:03. Under the hot sunshine she sat high in the nest, panted, and moved restlessly around, constantly preening her feathers and looking down beneath her breast. After two o'clock, when the sun was veiled by clouds and the air cooler, she incubated more reposefully. Before long rain began to fall, a few drops at first, soon becoming harder, and continuing intermittently until four o'clock. The honeycreeper sat continuously from 1:03 to 4:02, a period of 179 minutes, except for one brief absence when she was frightened from the nest by a passing man and returned three minutes later. At 4:02, when the rain had stopped and a brilliant rainbow arched above the forest on the opposite ridge, she left for a nine-minute recess, at the end of which she returned and sat uninterruptedly until nightfall. Her manner of incubation on a wet afternoon was radically different from that in rainless weather. In the entire

afternoon from 1:00 until 6:00, when it became too dark to see her, she was absent from her eggs only 12 minutes.

The mate of this female honeycreeper, who had been attentive to her during the construction of the nest, became most neglectful while she incubated. In the twelve hours that I watched her warm the eggs, in both fair and rainy weather, he followed her to the nest only once. His lack of interest was in strong contrast to the attentiveness of the male at the nest above the river.

While the female honeycreeper incubated in the nest in front of my house, a Chipseachery Flycatcher, searching for materials for the bulky roofed structure she was building near by, came to the honeycreeper's nest. The tiny honeycreeper stood up so bravely to the flycatcher twice her size that the latter did not touch her little cup, but prettily displayed her scarlet crown-patch, rested quietly near the nest for a minute, and then flew away with empty bill. Blue Honeycreepers, as we have seen, often steal material from the nests of other birds; but they are sometimes paid in their own coin.

Another female honeycreeper, nesting 20 feet above the ground in a dense copalchí tree (*Croton glabellus*) standing in a clean pasture, had an interesting way of leaving her eggs when disturbed. To look into this nest, I used a mirror fastened to the end of a long pole. The honeycreeper would remain sitting until I began to raise the mirror, then drop suddenly almost to the ground and fly low over the pasture, rising only after she had gone a considerable distance. On the morning her first egg hatched, she sat until my mirror struck the foliage beside the nest, then dropped like a dead weight almost to the ground and skimmed above the grass for a distance of 50 feet or more, not rising until she was close to the neighboring woodland.

At two nests the incubation period was 12 days, and at a third nest it was 13 days.

#### THE NESTLINGS

The newly hatched nestlings are blind, with a sparse gray down quite inadequate to cover their pink skins; the inside of their mouths is red. Brooded only by their mother, they are fed by both parents, but chiefly by the female. Unlike some other members of the family (*Coereba* and *Diglossa*) the Blue Honeycreepers do not regurgitate the food they bring to their nestlings but carry it conspicuously in their long, slender bills, with perhaps more inside their mouths. Fruit seems to form the bulk of the nestlings' diet, but many insects are served to them. Sometimes the parent comes with small black or blue berries lined up in a row in the narrow bill, single file. The bright red arils of the seeds of *Clusia* are frequently the parents' burden when they come to the nest and are conspicuous in their black bills. The insects given to the nestlings are small, and only projecting legs or antennae betray their presence between the nearly closed mandibles. Many, possibly most, of them are caught in the air, flycatcher fashion.

The male honeycreeper seems usually to be slow in beginning to feed the nestlings, and at best he is an inconstant attendant. Sometimes for an hour or so he will bring food more frequently than the female; but as a rule he brings far less than she, and for long periods he quite neglects his offspring, although he may follow his mate as she comes with food for them. Were the female no more dependable in caring for the nestlings than the male, they would probably die of starvation.

Observations made from time to time at the nest above the river gave a vivid picture of the male honeycreeper's erratic attendance. The eggs hatched on May 25, 1939. On May 27, from 11:00 to 12:00 a.m., the mother brought food 5 times, the male not at all, although he several times appeared in the vicinity and once followed his mate almost to the nest. The female did not brood at any time in this hour.

On May 29, when the nestlings were 4 days old, I watched the nest from 10:30 to 11:30. The female brought food 6 times and brooded for a single period of 5 minutes. The male twice accompanied her as she came with food, rested near the nest while she fed the nestlings, then followed when she flew off; but he did not once feed the nestlings.

On May 31, when the nestlings were 6 days old, I watched from 9:25 to 10:25. The female brought food 9 times and did not brood. The male followed his mate on her first 5 visits to the nest and once brought food which he delivered to the nestlings; but on the female's next 4 visits he did not appear. This was the first day that I saw him bring food to the nest.

On June 1, when the nestlings were 7 days old, I watched the nest from 6:30 to 7:30 a.m. The female fed the nestlings 13 times, the male 7 times. He brought most of this food in the first half-hour but then seemed to tire and stayed away. Sometimes he came with his mate, sometimes independently of her. The female brooded twice, each time for a few minutes only.

On June 2, when the nestlings were 8 days old, I watched from 10:20 to 11:20. The mother fed the nestlings 9 times, the father not once, although he twice followed his mate on her visits to the nest. But between 3:35 and 4:20 in the afternoon, when rain was threatening, each of the parents brought food 4 times, coming always separately. At 4:20 rain began to fall, and I discontinued observations. It seemed that this male honeycreeper was most active in feeding his nestlings during the cooler part of the day and that he left his mate to carry on alone while the sun was bright.

On June 5, when these nestlings were 11 days old, their mother fed them 13 times between 9:15 and 10:15 a.m. and 10 times between 10:15 and 11:15. The male brought food twice in the first hour but only once in the second hour. Yet he often followed the female when she came with food. Once when he bore a morsel in his bill, she begged for it and was fed by him. This was the only time that I saw a male Blue Honeycreeper feed his mate. But possibly he frequently gave her food at a greater distance from the nest and for this reason did not feed the nestlings more often.

I devoted two hours to watching a high, inaccessible nest in a ceiba tree that held two nestlings about a week old. From 5:50 to 6:50 a.m. the female brought food 8 times, the male thrice. But after 7 o'clock the father accelerated his rate of feeding and brought food as many times as his mate; each fed 11 times between 6:50 and 7:50. Male and female were quite independent of each other in their movements, coming and going at different times and bringing food from different directions. The male cleaned the nest. Some days later, I saw him bring food 6 times between 10:50 and 11:30 while the female fed the nestlings only thrice. This was the only interval when I witnessed a male Blue Honeycreeper outdo his mate in attention to the nestlings.

At the age of 11 days, the nestlings above the river were nearly feathered. They were restless and moved about much in the nest, devoted much time to preening their plumage, and sometimes exercised their wings by flapping them above their backs. They called frequently for food and seemed to be always hungry.

At 6:40 a.m. on June 8, when the young honeycreepers were 14 days old, I found that one had already left the nest, whereas the other rested upon its rim. The absent youngster was evidently hiding among the foliage at no great distance, for I saw the female carry food there and leave with empty bill; but the foliage screened its tiny greenish form from my view. In half an hour the female brought food 5 times, but the male only once. Red fruit pulp continued to be a conspicuous element in the fledglings' diet. Returning at noon, I found the nest deserted.

This is the only nest at which I was able to determine the nestling period. For both nestlings it was 14 days.

The females, always the more reliable attendants of the young, continue to provide for them after the males have forgotten them. Sometimes a mother comes with her short-billed youngsters to the feeding shelf, and while they wait on a neighboring bough brings them billfuls of banana, which they receive with sharp fledgling cries and quivering wings. The males are seldom interested in juveniles old enough to follow their parents to the table.

I have no evidence for a second brood and no record of a nest in El General later than June.

#### PLUMAGE CHANGES

The Blue Honeycreeper is, so far as I know, the one passerine bird of Central America of which the males change after the breeding season into plumage far duller than that in which they nested. I first began to suspect this in October, 1930, when all the numerous Blue Honeycreepers that I saw in the Lancetilla Valley of Honduras wore greenish plumage like the females. But as the years passed and I failed to discover any other Central American passerine that changed into a "winter" plumage, I began to doubt this early conclusion. My scepticism was strengthened by the puzzling situation I later found among the Blue Honeycreepers in Costa Rica.

Among the honeycreepers that swarmed in countless numbers through the shade trees of the coffee plantations about Colomba, Guatemala, around 3000 feet above sea level, in December, 1934, males in full breeding plumage were very rare—not more than one among every 40 or 50 honeycreepers, as I estimated. A few more showed scattered, inconspicuous patches of blue on their greenish bodies, but even these were far from numerous. Nearly all these honeycreepers wore the olive-green body plumage of the females and young males. By mid-January, when I was working in another part of the same coffee-producing zone at about the same altitude, I found a fair proportion of the honeycreepers blotched and streaked with blue and black; but males in full adult plumage were still far from common.

These observations in Guatemala appeared to support those I had earlier made in Honduras. The number of Blue Honeycreepers in the coffee plantations was so great that they seemed to represent a concentration of migratory or wandering birds rather than just the local breeding population. One had either to conclude that most of the adult males spent these months apart from the females and young or that they now wore a dress far duller than that in which they nested. I was led to accept provisionally the former alternative, improbable as it seemed, by observations made a year later in El General, where in December I found many males in full nuptial plumage. In the following years I saw such males through much of the non-breeding season. Although in October they accounted for only a small proportion of the population, they became increasingly abundant during the next few months. It was difficult to believe that in this region the adult males molted into a duller attire after the close of the breeding season. If so, it was necessary to assume that the molt did not proceed simultaneously in the whole population, but that different individuals performed it at periods separated by several months. There was also the possibility that in northern Central America, where the annual fluctuation in the length of the day is greater, the honeycreepers exhibited seasonal changes in coloration, while in southern Central America the adults wore the same dress throughout the year. At the Museum of Comparative Zoölogy at Cambridge I examined a large number of male Blue Honeycreepers in transitional plumage, from widely scattered parts of the species' range, without finding evidence that any were molting from a brighter to a duller dress. Dr. Herbert Friedmann kindly examined for me the specimens at the United States National Museum with similar negative results.

On February 22, 1949, Miss Helen Wheeler, a schoolgirl in the Canal Zone, wrote to me that two captive male Blue Honeycreepers, which had brilliant blue plumage when bought in the Panamá City market the preceding July, were changing into a dull green dress. When released in the forest on April 22, 1949, these males had not regained their original bright coloration, although a few azure feathers had appeared on their heads. Because they still wore the greenish plumage at a season when all free male honeycreepers in southern Central America seem to be in nuptial attire, it appeared that the loss of their brilliant plumage might have been induced by captivity; and I could not conclude from this observation that free birds undergo a similar transformation.

My first indubitable proof that free male honeycreepers molt into a duller plumage was obtained in July, 1953, while this book was passing through the press. On the sixteenth of the month, a male Blue Honeycreeper in transitional plumage came to the feeding shelf beside my house, filled his bill with banana, and carried it off toward the river, repeating this several times. Next morning he came with two fledglings, who waited near the board while he assiduously carried food to them. Young after they begin to fly about are attended by their mother far more often than by their father, but neither then nor during the next fortnight did I see a female take an interest in these young birds. This observation, unique in my experience, raised a number of questions. Was this faithful attendant perhaps an abnormal female partly colored like the males? Was it an abnormal male who had nested in greenish plumage and was belatedly acquiring the adult dress? Was it a young helper reared in an early nest, attending a later brood while it began to take on the adult plumage? I had never discovered a helper in this species, nor could I recall having seen any bird in transitional plumage in March, April and May, when the honeycreepers chiefly nest.

The honeycreeper himself gave me a definite answer to these questions as during the next fortnight he continued to visit the table with a single youngster, the other having disappeared. When I first saw him more than half of the surface of his body was dull green, the rest blue and black. The numerous bright azure feathers that flecked the top of his head quite disappeared during these two weeks. The black vanished from his back except for a narrow longitudinal streak on either side. The blue on the under surface shrank to a narrow, elongate patch in the center of the breast. There remained much pale blue on the rump, and he continued to wear the black tail, the black and yellow remiges, of breeding adult males. There could be no doubt that he was going into an "eclipse" plumage.

Several weeks earlier I had seen at the feeding shelf a male whose plumage was fully adult save for a few greenish feathers on his breast. In other years, too, I had seen in late June males with only a little green on their blue and black plumage, along with many others in all stages of transition between the bright adult attire and the greenish body of juveniles and females. According to the theory I then held, these were all youngsters acquiring adult colors. I was perplexed to find some so far advanced at so early a date, but possibly they had come from a distance, since honeycreepers seem to wander widely. Now I could hardly doubt that these males with only a little green on their bodies were breeding adults just starting to go into "eclipse."

My failure in earlier years to distinguish between adults and juveniles brought confusion into the records I accumulated to show the young males' progress to full breeding plumage. However, at least in the earlier stages of this transformation the youngsters can be distinguished by their wings, in which the olive juvenal remiges are gradually exchanged for black feathers. Individuals with both sorts of feathers on their wings are apparently all juveniles, since, so far as I have seen, adult males retain their yellow and black remiges throughout the year. But once the molt of the remiges is complete,

immature males can scarcely be distinguished in the field from those adults who have most completely lost their blue and black body plumage.

Upon leaving the nest, young Blue Honeycreepers are dull green, like adult females, but of a duller shade, and their bills are far shorter. The first step in the acquisition of the bright adult colors by the young males is the replacement of the dull olive remiges by black plumes which show yellow on the under surface. The molt of the remiges begins at the two extremities, with the result that at a certain stage the young males show an olive band down the center of the wing, bordered on both the inside and outside by black. Their wings now begin to show conspicuous areas of yellow in flight, as in the adult males. The replacement of the juvenal remiges is usually well advanced or even completed before the molt of the contour plumage becomes conspicuous. In Costa Rica there is an amazing difference in the time of molting of young males of the same population—a difference scarcely to be accounted for by differences in age, if the dates for eggs given earlier can be regarded as representative. I have a record of a young male beginning to acquire adult remiges on June 30. Throughout the second half of the year one sees in El General young and old males in every stage intermediate between the greenish body plumage with black and yellow remiges and the brilliant nuptial attire. Many are mottled and flecked with azure, deep blue, and black on green in the most varied patterns.

By January most of the Blue Honeycreepers in the vicinity of my house are either females or males in full breeding plumage. But a few of the young male honeycreepers that come to my feeding shelf still retain a number of juvenal remiges as late as the end of January. The most belated individuals do not show any traces of blue or black on their greenish body plumage until February, and one was still mostly olive-green on February 21, 1948. Thus, in this locality, March, April, and May are the only months in which I have failed to record male honeycreepers in some plumage intermediate between the juvenal or full eclipse and the bright adult attire.

In El Salvador, where as in other parts of northern Central America the Blue Honeycreepers' changes in color are more definitely seasonal than in Costa Rica, the acquisition of the adult plumage was studied by Dickey and van Rossem (1938:479-480), who wrote: "In postjuvenal plumage the sexes are very similar; in fact there seems no certain method aside from the larger size of the males by which to distinguish them during the short interval in which the postjuvenal body plumage is worn complete and the wing molt not yet started. The wing molt commences after the postjuvenal body plumage is complete and is finished by the middle of January. The black wings of the young males then form a conspicuous sex mark visible at some distance, although the body plumage of both males and females is still alike.

"Scarcely is the postjuvenal wing molt complete when the first prenuptial molt begins. This is a complete body and tail molt in both sexes, but is of course much more noticeable in the males. At this time (January 1 to February 15) the males take on the black and blue plumage of maturity and are then not to be distinguished from adult birds. The molt is a very gradual one, beginning on the rump and thighs, and then as scattered feathers everywhere. The cerulean crown patch and the chin are the last areas to be affected. Thus the young males have four distinct plumage combinations the first year of their lives—the juvenal plumage, the green postjuvenal plumage with greenish juvenal wings, the green postjuvenal plumage with black postjuvenal wings, the black and blue prenuptial or first spring plumage. The curious part of this program is that each step is nearly complete before the subsequent step is initiated."

Since in this account no mention is made of the striking seasonal changes in the appearance of the adult males, one wonders whether those in transitional plumages were

not confused with the juveniles. Even in its own family the Blue Honeycreeper seems to be exceptional in its plumage changes. The Green Honeycreeper is likewise a constant attendant at my shelf at all seasons, but I have seen no indication that adult males ever lose their bright green and black nuptial attire. We have still much to learn about the Blue Honeycreepers' changes in coloration. Indeed, this species merits attention in every way.

#### SUMMARY

Blue Honeycreepers forage in the tops of forest trees, along the woodland edges, and in plantations and clearings with scattered trees. When not breeding they wander widely in small flocks composed of both sexes.

The food is varied. They are fond of bananas and other fruits, probe blossoms for nectar or minute insects, search the foliage for invertebrates, and even catch insects on the wing.

The voice is thin and weak, and the birds practically never sing in full daylight. But at daybreak in the breeding season males deliver a weak, unmelodious dawn-song, continued persistently for many minutes.

Disputes, always between birds of the same sex and of obscure origin, are settled by endless posturing and calling. Finally the less enduring of the contestants flees and may be pursued by the victor, but physical contact has not been seen.

In El General the honeycreepers nest in April, May and June. The slight, open cup, placed in a bush or tree in a pasture or garden, is built by the female alone, while her mate often follows as she flies back and forth gathering material. The shallow Central American nests differ greatly from the deep purses ascribed to this species in northern South America. While it is not impossible that the same morphological species builds such fundamentally different structures in various parts of its range, it seems more likely that the pensile nests found in the Guianas were wrongly ascribed to the Blue Honeycreeper.

Two speckled white eggs are laid early in the morning on consecutive days. The blackish eggs ascribed to this species in northern South America were possibly laid by some other bird.

Only the female incubates, taking sessions usually less than an hour in length. One female covered her nest for 67 per cent of 5½ hours, another for 71 per cent of seven hours of observation, during rainless weather. At two nests the period of incubation was 12 days; at a third nest it was 13 days.

The nestlings, hatched with sparse gray down, are brooded by the female, and they are fed by both parents. The male, however, is irregular in his attendance, and the female is the mainstay of the young. Fruit seems to form the bulk of their food, but many insects are given them. At one nest the nestling period was 14 days.

As the breeding season comes to an end in June or July, adult males exchange their rich nuptial colors for a greenish body plumage resembling that of the females, but they retain the black and yellow remiges. One male lost his bright nuptial attire as he continued to feed a fledgling. Males in full breeding plumage become very rare, but in Costa Rica a few are found even in October. Thence until the end of the year they become increasingly abundant. In Guatemala, however, males in full nuptial attire are exceedingly rare even in December but become more numerous in January.

While the adult males undergo these changes, the young males acquire the nuptial plumage. The first step is the replacement of the olive-green juvenal remiges by black feathers yellow on the inner surface, as in the adults. The molt of the remiges is nearly or quite complete before the azure, deep blue, and black feathers appear on the head



and body. In Costa Rica some young males begin to acquire adult remiges in June but others not until January. These belated birds do not begin to show blue and black body plumage until February. Thus males in transitional plumage are seen in every month except March, April, and May, when the honeycreepers are nesting.

## BANANAQUIT

### *Coereba flaveola*

The Bananaquit is an amazingly prolific, adaptable honeycreeper, that is by far the most widespread and best known member of the family. Thirty-five races of this species are recognized by Hellmayer (1935:284-314). They inhabit every part of South America except Chile, Uruguay, and the cooler parts of Argentina and they occur through nearly all of Central America and southern México, in nearly all the Antilles, Greater and Lesser, with the curious exception of Cuba, in the Bahamas and on the small isolated islets of the Caribbean Sea, such as Old Providence, San Andrés and the Caymans. They also occur on the Pearl Islands in the Gulf of Panamá and on Gorgona off the Pacific coast of Colombia. It is not surprising that in so plastic and adaptable a species numerous well-marked forms, many of them until recently considered to be good species, should have evolved in the more insulated portions of this far-flung range.

My own studies have been made chiefly on the Mexican race, *Coereba flaveola mexicana*, in the Térraba Valley of Costa Rica and on the Colombian form, *Coereba flaveola columbiana*, in the Panamá Canal Zone. These two forms differ but little in appearance and habits. They are very small birds, easily recognized by the blackish head with a conspicuous white stripe above each eye, grayish-olive back and yellowish-olive rump, light gray throat, and bright yellow breast. There is a small white spot on the outer remiges, hardly visible until the wing is spread. Above all, their minute size and short, sharp, strongly curved, black bill aid in their identification and set them off from the far larger flycatchers—the Chipsacheery, Kiskadee, Boat-billed Flycatcher and others—which in color pattern they resemble to a surprising degree. The Bananaquit bears not the slightest similarity in appearance or the form of the bill to the other Central American honeycreepers. Male and female are identical in plumage; but the tireless singing of the former serves to distinguish him from his mate.

The name deserves a word of explanation. Gosse (1847:254) states that “the name of *Quit* is applied without much discrimination by the negroes of Jamaica, to several small birds, such as the Banana Quit, which is a Creeper, and the Blue Quit, and Grass Quits, which are finches; it is probably an African designation.” Although it carries the sanction of long usage, “bananaquit” is not a particularly appropriate name for this honeycreeper, at least as applied to the Central American birds. In Costa Rica, four or five other species of the family are more fond of bananas than this one.

Other races of the Bananaquit are among the most common birds of the regions they inhabit and are amazingly catholic in their choice of habitat. Belcher and Smooker (1937:518) consider this species to be the most common and widely distributed small passerine bird on the islands of Trinidad and Tobago, where it is found in “practically every class of country except, it may be, mangroves at a distance from dry land.” On Puerto Rico, according to Wetmore (1927:498), the Bananaquit is the most abundant and widely distributed species of bird. It is found wherever there is cover for it, in mangroves, pastures, coffee plantations, thickets and forests. “Seemingly it is able to adapt itself to all conditions. It is the only common bird of the dense, humid rain forests that clothe the higher slopes of El Yunque, and it is equally common in arid districts on the dry southern coast, where rains come seldom.” It outnumbers all other species in coffee plantations.

In Central America the Bananaquit is less adaptable and less generally abundant. Even where I have found it most numerous, as in the Térraba Valley of Costa Rica and

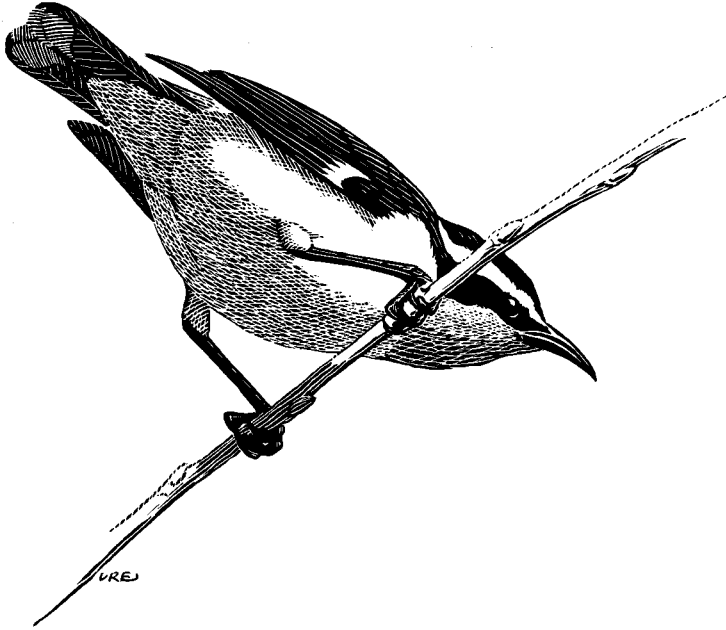


Fig. 65. Bananaquit.

in the Canal Zone, it is by no means the most common species among the teeming bird life of these areas. It is largely confined to regions where the natural vegetation is rain-forest, hence it is rare or absent on the Pacific coast to the north of the Gulf of Nicoya. Even in the humid Caribbean lowlands of Honduras, Guatemala and southern México, it is far from common or uniformly distributed. I have never seen the Bananaquit in the midst of heavy forest, although it often occurs about its edges. It inhabits light, open woodlands, scrubby pastures, and plantations, and it is a common inhabitant of dooryards, gardens and orchards where there is an abundance of flowering trees and shrubs. Less gregarious than species of *Cyanerpes* and *Dacnis*, Bananaquits do not flock, but at all seasons live singly or in pairs. A heat-loving bird, it extends from the coasts upward to about 4000 feet in Costa Rica, but apparently not so high in Guatemala.

#### FOOD

The favorite occupation of these brisk little birds is probing the hearts of nectar-bearing flowers. Acacia-like blossoms with clustered stamens attract them greatly; but the flowers of a wide variety of plants appeal to them; and they even visit the great, flaring, yellow trumpets of the cultivated *Allamanda*, longer than themselves, whose corollas they pierce at the base with their sharp bills, since they cannot otherwise reach nectar so deeply placed. Unable to hover in the manner of hummingbirds, they cling beside the blossoms in all conceivable positions, head or tail uppermost, it makes no difference. While gathering minute insects or spiders from the foliage, they display the same ability to cling in all attitudes, and they are often seen in an inverted position. They pluck the tiny white protein corpuscles from the hairy cushions at the bases of the petioles of the *Cecropia* leaves; I have seen them do this so often that I feel sure

that this is an important source of nourishment for them, as it is for the Azteca ants that dwell in the hollow internodes of the tree. In recently burned clearings in the forest where pokeweed (*Phytolacca rivinoides*) grows rankly, they puncture the berries with sharp bills and suck out the purple juice, getting their bills glistening wet in the process. Although the Bananaquits live in my yard throughout the year, they only rarely visit the feeding shelf to eat the bananas daily displayed there; yet these same fruits attract numbers of Blue Honeycreepers, Green Honeycreepers, Turquoise Dacnises, and Hyacinthine Honeycreepers from more distant haunts. In Puerto Rico the Bananaquit, which is here far more familiar and domestic than in Central America, enters houses through open doors and windows to search for insects and spiders in the rooms; it boldly flies into the dining rooms of country hotels to remove sugar from the bowls on the table in front of the guests; and syrup is sometimes placed for it in dishes on the counters of rural shops. It also frequently visits banana flowers and it is said to pierce ripe bananas to reach their pulp; and it may eat red raspberries (Wetmore, 1927:498-501).

One morning at the end of August I watched a Bananaquit hunting over the trunk of a small Spanish plum tree. It clung to the rough bark in such a manner that at the first distant glimpse I took it to be a newly arrived Black-and-White Warbler, the white stripes at the sides of its black head strengthening the illusion suggested by its posture. The Bananaquit hung in various orientations, head, tail or a side uppermost, and sometimes moved over the bark for an inch or so, but this was apparently the limit of its ability to creep. It was collecting food, probably for the fledglings that had left a neighboring nest a few days earlier; it held the insects it found visibly in its bill, instead of swallowing them to regurgitate later. This is the only time I have seen any kind of honeycreeper perform the activity for which the family is so unfortunately named.

#### VOICE

The song of the Bananaquit is a high-pitched trilling, or perhaps better, shrilling, of an undulatory character, almost insect-like in its thinness and lack of volume. What the little songster lacks in volume he makes up in persistence, for few birds sing more constantly than this. The season of song, like that of nesting, extends through most of the year. In the basin of El General, the Bananaquits sing in every month, but very little in the driest weather, in January and February and in March before the rains begin. During the wet and often gloomy months of September, October, and November and at the beginning of the drier weather in December, when few birds sing, Bananaquits are the most songful feathered creatures of the region. On Barro Colorado Island they sang much in February and March, although at this season they are almost silent in El General—differences no doubt correlated with variations in the nesting season soon to be considered. At high noon, when the sun pours down and most bird voices are hushed in the midday stillness, the Bananaquits sing persistently, seeming never to tire of repeating over and over their wheezy little trill. Wetmore (1927:498-501) comments upon the dauntless character of the Puerto Rican Bananaquit, and tells of one bird which sang after a violent storm of wind and rain as soon as the heaviest down-pour was over. He states that young birds sing as soon as they are fully feathered; but I have not noticed this among the Central American Bananaquits, which in general seem to be less precocious than some of the Antillean races. Song appears to be confined to the males.

The call note is a slight monosyllable, sometimes wiry-sharp, sometimes lisping in character. It is especially sharp, and tirelessly reiterated, when two Bananaquits engage in a quarrel.

## THE NESTING SEASON

Like those other nectar-sipping birds, the hummingbirds and flower-piercers (*Diglossa*), the Bananaquit has a breeding season which differs greatly from that of the vast majority of passerine birds among which it dwells. A number of authors have commented on the unusually long season of reproduction of several races of this species. Bond (1943:120) states that "there is no definite breeding time; nests are found virtually throughout the year anywhere in the West Indies." In Puerto Rico, Wetmore (*loc. cit.*) believes that the nesting season of the race *portoricensis* extends without definite break throughout the year, although occupied nests are most abundant from February to June. Several broods are raised, but how many can be told only by extended observations of one pair. In Trinidad and Tobago, Belcher and Smooker (1937:518-519) state of the race *luteola* that "nesting goes on throughout the year, but reaches its peak, as in the case of so many other small birds, in April and May." In Venezuela, Cherrie (1916:166) found this race of the Bananaquit breeding most abundantly throughout the dry season, but he believed that it nested in every month of the year. On the other side of the Equator, at Cantagallo in the Province of Rio de Janeiro, Brazil, where most birds nest between August and February, Euler (1867:181) in the course of four years found the nests of Bananaquits of the race *chloropyga* in July, in the midst of the dry season. He also records nests in October (p. 193).

For Central America, we have a few published records of nest building, but apparently none of eggs or nestlings. Since the Bananaquit constructs nests for use as dormitories even at seasons when it does not breed, nest building is in itself no indication of reproductive activity. On Barro Colorado Island, in the Canal Zone, I found six breeding nests, of the race *colombiana*, between late December and early June. The first of these nests contained a newly laid egg on December 29; the last held nestlings a week old on June 1. Here breeding goes on continuously during the short dry season and the early part of the wet season. During the second half of the year I have passed very little time in the Canal Zone, and I have no information on the breeding of the Bananaquit in the period from early June to late December.

From the basin of El General in the upper Térraba Valley of Costa Rica, between 2000 and 3000 feet above sea level, I have records of 30 occupied breeding nests. These indicate that breeding begins late in May, is at its peak from June through November and continues until February, the last nestlings taking wing early in March. I have no knowledge of nesting in April, when breeding activity for the great majority of the passerine birds of this region is at its height. On the other hand, from July through February, when nests of other passerines are extremely rare, the Bananaquit breeds freely. Its reproductive period begins after there have been about two months of rain, is near its peak during the wettest months of the year, and tapers off during the early part of the dry season, which starts about the beginning of January. By March, when Bananaquits cease to nest, flowers have become very rare in the clearings as a result of continued drought. After the rains return in late March or April, the vegetation flourishes again; soon flowers become more plentiful, and then the Bananaquit resumes nesting.

Barro Colorado Island and the basin of El General, the localities where my nests of the Bananaquit were found, both lie between the ninth and tenth degrees of north latitude, the first on the Caribbean, the second on the Pacific slope. Yet on Barro Colorado the Bananaquit breeds through the dry season, whereas in El General it apparently does not. This difference may be associated with the greater severity of the dry season usual on the Pacific side of Central America; although in El General the period

of drought is in most years less protracted than at other points both to the north and the south. Parallel differences are found in the breeding seasons of the Rieffer Hummingbird in the two regions: in Caribbean Panamá it nests throughout the year; in El General it appears to breed at all seasons except the period from the end of January to late May.

#### NEST BUILDING

In form, the nest of the Bananaquit differs not only from that of all other honeycreepers known to me but from that of every other species of Central American bird whose nest I have seen. It is a usually thick-walled, closed structure, roughly ovoid or globular in form, with a little, round, downwardly facing doorway at one side of the bottom. There is considerable variety in the size and finish of the nests, associated with the circumstance that some are used only as dormitories whereas others hold the eggs and young. But all that I have seen are essentially similar in form; the dormitories grade into the breeding nests in both size and the thickness of the walls; and there is no hard and fast line between them. Indeed, a well made dormitory of a male may later be taken over by his mate and be used for raising a brood. In site, too, I have noticed no constant differences between the two classes of nests. It seems simplest, therefore, to consider all the Bananaquits' nests together, for whatever purpose they are destined.

The position chosen for the nest is extremely variable; the site is sometimes within five feet of the ground, sometimes high up in trees. Breeding nests and dormitories may be placed equally low. A thorny orange or lemon tree in a clearing is a favorite nest site; and in these trees the nest, situated among the smaller branches, is most likely to be near the ground. Other nests are placed among the boughs overhanging rivers, either high or low above the water, in a vine tangle at the edge of the forest, or among the broad bases of the fronds of a spiny palm tree. On rare occasions the Bananaquits make use of a small, empty, cup-shaped nest, as that of a seedeater, as the foundation of their own closed construction. Often the nests are placed with little regard for concealment.

The breeding nest, which may serve also as the female Bananaquit's dormitory for considerable periods when she is without eggs or nestlings, is built by both sexes together, as I have repeatedly seen in Panamá and Costa Rica. The male usually sings profusely as he works; the female is silent or voices only her sharp little call. On December 24, 1930, I found my first Bananaquits' nest while the birds were building. It was situated in the broad axil of a frond of a very spiny palm that grew beside a beautiful little sheltered cove in the wooded shoreline of Barro Colorado Island. While watching the Bananaquits I sat quietly in my cayuco in the midst of the shady cove, rocked gently by the little waves which found their way to the head of this long arm of Gatún Lake. The Bananaquits flitted briskly between the trees on the shore, plucking here at a slender dead vine and there at a length of fiber dangling beneath a palm frond and filling their bills with a generous load before returning to the nest. Often they were so quick at gathering material that before one had finished arranging its contribution within the nest, the other was waiting outside with laden bill. When the two met at the nest they conversed briefly with high-pitched, rapid twitters.

In one instance the breeding nest was built in four or five days by both sexes working together; and I have known a juvenal Bananaquit to finish its dormitory in three or four days, working alone. When completed, the cozy covered nest measures 4 or 5 inches in external diameter. If it has long been in use and has been beaten upon by heavy rains, its height may be considerably less than the horizontal diameter. The round doorway, at one end and facing obliquely downward, is about  $1\frac{5}{8}$  inches in diameter. The interior of the chamber of a breeding nest was approximately 3 inches in diameter, and that of a dormitory was  $2\frac{1}{4}$  inches in diameter. The materials of the nest are varied

and include, according to what is available in the immediate vicinity, coarse vegetable fibers, grass blades, whole small bamboo leaves, strips from the leaves of bananas or of other monocotyledonous plants with huge blades, pieces of vines and weed stems, fibrous rootlets chiefly of epiphytic plants, tendrils, pieces of papery bark, and more or less green moss. The interior may be unlined or, in breeding nests, it is softly lined with fine fibers, seed down, and sometimes with downy feathers.

Although the male as a rule helps the female with her nest, so far as I have seen he builds his sleeping nest without assistance, often singing profusely as he toils alone. He may leave holes in the roof through which the sky may be seen, or he finishes his structure as substantially as the breeding nest.

#### THE EGGS

Because the nest is not used merely for breeding but serves also as a dormitory, the period between its completion and the deposition of eggs is extremely variable. The first egg may be laid four or five days after finishing the nest, or a month or more may elapse before its appearance, the female meanwhile passing the nights in the nest. From Costa Rica I have 25 records of nests with two eggs or nestlings, and from the Canal Zone, four records of nests with two eggs or nestlings; none in either locality contained more. In Trinidad and Tobago, *luteola* ordinarily lays two eggs, but sometimes three (Belcher and Smooker, 1937:519). Cherrie (1916:166) records a set of three eggs from Venezuela. In Puerto Rico, the Bananaquit lays two or three eggs (Wetmore, 1927:500). It is almost impossible to remove the eggs from the well enclosed nest without endangering them or distorting or lifting up the structure which contains them. Since I wished to use my accessible nests for future studies, I have no measurements or accurate description of the eggs. As seen with a mirror inside the nest, they are dull white spotted with brown. Belcher and Smooker give the average measurements of ten eggs of the race *luteola* as 17.2 by 12.8 millimeters.

The distribution according to the month of laying of 30 nests in the valley of El General, 2000 to 3000 feet above sea level, is as follows: January, 6; February, 3; May, 1; June, 5; July, 3; August, 6; September, 1; October, 2; November, 1; December, 2.

#### INCUBATION

Incubation is performed by the female alone. On Barro Colorado Island in February, 1935, I found a nest in an orange tree on the steep hillside in front of the main building. The doorway faced down the slope; and by sitting downhill from the nest, in my blind, I could look up through the aperture and see the head of the bird as she incubated—an advantage in studying by no means enjoyed at every nest. On February 27 I watched from 1:25 p.m. until 6:45, when it was nearly dark; and I continued next morning from 6:10, when day was breaking, until 1:02 p.m. The female sat with a steadfastness unexpected in so small a bird. Her 7 sessions ranged from 47 to 82 minutes and averaged 60.7 minutes. Her 7 recesses varied from 12 to 29 minutes and averaged 17 minutes. She spent 78.1 per cent of the daylight hours in the nest. Although an attempt to make the Bananaquit smear paint on herself as a distinguishing mark had failed, as it usually does with song-birds, the fact that the member of the pair which incubated was never heard to sing was a good indication that it was always the female. During the morning, the male sometimes accompanied his mate as she returned to the nest, but he never came closer than the next tree, where he sang for a few minutes, then departed. In the afternoon I did not see him.

When ready to go back into her nest, the female Bananaquit would pause in a neighboring tree and utter a lisping little *tsip* over and over. Then with consummate deft-

ness she would fly upward into the narrow aperture, seeming scarcely to touch the rim as she passed rapidly through it. Once inside, she always turned to sit with her head in the doorway, looking out. Once while she was incubating, a female Blue Honeycreeper pulled some loose fibers from the back of the nest, where the Bananaquit of course could not see the thief. But apprised by the shaking of the nest, she darted forth and drove the honeycreeper to a neighboring avocado tree. Here the two faced each other, the Blue Honeycreeper answering the Bananaquit's *tsips* with nasal *mews*. Soon, without having come to blows, the two little birds darted off in opposite directions, the honeycreeper escaping with her plunder.

Some days later, I confronted this female Bananaquit with some "intelligence tests." First, during her absence, I closed her doorway with a big, loose fluff of white cotton. Upon returning and finding her entranceway blocked, the little bird climbed over and around the nest, then took the cotton in her bill and pulled it out, only two minutes after finding it there. Next she tried to carry it away; but it caught on a big thorn beside the doorway and was difficult to move; so she climbed around the obstacle to sit in the nest with the mass of cotton, bigger than herself, hanging in front of her doorway. After her next departure I closed off the doorway with a green leaf. A minute after her return she seized the leaf by its exposed edge and carried it away. The excitement brought the male into the nest tree. This was the first time I saw him closer than a neighboring tree. After the female removed the leaf, he went three times to look into the nest, then, satisfied that all was well again, he flew away, singing.

The incubation period was 12 days at one nest and 13 days at two nests.

#### THE NESTLINGS

The nestlings are fed by both parents, with food carried in the throat or perhaps in regions deeper still. Only rarely are the legs or wings of an insect seen projecting from the Bananaquit's bill as it approaches the nest with food. The form of the nest makes it difficult to see much of the act of feeding until the nestlings are older, when they stretch their heads through the doorway, below which the parent clings while it produces food from its throat and with very rapid movements gives portions to the two youngsters, alternately.

The female Bananaquit may cease to brood her nestlings when they are ten days old, or she may continue to cover them during the night until their departure from the nest. When sleeping alone, or upon eggs or tiny nestlings, she turns back her head among her out-fluffed plumage, and only her yellow breast shows in the doorway. But as the youngsters grow older and larger, they occupy so much space in the nest that their brooding mother is forced forward, and she then sleeps with her head exposed in the doorway.

From two nests the young departed at the age of 17 days, from another when 18 or 19 days old. If disturbed, they may dart from the nest when only 15 or 16 days old, when they are already well feathered and can fly fairly well. They are easily distinguished from the adults by their duller plumage; their superciliary stripes are buffy rather than white, their breasts are very dull yellow instead of bright yellow.

After the fledglings have flown from the nest, they are rarely seen with their parents. When hungry, they perch obscurely amid the foliage and utter interminably, at regular intervals, a sharp, squeaky note. The mother Bananaquit, especially if she has brooded the nestlings every night until their departure, returns to sleep in the nest they have just deserted. She may continue to use it as her dormitory until it again becomes the receptacle of eggs and nestlings, or until, with her mate's help, she builds a new nest. The female who ceased to brood her nestlings after their tenth day, left her nest unoc-



cupied for several nights after their departure, but in less than a week she resumed her old habit of sleeping in it. I did not learn where she passed her nights in the interval; but probably it was in another nest. Fourteen days after the young of her first brood took wing, this Bananaquit laid the first egg for the second brood in the same nest. Another female brooded her nestlings every night except their last in the nest, then returned on the evening after their exit, to sleep there alone. But this same individual, when she raised her subsequent brood in a new nest, brooded her youngsters by night as long as they stayed in it, and of course she returned to sleep there on the evening after they flew out.

While the mother Bananaquit returns to the shelter of the nest, her fledglings are left to sleep in the open. I have never even seen the youngsters accompany their mother to the vicinity of the nest as she returns to it at the day's end. Since sleeping among the foliage seems to be the custom of nearly all species of honeycreepers, doubtless the young Bananaquits suffer no great inconvenience thereby. After a period, they begin to seek proper lodgings for themselves. Twice I have known young Bananaquits to return to sleep in the nest where, presumably, they had been hatched and reared, after their mother had constructed a new dormitory for herself. These young birds, if in fact they were returning children of the house, were already over a month old. Like the adults, they slept one in a nest.

For nearly a decade I had been familiar with the Bananaquit's custom of building sleeping nests before I found an individual in immature plumage engaged in this activity. This youngster had an eventful career, to which we shall return a little later. I do not know how frequently the Bananaquits undertake to build before they acquire the colors of maturity, but certainly they are dependent for some weeks on such lodges as they can find already made. In the absence of available nests constructed by their own kind, Bananaquits may take shelter in the small enclosed nests of wrens—as wrens on rare occasions sleep in those of Bananaquits. One evening, while watching the dormitory of a Black-capped Wren above the rocky shore of a tumultuous mountain stream, I saw a Bananaquit in adult plumage fly across the channel and cautiously approach the moss-covered globe. But in its expectation of finding a lodging for the night the Bananaquit was destined to be disappointed; for the wren had retired five minutes earlier and darted out when the smaller visitor reached the doorway. The Bananaquit vanished; then the wren returned at its leisure to the dormitory.

#### NUMBER OF BROODS

How many broods a single pair of Bananaquits may raise during their long breeding season is unknown. A pair which nested on Barro Colorado Island laid three sets of eggs between January and June, 1935, and were successful in rearing at least the first two broods. The following are the most important dates in the history of this pair:

February 7. Nest A found with two eggs.

February 8. Both eggs hatched.

February 25. The nestlings left.

March 11-12. Two eggs laid in nest A for second brood.

March 25. Both eggs hatched.

April 9. Nestlings frightened from the nest.

April 15. A new nest, B, nearly completed, was found about 25 feet from nest A and was believed to belong to the same pair. It was used for sleeping by the female.

April 20. Nest B was upset by a Streaked Flycatcher pulling material from it. The female Bananaquit now returns to sleep in nest A.

April 29-May 2. Nest C built about 25 feet from nest A. When completed, the female sleeps in it, leaving nest A empty.

May 11-12. Two eggs laid in nest C for third brood.

May 24. Both eggs hatched.

June 2. The nestlings thrive. I leave the island.

In El General, Costa Rica, a pair of Bananaquits raised nestlings which took wing on September 15, 1936. The female continued to sleep in the old nest until she and her mate built a new nest on the other side of my cabin. The new nest was nearly completed by October 18, when the female began to sleep in it. About November 25 she laid two eggs in this nest, and she successfully reared her young, which left on December 24.

#### SLEEPING HABITS

At Cantagallo, Brazil, Euler (1867:406-408) noticed that nests of the Bananaquit were seldom more than five feet above the ground, placed in exposed positions among the outer twigs rather than among leaves or in crotches, and often situated above roads, so that this was one of the kinds of nests easiest to find in the locality. He observed that perhaps one nest in ten contained eggs and attributed this to the shyness of *Coereba*, which he believed would desert the nest if it were touched by human hands. Many years later Wetmore (1927:498) discovered that empty nests of the Puerto Rican Bananaquit were used as sleeping quarters. In Trinidad, Belcher and Smooker (1937:518-519) distinguished breeding nests from play or roosting nests. The latter are smaller and more loosely put together. "A certain ragged look, especially about the entrance, serves to distinguish a nest of this class from a small example of the true nest, such as is sometimes found." These scattered observations acquire added significance when we consider in detail the sleeping habits of the Bananaquits.

While other kinds of honeycreepers travel about in flocks during the months when they are not engaged in reproduction, the home-loving Bananaquits are sedentary birds, never forming flocks of their own kind, and only occasionally joining in mixed companies of other small birds. Although male and female appear to remain mated throughout the year, they invariably sleep in separate nests; and I have never known two individuals past the nestling stage to sleep together. While the male, as we have seen, helps his mate to build the nests in which she will sleep and raise the family, she does not reciprocate the favor; for he seems always to construct his own dormitory without assistance. Usually he sings profusely as he labors. His nest is of the same form as the brood nest but it may be smaller and often has a much thinner roof, through which flecks of sky may be seen. But both the male's and the female's nests may be reinforced at a later date, if found to be inconveniently flimsy. Often the male builds himself a dormitory in no wise inferior to the brood nest, and I have known the female to claim it for her eggs and raise the nestlings in it. Many a time I have peeped into the male Bananaquit's nest at night and seen only a fluff of yellow feathers plugging the round doorway. But at times he awakes under the beam of light and of a sudden the aperture is occupied by a white-striped head, with shining black eyes and a very sharp, strongly curved bill. Unless his nest is shaken, or his visitor unnecessarily noisy, the little bird stays in this attitude of alertness until the intruder who has interrupted his slumbers extinguishes the light and steals away.

Bananaquits go to rest much earlier than their bird neighbors which roost in the foliage; and this is especially true on rainy evenings. Yet I have not known them to take shelter in their nests during downpours earlier in the day. As a rule, the male retires later in the evening than his mate, even when she has neither eggs or nestlings to brood in her nest. Sometimes he escorts her to her sleeping nest before flying to his own not far off. Often, as he prepares to enter for the night, he sings among the branches about his

dormitory, continuing perhaps for many minutes; but the moment he flits through the doorway he becomes silent until morning.

#### A SINGLE PAIR FOLLOWED THROUGH THE YEAR

While I lived in the valley of the Río Buena Vista, in the Térraba drainage of southern Costa Rica, I followed for over a year the activities of the pair of Bananaquits which slept and nested about my thatched cabin. In early April of the first year, 1936, the male Bananaquit, singing vehemently, built his dormitory, nest A, in a small guava tree behind the kitchen, about nine feet above the ground. This sheltered him nightly for more than three months, in which period I did not make the acquaintance of his mate, if he already had one. In mid-July, his old nest became dilapidated and he began a new structure, nest B, only five feet above the ground, on one of the lowest boughs of the orange tree in front of my window. At first the work of building went slowly; and at the end of eight days he had hardly more than the bare outline of a nest.

But on the morning of July 22, while a fine rain fell, he set about with a will to complete his task. The dark and gloomy heavens failed to depress his spirits, nor the drizzle to impede his work; for he sang incessantly as in quick succession he brought innumerable billfuls of material to the nest. Nor was he obliged to travel far for materials, for he found two convenient quarries close at hand. The first, of which he made most use, was the thatch of my roof, to which he flew scores of times to pull away long, slender shreds of the weathered sugar-cane leaf, softened by the rain. He tugged valiantly until he had torn off a strip that met his approval, and he made up a load of several pieces before setting forth on the short flight to his nest. The second quarry was a nest in the top of the orange tree where he was building, a nest with an interesting history. A pair of Blue Tanagers had built this nest earlier in the year and raised a family in it. Then a Gray-capped Flycatcher had claimed the empty bowl and roofed it over, converting it into a domed structure with the doorway in the side—a transformation much the same, on a larger scale, as the Bananaquits sometimes effect with a seedeater's nest. But before the Gray-capped Flycatcher could use the nest, a pair of Parasitic Flycatchers wrested it away from her and raised a family in it. Now the Bananaquit was pulling well weathered weed stems and grass blades from the abandoned structure and taking them down to his own nest in the lower storeys of the orange tree. In the intervals of gathering heavier material, he picked up downy chicken feathers from the yard. The little bird worked and sang with tremendous energy until the middle of the morning, then seemed to tire.

That evening he slept for the last time in nest A in the guava tree that had sheltered him for three months. The following day he continued to build; and at the day's end his new dormitory was ready for occupancy. The nest in the guava tree remained empty.

But the Bananaquit did not long enjoy the use of his new shelter. Before the middle of August, his mate, who now at last appeared, claimed it and laid two eggs therein. Why she did not have a nest of her own built in the customary manner by both together, I do not know. Possibly one had been made and lost at a greater distance from my cabin, and, pressed for time, the female had requisitioned this sleeping nest for her eggs. The transfer of possession was effected so quietly that I was amazed to find the eggs, already well advanced in incubation, in the nest where, until I had made this discovery, I believed that the male still slept. But he had gone back to his earlier dilapidated lodging in the guava tree behind the kitchen, a hundred feet away. He sojourned here only a few nights, then took up his abode in a nest, C, apparently newly finished, situated across the roadway that passed in front of the cabin. This was also in a guava tree, eleven feet above the ground, and 225 feet distant from his first dormitory. The nest he had relin-

quished to his mate was about midway between these two guava-tree nests. This latest lodging was to serve him until January, a period of nearly five months, and the longest period of occupancy of a Bananaquit's nest of which I have knowledge.

Meanwhile, the old abandoned dormitory behind the kitchen was occupied for a few nights by a young Chinchirigiú Wren. Another occasional tenant of Bananaquit nests is the marmosa. Once in Panamá, when I was about to introduce a finger into one of these nests to feel for the presence of eggs, I was stopped short by the snarling, sharp-toothed jaws of this tiny marsupial. It may well have devoured eggs or nestlings before installing itself. Another Bananaquit's nest was occupied by large black ants.

The female Bananaquit prospered in the low nest in the orange tree, hatched both eggs, and with her mate's assistance, brought forth two healthy fledglings. These she left to roost in the open, beneath heavy September rains, while she continued to sleep in the nest in which they had been raised. At the beginning of October I found an empty Bananaquit's nest, and in an experimental mood tied it among the lower branches of the orange tree. The female's sleeping nest falling to the ground soon after this, she found a convenient substitute in the one I had attached to the branch close beside it. I returned the fallen structure to its original site, nowise injured; and a young Bananaquit, possibly one of the two hatched in that same nest a little more than a month earlier, came to sleep in it. But frightened by my early morning visit, it did not return a second night.

In the evening, just before retiring, the male and female honeycreepers would often forage in the orange trees in front of my cabin. They hopped nervously about each other, continually flitting their wings and revealing the small white patches on the outer remiges, and every few seconds they repeated their sharp, metallic, monosyllabic call. They searched for tiny insects among the dark orange foliage, and they often hung upside down to pluck something from the under surface of a leaf. Presently the female would dart into the low nest that I had given her, continuing her sharp calls until she had vanished inside. Then the male went off to his nest in the guava tree across the roadway.

In the middle of October, this pair built a new nest, D, eight feet above the ground, in a guava tree at the southwestern corner of the cabin. Because male and female worked together, I felt certain that the female, not the male, would occupy it. By the evening of October 18 it was nearly finished, and she retired into it for the night. The nest I had placed in the orange tree was now deserted. Even after the new nest had been in use as a dormitory for several nights, the birds continued to bring bits of material to add to it. The female slept here a full month before, in mid-November, she laid the first egg of her second set. These hatched early in December. She brooded the nestlings every night until their departure on December 24, and on Christmas Eve retired alone into the nest they had just forsaken, so that her tenancy was uninterrupted over a period of more than four months.

Meanwhile, nest C of the male in the guava tree across the road was becoming old and weather-beaten. After the end of the year I no longer found him here; and several weeks passed before I located his new nest, E, in an *Erythrina* tree beside my neighbor's house. One evening in the middle of February, I came upon him clinging below the entrance of his mate's nest D in the guava tree at the corner of my cabin, singing loudly, which at this season he rarely did. The female had already entered for the night, but would not allow him to join her within. After a while, he desisted from his attempt to push inside and retreated to a perch a short way off, where he devoted much attention to his feet. His mate had evidently been pecking them to make him release his hold on her doorsill. Then he flew over and entered his own nest, E, which was already rather

the worse for the wear. The nest he had helped the female to build in October, although much older, was in far better repair; and probably this explains why he wanted to sleep in it with her. But she preferred to be alone. Earlier I had seen a Thin-billed Woodhewer, a Neotropical House Wren, and a Rufous-browed Wren, repulsed in much the same fashion when they tried to join their mates in the dormitory.

At the end of February, the female Bananaquit's second nest, D, fell from the guava tree, after giving more than four months of service. Henceforth, the pair changed dormitories so frequently that, occupied as I was with the activities of many other kinds of birds that now began to breed, I found it difficult to follow their movements. Birds of many kinds make inroads on unguarded nests of their neighbors to carry off material they can use for their own; and I believe that this explains the frequent loss of the Bananaquits' dormitories, unwatched by day as they were during these months when the great majority of the local birds were nesting, but not the Bananaquits. Then, in mid-April, I found the female sleeping in a new nest, F, in an *Erythrina* tree near the kitchen, a flimsy, hastily built structure, its roof hardly more than an open meshwork through which much sky showed. It could not have been very effective in shedding the rain, which was at this season falling hard almost every afternoon. After it had been in use a few nights, the pair resumed work and made it as snug as any.

In early May, the female Bananaquit's *Erythrina*-tree nest, after only three weeks of use, met the fate of several of its immediate predecessors. Doubtless some bird gathering material for its nest had pulled at it until it fell to the ground. Two days later, the male Bananaquit, who had a liking for low nests, was found sleeping in a half-finished structure in a lemon tree in the front yard, only five feet above the ground. During the two following mornings, he worked at making his roof thicker, helping himself to the thatch of my own roof, and pilfering from a Gray-capped Flycatcher who was tearing materials from her old nest to build a new one. With the Bananaquit's assistance, the demolition of the abandoned structure proceeded rapidly. The female Bananaquit lost her dormitory, and her mate at once set about to build a new one for himself! A reasonable inference was that he had again yielded his own bedroom to her. Unfortunately, I did not know the position of his previous dormitory and could not prove the point. But in view of the known history of this pair, the presumptive evidence is strong.

Again the female honeycreeper did not help her mate with his nest, even if he were building it for her ultimate use. But on the evening after the new dormitory was completed, she entered, as though to try it out and see whether she liked it better than the one he had apparently already relinquished to her. Meanwhile the male hopped excitedly around the doorway of his new nest, fearful, no doubt, of again losing his nest. But at the end of a minute she came out and both flew off together. Later the male returned, and after singing many times, he darted into his neat new dormitory for the work.

Two weeks later, on a rainy evening, the male Bananaquit retired early into his low nest in the lemon tree. He had not been long inside when his mate arrived and tried to force herself in beside him, or perhaps even to put him out and occupy this tight new shelter alone. But even a male Bananaquit's endurance has limits; he had helped build her nests, relinquished two of his own to her, and now this attempt to push him out-of-doors on a cold, wet night! Valiantly he strove to keep her outside, in his tense excitement singing in the nest, a most unusual occurrence. Before long, both contestants fell to the ground, clinched together. Immediately separating, the male promptly returned to his nest, while his mate flew off through the rain, calling sharply. I proved that it was the male who had returned to the nest by putting him out on my own account; he revealed his identity by singing a few notes before returning, despite all the rain and

gloom. Apparently two grown Bananaquits will never sleep together under any circumstances. Indeed, there is hardly room in the little nest for two.

The next evening, the female Bananaquit did not come near her mate's nest. Probably she had learned her lesson. Soon after that I moved away from the valley, and my year-long acquaintance with these little birds came to an end.

#### EFFORTS OF A YOUNG BANANAQUIT TO ESTABLISH A DORMITORY

Nearly seven years after I had taken leave of the pair of adult Bananaquits whose history we have followed, for the first time I saw an individual in immature plumage building a nest. I had returned to southern Costa Rica, in the valley of the Río Peña Blanca, eight or ten miles from the point where the foregoing observations were made. This young Bananaquit was discovered on the morning of March 22, 1944, carrying materials to a leafy twig ten feet above the ground in an Inga tree growing beside the creek in front of my house. It still gave no evidence of having begun the postjuvinal molt, for its breast was dingy yellow and its superciliary bands were buffy rather than pure white. Yet it labored with all the energy of a building adult, bringing billful after billful of fibrous materials, grass inflorescences and moss. Three days later the nest was completed or nearly so, and it closely resembled those built by adult birds. That evening I came to watch the young builder retire into the snug shelter it had fashioned for itself. To my surprise, it was not the juvenal bird, but one that wore the brighter colors of maturity who came to sleep in the nest. The young Bananaquit did not appear, nor did it the following evening, when again the adult entered the nest. I believe that this mature bird was one which for several months had slept in an orange tree not far from the Inga where the youngster had built, but had lost this dormitory, and I think also another subsequently constructed, when the flycatchers and other birds began to seek material for their breeding nests. Apparently, after the loss of two dormitories of its own, it had solved the housing problem by dispossessing the young Bananaquit which had intruded in its territory.

By April 1, the nest in the Inga had vanished, doubtless also having gone to swell the bulk of the structures which flycatchers, tanagers and other birds were now building on all sides. On April 4, a juvenal Bananaquit began a nest in a guava tree behind the house, about a hundred yards from the site of the lost nest in the Inga. I had no way of proving that this was the same young bird that had built the earlier nest; but the details of location and the date, added to the fact that in former years I had seen so many adults building but never a juvenile, made it seem highly probable that it was the same individual. The little bird labored with tremendous zeal, bringing dry grass picked up in the yard, orchid roots, sometimes whole small plants of the pygmy orchid *Oncidium Titania*, and bits of papery guava bark pulled from neighboring trees. In the half hour from 6:50 to 7:20 a.m. it carried 41 billfuls of material to the nest. In the next quarter hour, it brought 22 additional loads, making a total of 63 in 45 minutes. Then it took a well earned rest for fifteen minutes. Such intense activity, too exhausting to be continued through the day, was relaxed after the middle of the morning. But in three days the nest appeared to be completed. The evening after it was finished was dark and wet. As I approached the nest a bird that had retired early fled from it and did not return for the night.

Next morning, sharp little notes, many times repeated, drew my attention to the honeycreepers in the yard. Two mature individuals were sipping nectar from the violet flowers of the *Stachytarpheta* hedge, while the young bird made occasional visits to its nest. One of the adults several times chased the young bird, and twice one or the other of them entered the newly made nest in the guava tree. In the evening, these pursuits

were repeated. An adult male, easily recognized by his bright plumage and song, drove the youngster around the corner of the house. Then he entered the young bird's nest, which he had inspected earlier in the day. After he was comfortably ensconced within, the builder of the nest approached and rested hesitantly upon a neighboring bough, making no attempt to force an entry. Yet it lingered in the vicinity, calling; and presently the old bird emerged from the nest to drive it away. Soon the mature male returned to his lodging. The young builder appeared yet once more, fluttered before the doorway, saw the intruder resting within, then silently flew off toward the neighboring forest. Again it had labored only to provide a home for another!

Four days later the young Bananaquit began yet another nest, only eight feet above the ground in the orange tree growing close by the guava that held the stolen structure. In the morning there was only a slight foundation, but by evening of the same day the nest was covered over, although the roof was still thin. The dormitory seemed ready for occupancy after only a single day's work. At about five o'clock that evening, while a slight drizzle fell, I found the young builder and its mature persecutor in the guava tree that held the earlier nest. Soon the older Bananaquit drove the younger away. But presently they returned, the old bird to retire into the guava-tree nest, the youngster into the newly finished nest in the orange tree. The old bird was the more confident, looking down from his doorway while I stood below; but the young one fled at my approach, to return a little later. On this wet evening, both had gone to rest an hour before it grew dark.

The following morning the young Bananaquit labored to strengthen the walls and roof, and it worked the next morning also, after a second night in the orange-tree nest. That evening it retired a few minutes after five o'clock, an hour before nightfall, although the weather was fair. Growing bolder as the period of its tenure lengthened, it would permit me to approach to within a few feet before darting from the nest, and it would return while I watched a few paces away.

For a week, the old Bananaquit and the young continued to sleep in the neighboring nests built by the latter. Then one afternoon, while a drizzle fell, I again heard the sharp, monosyllabic notes, incessantly reiterated, that told me there was tension between the Bananaquits in the yard; yet since they remained well concealed in the spreading *Stachytarpheta* hedge, I could not follow their movements. But as the day ended I did learn the outcome of the dispute: the adult slept in the orange-tree nest, thus once more dispossessing the young bird. The dormitory in the neighboring guava tree remained empty for the night. The mature bird's change in lodging appeared to have been made more for the purpose of evicting his young neighbor than of obtaining a better residence for himself, for the nest he abandoned in the guava tree was in no way inferior to that which he now occupied in the orange tree. A few evenings later, I found both of these nests occupied by adult birds, doubtless a mated pair.

And still the young Bananaquit continued to build! Now it started a nest in the top of the calabash tree in front of the house. Working with its usual tireless energy, it made this new dormitory ready for occupancy by evening of the second day, even in the face of the depredations of a Chipsacheery Flycatcher building nearby, who helped herself to many of the straws and blades of grass that the Bananaquit brought. After a first night in the calabash-tree nest, the Bananaquit continued to build. While it was so engaged, one of the adults came twice to inspect the work. Once the intruder went to look in the doorway, where the young builder met him. The two fluttered face to face in the air, then dropped down below the edge of the terrace, where I could no longer see them.

Soon the builder returned to its task, but was from time to time interrupted by the Chipsacheery coming to tear away more material for her own nest. When the Banana-

quit found her trespassing, it made a spirited attack that drove away the relatively huge but mild-tempered flycatcher; and so long as it continued active building, little damage was done to its nest. But after a while the different habits of work of the two birds began to tell against the smaller one. The Bananaquit labored with concentrated activity in the early morning, then grew tired and flew away to sip nectar and rest. The flycatcher, slowly but steadily, continued building through much of the day, and after the Bananaquit's departure repeated her visits to the nest in the calabash tree with devastating results. Returning again and again at regular intervals through the late morning and even into the afternoon, she carried off now a straw, now a tendril, now a rootlet, with never any resistance from the absent owner. By evening, when the Bananaquit came to enter its laboriously built nest, it found only a few shreds remaining in the calabash tree.

That evening there was another dispute between the young Bananaquit and its adult rival among the topmost boughs of a guava tree beside the house. The hostilities were restricted to much flitting about and the utterance of many sharp calls. Presently the young bird flew over the house top and away, leaving the other in possession of the field. Like Blue Honeycreepers, Bananaquits settle disputes largely by voice and by chasing rather than by actual fighting.

In the following days, the young Bananaquit rebuilt the nest in the calabash tree. Now that the Chipsacheery had completed her own, it suffered no more interference from her; but the adult Bananaquit continued his annoying visits. A Song Tanager's recently abandoned nest in a neighboring tree served as a quarry for material and made the task of building easier for the young Bananaquit. Meanwhile the two earlier nests, in the guava and orange trees, had been damaged by building birds that plucked material from them; and the adult Bananaquits who had taken possession of them decided that they would no longer serve as dormitories. The result was what we have already learned to expect. After completing the second nest in the calabash tree, the youngster enjoyed it for only four or five nights before one of its elders displaced it. But the latter did not long occupy its stolen nest, for it was soon torn apart, this time by a Neotropical Kingbird building in a tree top not far off.

During May the adult Bananaquits were no longer found sleeping in the immediate vicinity of the house. I discovered two more dormitories that were occupied alternately by the young Bananaquit, although, busy now with other birds, I did not see it build them. One was in another calabash tree in front of the house, the other in a second guava tree at the rear. By May 20, the young bird was in transitional plumage; and by the end of the month it had either been displaced from its second guava-tree nest by an adult, or continuing to sleep there, had become itself an adult in appearance. Since I was no longer sure of its identity, my interest in its vicissitudes waned. If I was correct in believing that the young Bananaquit whose fortunes I followed was always the same, in the course of two months it had built seven nests, five of which were wrested from it, one after another, by the adults in whose territory it seemed to have intruded. The fact that all these nests, save possibly the last two, were built in sequence and never simultaneously, strengthens my conclusion that the builder was always the same.

It seemed that this young Bananaquit, through its indomitable persistence and tireless building, had won the right to live and sleep on territory originally claimed by an adult pair. At least, by continuing to build nest after nest as they were successively wrested from it by the owners of the ground, it managed to remain on their land until it acquired the adult colors.

In the middle of November, 1946, a Bananaquit in dull juvenal plumage was discovered carrying material into one of the calabash trees in front of my house. Disturbed by an adult of its kind, it did not complete its nest; but a few nights later I found it



sleeping in a crotch in the top of the calabash tree, in an open nest apparently built earlier in the year by some small finch or tanager; possibly it had been somewhat renovated by the Bananaquit. Although the Bananaquit's dormitory had no roof of its own, it was well covered over by the clustered foliage of the calabash tree. The young bird slept here only a few nights, after which a Neotropic House Wren was found roosting in this open nest canopied by the foliage. I had heard angry notes in the evening as the birds went to roost, and apparently the larger wren drove away the young Bananaquit. In establishing homes for themselves, the immature Bananaquits must compete not only with their own but with other species.

One morning late in March I watched a Bananaquit in juvenal plumage building a nest in a calabash tree in front of my house. By evening it had only a slight structure, far too small to contain itself, and the nest was precariously attached to the side of a moss-covered bough. After sunset I watched the little bird trying to settle down for the night. It hunted over the mossy limbs of the calabash tree in which it had built and of a neighboring tree of the same kind, apparently looking for its skimpy nest, but not actually going to it, so far as I saw. In the neighboring calabash tree a Northern Tyranniscus was incubating two eggs in a covered nest of mosses and plant down, suspended beneath a mossy branch. Twice the Bananaquit approached this little closed nest as though it wished to enter, but both times it was chased away by the tiny flycatchers, the pair of which darted at it with spirit and excited cries. Finally the Bananaquit flew up into a dense cluster of foliage at the top of a guava tree close beside the house and remained there for the night. From the ground I could see only its head amid the clustered leaves.

That Bananaquits not infrequently compete with birds of other kinds for a dormitory is also evident from another observation I made among these calabash trees earlier in the same year. Returning home after an absence of several months, I found a Spotted-throated Wren sleeping in a flimsy covered nest with a round doorway facing obliquely downward, situated among the clustered foliage of a calabash tree. On several evenings in early January I watched the wren cautiously approach the tree and slip into its skimpy dormitory. After the middle of the month it abandoned this lodging, which was surprisingly far from the dense thickets which this wren prefers. A week or so later a Bananaquit began to sleep in this same nest, which might have been built by either of these two species; in its unfinished form it lacked the distinctive character of either the Spotted-throated Wren's or the Bananaquit's nest.

#### SUMMARY

The Bananaquit, a most adaptable species of extremely wide distribution, is in Central America found chiefly in clearings in the rain-forest and about the woodland edges rather than within the forest itself. In Costa Rica it extends upward to about 4000 feet above sea level. Bananaquits live singly or in pairs at all seasons, never flocking.

The song, a high-pitched, undulatory trilling, is in El General delivered freely through most of the year. Bananaquits sing least when the weather is driest in February and March.

Much of their food is found in blossoms, which they tirelessly probe. Larger corollas are pierced at the base by their sharp bills. They suck juices from berries and pluck protein bodies from the bases of the petioles of *Cecropia*, and they also forage much among foliage.

In some localities the Bananaquit has been reported to breed practically throughout the year, with the peak of activity in the spring months when the majority of small passerines nest. In El General, however, the almost year-long breeding season is inter-

rupted in March, April and May, at the very time when most other passerines are nesting freely. This break in the Bananaquits' breeding season is correlated with the relative paucity of flowers at the end of the dry season and the beginning of the rainy season.

The nest, a roughly globular structure with a small, round, downwardly facing doorway, is placed in a wide variety of situations. Some nests are used for sleeping as well as breeding, others serve merely as dormitories for nonbreeding birds. Those of the former sort are often built by both sexes working together, and they may be completed in four or five days.

Sometimes the eggs are laid a few days after the completion of the nest, but at other times a month or more may elapse before laying begins, the female meanwhile using the nest as a dormitory. In southern Central America two eggs are regularly laid, but in other regions sets of three are sometimes found.

Only the female incubates. One watched for 12 hours took sessions ranging from 47 to 82 minutes and averaging 60.7 minutes; recesses ranged from 12 to 29 minutes and averaged 17 minutes. Thus the bird covered the eggs 78 per cent of the day. The period of incubation is 12 or 13 days.

The nestlings are fed by both parents, largely on regurgitated food. The female may cease to brood them by night when they are only ten days old, or she may continue to sleep with them until at the age of 17 or 19 days they leave the nest, already able to fly well.

The mother may continue to sleep in the nest after the young have flown, but the latter are left to roost in the open until they can find or build dormitories for themselves. Sometimes young Bananaquits take advantage of abandoned closed nests made by other Bananaquits, wrens, and flycatchers; but some at least build dormitories for themselves before acquiring the adult plumage. These young are sometimes evicted from their new nests by the adults in whose territory they build. The latter may then sleep in the stolen nest.

A pair may rear at least two broods in succession.

Unlike many other honeycreepers, Bananaquits are sedentary birds occupying the same territory throughout the year; both sexes build lodges for sleeping in this territory. Adults and young, except nestlings, always sleep singly, even resisting the occasional attempts of their mates to enter the dormitory with them. Although a female's dormitory used also for breeding may be built by both sexes, the male seems usually to construct his lodge without assistance. It may be flimsier than the breeding nest, with light showing through the roof, but it is sometimes reinforced after a period of occupancy. New dormitories are built in the course of the year at points scattered over the territory. Before or after being abandoned by the builders, they may be occupied by small mammals, wrens, ants, and other creatures.

## SLATY FLOWER-PIERCER

### *Diglossa baritula*

I am not ashamed to admit that the first time I saw a flower-piercer, in a clearing in a cypress forest in the high mountains of Guatemala, I failed miserably in guessing what kind of bird it might be, for I recorded it in my notes as a flycatcher! Later, not quite convinced, I began to incline toward the opinion that it must be a wood warbler, a species of redstart, perhaps. By that time I was no longer where I could observe the living bird, but was obliged to rely solely on books and museum specimens; and it was long before I discovered that the flower-piercer belongs to the honeycreeper family and that its book name is the Guatemalan *Diglossa*. But who would have imagined that this dully clad little bird, with slaty-black wings and tail, light cinnamon under parts, a short, upwardly-tilted, little bill with a sharp down-turned hook at the tip and bristles at the base like a flycatcher, could belong to the honeycreeper family? The other honeycreepers which I at that time knew were all denizens of the warm lowlands—gem-like birds arrayed in the most brilliant colors. All were species with sharp, slender, rather long bills, more or less curved downward, but not hooked at the tip. Superficially, at least, this soberly attired honeycreeper of the cold heights was as different as it could be from all its lowland relations.

The genus *Diglossa* is an aberrant branch of the honeycreeper family, readily distinguished by the peculiar bill. In plumage most of the numerous species are dull, with black or grays predominating in the males, paler grays and shades of olive in the females. But some of the South American forms are a splendid deep blue, and others are ornamented with elongated white feathers on the flanks. It is a highland genus, best represented in the Andes of Ecuador and Perú, where it is found at great altitudes, reaching up even into the bleak páramos, but rarely found as low as the Upper Tropical Zone. A single variable species extends north of the Andes, in Central America and southern México. The distribution of *Diglossa baritula* is discontinuous like that of the higher mountains where alone it dwells; and this discontinuity is reflected in the differentiation of more or less distinct subspecies, one of which (*plumbea*) inhabits the mountain system of Costa Rica and western Panamá, another (*montana*) the high massif of Guatemala and Chiapas, while still a third (*baritula*) is found north of the Isthmus of Tehuantepec in México. The Mexican race was found by Sumichrast (1869) in the alpine region of the state of Veracruz, where he met it as high as 3000 meters (10,000 feet) above sea level. He records that locally it bears the names *picochueco* (crooked-bill) and *mieleiro* (honey-seeker) and that "its general habits, and manner of feeding, are analogous to those of the Trochilidae."

Throughout the highlands of Guatemala, where it prefers the more humid districts, the Guatemalan form of the Slaty Flower-piercer (*Diglossa baritula montana*) is the sole representative of its family, and it rarely, if ever, comes in contact with its more brilliant relations of the lowlands. I have found it, in bushy clearings where flowers abound, as low as 5500 feet, and, at the other extreme, among flowering shrubs in the moister and more protected spots on the lofty plateau of the Sierra Cuchumatanes, nearly 11,000 feet above sea level. But nowhere have I seen the flower-piercer more in evidence than in the openings among the cypress forests near the summit of the Sierra de Tecpán, almost 10,000 feet above sea level, where a profusion of flowering shrubs and herbs supplied it with an abundance of food. It was here that I first made the

acquaintance of the anomalous little bird, and surprised it sipping nectar after its own peculiar fashion, and later found it nesting in the coldest season of the year.

#### FOOD

On a sunny morning toward the end of January, while watching the hummingbirds on the steep, bushy southern slope where the scarlet blossoms of *Salvia cinnabarina* were so abundant, I first saw a flower-piercer plying its trade. The individual which revealed to me its methods happened to be a female, readily distinguished from the male

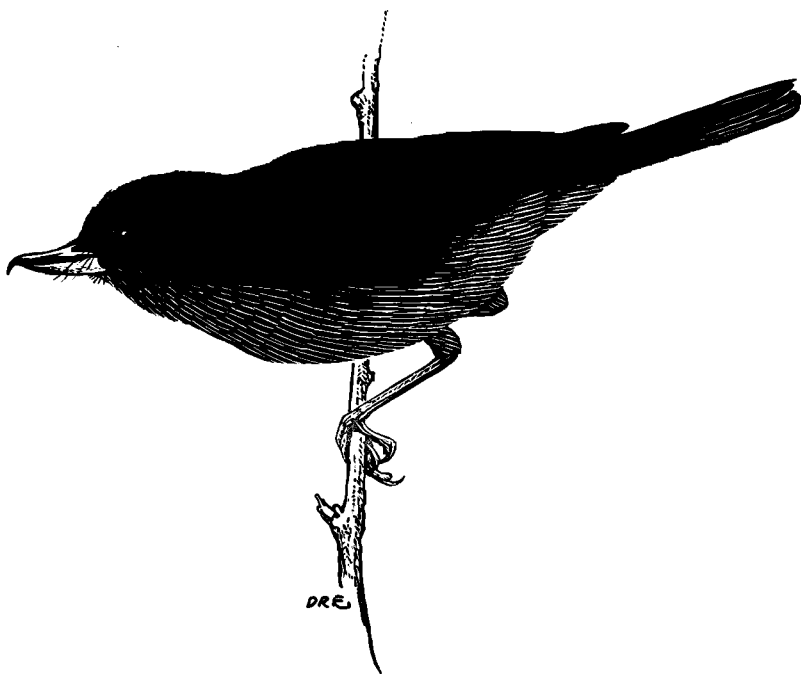


Fig. 66. Slaty Flower-piercer.

by her grayer back and paler breast. She entered a close stand of the upright stems of the salvia, which bore a profusion of flowers, and went rapidly from blossom to blossom. But instead of hovering in front of the flowers and inserting her bill to sip out the nectar, as the hummingbirds did, she clung to the stalk, and with her short, up-tilted, black bill bit the slender base of each long, scarlet corolla tube. A second at each flower was sufficient to accomplish her purpose, and she moved from one to another so rapidly that it was difficult for me to follow in detail just what she did. I tried to make mental note of the particular flowers which she visited; but she bit so many that before she had finished her feast of nectar I had lost sight of all but two. When at length she flew out of the flower bed, I plucked these two flowers to examine them. Each was punctured by a minute longitudinal slit at the base of the tube, just above the point where it emerged from the short green calyx. Going carefully over the flowers in the patch where the flower-piercer had been at work, I found 21 which had been perforated in this manner. I tested a number of these punctured flowers by sucking at the lower end of the corolla tube, after pulling it out of the calyx, and found that all had been drained of their nectar, which the bird must somehow have removed through the perforation.

I readily understood why the flower-piercer had found it convenient to puncture the corollas in order to reach the nectar. They were far longer than her bill; and she could hardly have procured the nectar at the base while hovering in front of them, in the manner of a hummingbird, even if she were able to support herself motionless on vibrating wings, a feat which I very much doubted her ability to perform. Bumblebees frequently bite through the base of a flower, or of a nectar-bearing spur, if it happens to be longer than their tongue and it is impossible for them to obtain the nectar in the usual manner. What puzzled me was the mode in which the perforations in the corolla tubes has been made. The sharp, downwardly pointing hook of the bill would be a distinct hindrance in inserting that bill into a narrow corolla; and from the first I could hardly doubt that it must have some use to compensate for this disadvantage. My first hasty conclusion was that the hook itself was employed to puncture the tissue of the flower; but a little reflection made this view seem improbable.

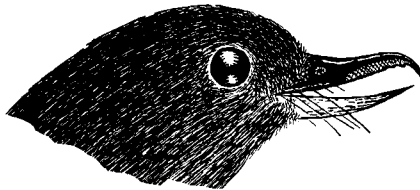


Fig. 67. Bill structure of a flower-piercer.

When next I came upon a flower-piercer at work among the salvia blossoms, I was careful to observe the position of the bird as it bit certain particular flowers. Then, when it had gone, I went up to those flowers to learn the exact location of the perforations. In every instance, the little longitudinal slit was to be found near the lower edge of the side of the corolla which had been turned toward the bird at the time it was made. Obviously, it was impossible that the hook at the end of the upper mandible had perforated the corolla in this position. But on the upper side of the corolla tube, and extending around to the side that had been turned away from the bird, was a narrow, dark-colored bruise. This was usually so much more conspicuous than the perforation that after this I looked for it, rather than for the actual puncture, to pick out the flowers which the flower-piercer had visited. From the known position of the bird, this bruise could have been made only by the hooked end of the upper mandible.

Piecing these facts together, I obtained a clear picture of the mode of operation of the flower-piercer's peculiar bill—a picture that it had been impossible to obtain from direct observation because, although not particularly shy, the little bird would never allow me to come close enough to follow the rapid movements of so small an object. The upper mandible was used merely to hook over the corolla tube and prevent its slipping away, while the short, upwardly tilted lower mandible pressed against the tissue and pierced it through. Then the tongue was probably inserted into the perforation to suck out the nectar. The whole operation was performed in a trice, and in a minute's time the flower-piercer could visit many flowers and gather much nectar.

From the point of view of the flower, this method of removing its nectar yields no benefit. The hummingbird which gets its forehead liberally dusted with the pollen from the two stamens of a salvia blossom makes possible the fertilization of the ovules and unwittingly pays for the nectar it procures. So do the bees, if they obtain their nectar in what Darwin called the "legitimate" fashion. The flower-piercer is unconsciously and unavoidably taking what was evolved by the plant for other purposes. Were it not for

the pollen-bearers, which are always the flower-piercer's neighbors, the flowers upon which it depends for food would probably become extinct through failure to set seed, and the flower-piercer would face a famine.

Once I had made the discovery of the flower-piercer's peculiar method of obtaining nectar, I became interested in learning how great a variety of flowers it could treat in this fashion. Whether it visits the little red flowers of *Fuchsia minutiflora*, only seven or eight millimeters long, or the great purple bells of a convolvulus, more than half its own length, the bird, so far as I have been able to discover, always bites the base of the corolla, leaving one side bruised by the hooked upper mandible, the other perforated by the lower mandible. When it wishes to suck the nectar from the large crimson blossoms of the shrubby *Salvia nervata*, which grows so profusely in the more open spaces in the cypress forest on the Sierra de Tecpán, it must not only pierce the corolla but the calyx as well; for the calyx of these flowers is much longer than that of *S. cinnabarina* and covers over the base of the corolla where the nectar is stored. The double thickness of tissues, however, seems to give the bird no trouble. Indeed, it seems to manage to obtain the sweet liquid from any tubular flower found in its haunts, whether the short yellow blossoms of a *Cestrum*, the orange-red corollas of *Centropogon*, the big pendent red-and-green blossoms of *Fuchsia splendens*, or the flowers of almost every color of a great variety of salvias which grow in such abundance over the highlands of Guatemala.

One morning I watched a flower-piercer biting the red flowers of a mint, a shrubby species of *Satureia*, which hang like twin fairy bells below the slender, gracefully curving stem, one from the axil of each of the opposite leaves. When the bird had gone on its way, I examined the corollas and found several which had been pierced, not at the narrow base, where one might have expected the stores of nectar to be found, but considerably near the apex at the point where the tube expanded to form the bell. Then I noticed that the nectar had flowed downward in the pendent corollas and that a liberal drop of it could be seen shining through the delicate, transparent tissue at the point where it had been punctured—or rather, at the corresponding point of unpierced corollas, for none remained in the perforated bells. The bird had noticed the place where the nectar stood and had bitten the flower accordingly.

The flower-piercer is not the only honeycreeper which punctures corollas in order to reach the food they contain, although, so far as I am aware, its method of doing this is unique. I have more than once seen the little Bananaquit pierce the large, bright yellow, trumpet-shaped flowers of *Allamanda*, a somewhat scandent shrub widely planted for ornament in tropical America. The golden corollas are so long that the honeycreeper could hardly reach their nectar except by pushing its sharp, down-curved bill through the yielding tissue. An eccentric hummingbird will sometimes choose to pierce the base of a flower which others of its kind are visiting in the normal fashion. I have seen the White-eared Hummingbird puncture in this manner the lovely blue flowers of *Salvia cacaliaefolia*, and the Longuemare's Hermit will puncture the slender red corolla tubes of *Scutellaria costaricana*. But in all these cases the sharp-pointed bill is merely forced through the delicate tissue of the corolla as one would push through a needle; there is no special structure for accomplishing the act.

But no bird lives exclusively on a diet of nectar. Like the hummingbirds, the flower-piercer is adept at catching small insects on the wing. It perches among the low bushes of the sunny forest clearings where it dwells and makes short darts of at most a few yards to snatch the flying insects from the air. The prominent bristles surrounding the base of the bill, which it possesses in common with many other insect-catching birds, must aid in making its captures, probably by deflecting into the open mouth an occasional insect which without them would escape by the side. The first *Diglossa* that I

ever saw was engaged in this pursuit, which gave me some justification in calling it a flycatcher. From February to May, when the salvias do not blossom and flowers of all kinds are rather scarce, their ability to snatch up insects on the wing must serve the flower-piercers in good stead.

Preference for areas of low, bushy growth, rather than the tree tops, is another point in which the flower-piercer differs from the more typical honeycreepers. Although these



Fig. 68. Giant cypress trees (*Cupressus Benthami*) with an understory of bamboo and flowering shrubs, near the summit of Cerro de Tecpán, Guatemala. In or about the edges of this forest occurred Slaty Flower-piercers, Pink-headed and Hartlaub warblers, Mexican Trogons and other birds of the Temperate Zone.

birds were abundant near the summit of the Sierra de Tecpán, it was not in the heavy cypress forests that I saw them, but on the open, bushy slopes where they found the scarlet blossoms of *Salvia cinnabarina*, or in small, sunny clearings in the cloud forest, bright with the crimson flowers of *Salvia nervata*. The flower-piercers seemed to fly neither high nor far but were attached to particular small areas where there were plenty of flowers; and I found them day after day making the rounds of each new crop of blossoms on the same bushes and herbs. Here they sang their plaintive, slightly squeaky little trill, and called *tsip tsip* in a weak, lisping voice. They did not, like the Violet-ear Hummingbirds, disappear after the salvias passed from bloom, but remained near the

summit of the mountain throughout the year, contenting themselves with the ever-blooming *Satureia*, and such scattered flowers as they could find, together with the insects they caught.

When I went from "Santa Elena" at the summit of the range to "Chichavac," an estate a thousand feet lower, I saw far less of the flower-piercers. Among the dry oak forests of the middle and lower slopes, from 9000 feet downward, these birds were not so abundant as in the moister forests near the summit; and I found them chiefly in deep, sheltered ravines. After March, when flowers of all kinds became very rare, flower-piercers disappeared from Chichavac; and I did not again meet them there until late in July, after two months of rain had brought forth numerous flowers of other kinds. They soon became fairly abundant in the more open oak woods and in the clearings where there were flowering shrubs. One even frequented the garden by the house, where he sometimes foraged among the foliage of the floripondia (*Datura candida*) bushes. I did not see him attempt to pierce the giant white blossoms, in any one of which three or four flower-piercers might comfortably have ensconced themselves.

#### SONG

Strangely enough, after their return to Chichavac in late July, the flower-piercers sang often. By this time of the year even the late-singing Russet-headed Nightingale-thrushes were becoming silent, and with the exception of the Rufous-collared Sparrows, no bird sang more than the flower-piercers. On the top of a ridge, I found a flower-piercer which sang *chee chee chee chee chee chee*, in a plaintive, high-pitched voice, and at times uttered a rapid trill in much the same tone. Most often he sang among the bushes, but once he alighted on the topmost twig of a tall dead tree and repeated his slightly squeaky song over and over again.

#### THE NESTING SEASON

The flower-piercers in Guatemala sang so persistently that I thought it worth while to look for a nest, although at that time, past the middle of August, I knew of no birds which were nesting except the Rufous-collared Sparrows on the plains near Tecpán, 500 feet lower. In truth, I was not at all confident of finding the flower-piercers breeding in the middle of the wet season. I thought it far more likely that they would nest at the beginning of the dry season, along with the hummingbirds.

This conjecture proved to be correct. Although I did not find nests of the flower-piercer until December, I saw fledglings which must have hatched from eggs laid no later than the middle of November. I am aware of no more convincing example of the dependence of a bird's breeding season on its food supply; but to understand this connection we must consider briefly the climate of the region and how it is related to the time of nesting of the great majority of the birds. In the western highlands of Guatemala, the dry season begins about the middle of October and continues with increasing severity until about mid-May. At 8500 feet above sea level frost forms with regularity on clear, windless nights from about the first of November until the end of March; and at higher altitudes the season of frosts is considerably longer. During the wet season, from mid-May until mid-October, there is usually no frost; but the rains are cold and may continue for days together. Most of the birds on the Sierra de Tecpán, whose feeding habits were not greatly specialized, nested at the end of the dry season, in April and May, taking advantage of the brief period between the end of the frosts and the cold, hard rains of June. Now the weather was mildest, and there was no lack of flying insects, nor of larvae which found food and moisture in the foliage of the deeply rooted trees and shrubs, many of which had recently renewed their leafage. Those birds which



nourished their young principally on the grubs and pupae that they found among and beneath the dead leaves and litter on the forest floor—the White-breasted Blue Mockingbird, the Chestnut-capped Atlapetes and the Russet-headed Nightingale Thrush—nested chiefly in late May, June and July, in the early part of the rainy season, when the return of moisture to the dry litter stimulated the development of the kind of food upon which they depended.

And now at the beginning of the dry season those birds which are specialists in procuring nectar were all breeding at the time when the principal nectar-producing flowers were most abundant—when the sunny skies and moist soil of November and December turned the Guatemalan highlands into one great flower garden and every wayside, weedy field and open copse was aglow with brilliant blossoms, among which mints, and especially species of *Salvia*, were prominent. Yet this was the cold season of the year; by night there were heavy frosts that whitened open fields, by day cold, drying winds. Frost, wind and drought together would by January kill and desiccate most of the flowering herbs; yet while they spread their blossoms liberally, some of the smallest of all the birds defied the inclement weather to rear their young when there was no lack of nectar for their nourishment. In breeding at the same time as the hummingbirds, the flower-piercer parted ways with all of those neighbors to which, as a passeriform bird, it was most closely allied, and joined with kinds to which its only affinity was a common taste for nectar.

#### THE NEST AND EGGS

Of all the surprises which the eccentric flower-piercer gave me, the nest was the greatest. Some years earlier, I had found the globular, warm nests of the Bananaquit of the lowlands which are used both for sleeping and breeding. Surely, the flower-piercer might to good advantage imitate its relations in nest building, for it incubates its eggs through nights so penetratingly cold that a man can hardly obtain enough blankets to keep himself comfortably warm. But no, it seems that the flower-piercer must be different at any cost; it makes an open nest for eggs and young, and sleeps, so far as I could learn, without any nest at all.

My first nest of the Guatemalan Slaty Flower-piercer was situated at an altitude of about 9500 feet above sea level, on the bushy mountain slope which I used to call "The Hummingbirds' Hillside." It was supported, four feet above the ground, between two head-high cypress saplings that grew close together. The deep, open cup was composed of brown pinnae of the bracken fern, dried and shrivelled small leaves, dead pine needles, and fine rootlets. The interior was lined with fine, black, fibrous rootlets and the hair-like stalks which bear the spore capsules of mosses, with the latter still attached. It measured  $1\frac{3}{4}$  inches in internal diameter by  $1\frac{1}{4}$  in depth. When I stumbled upon this nest on December 3, 1933, it was apparently completed but contained no egg. Revisiting the nest on December 10, I found within it two pretty, bright blue eggs, heavily spotted with brown on the larger end. They measured 16.3 by 12.7 and 15.9 by 12.7 millimeters.

On December 15, I discovered a second nest in the same locality. It was five feet above the ground in a shrubby *Cestrum* in a bushy pasture. Resembling the first in form, it was composed of slightly different materials, including weed stems, pieces of slender vines and tendrils, many of the stems of a light straw-color. It was lined with a great number of sporophytes of the moss *Funaria* and some black fibrous roots. The long, slender setae of the moss were bright chestnut in color and had the capsules still attached. The nest contained a single egg when found, and upon my return a few days later nest and egg appeared to have been abandoned.

## INCUBATION

On December 14, as soon as the tent blind was adjusted, I hid myself inside to see how the birds would accept it. Both male and female flitted about in the bushes behind the nest, complaining in their weak little *tsips* and uttering their high, plaintive trills. Gradually they approached nearer and nearer, each advance bolder than the last, until they found themselves face to face with the strange object which had so suddenly sprung up in their domain. The female from the first ventured nearer the nest, and consequently nearer the tent. Finally she alighted on a twig beside the nest, but fled away at once. At the next advance she stood on the part of the nest's rim farthest from the tent but passed over the eggs without settling upon them. Then the pair withdrew back among the bushes for a brief period. Upon reappearing, the female several times came up to the nest but each time took flight immediately. She seemed to be fastened between two tense springs, one of which, devotion to her eggs, drew her toward the nest, while the other, fear of the tent, pulled her back into the sheltering shrubbery. But since the tent remained quietly in its place and gave no indication of being dangerous, her fear gradually diminished. Finally she alighted on a twig beside the nest and slowly, cautiously, lowered herself into it, about 25 minutes after I had entered the blind. Once she was well settled, the male, himself reassured by her confidence, flew to a twig a few inches above her, looked down, trilled once, then went off, flitting from bush to bush and finally disappearing among the vegetation. Left alone, the female at first kept a wary eye fixed upon the tent, but at last she settled down and was at rest. Still, never relaxing her vigilance, she remained alert, and at the slightest sound I made within the blind she looked around to discover its source. After sitting for 19 minutes, she spontaneously left the nest, and I departed from my place of concealment.

Returning at the beginning of the afternoon, I entered the tent once more, to watch until nightfall. The female flower-piercer was absent when I arrived, but she reappeared in a few minutes and, after a little hesitation, went on the nest. As soon as she was well settled, the male alighted beside the nest, gave a little trill, and then flew out of sight, leaving his mate alone with her eggs. After warming them for nearly half an hour, she left in quest of food. Again she returned alone; but when she had comfortably ensconced herself on the eggs, the male approached, trilling, and clung for a moment to the twiglets on the far side of the nest to look down on his mate as though to assure himself that all was well. Then he went away, as before. He visited his mate repeatedly in this way during the afternoon and the following morning. Sometimes she acknowledged it by trilling in return but more frequently by calling *tsip tsip* from the nest; at other times she received his attention in silence.

A few minutes after five o'clock, the female flower-piercer returned alone from her last recess of the day and flitted about in sight of the tent, catching insects on the wing and at intervals uttering her weak call. Then she entered the nest, only to leave immediately; but she returned at once and this time remained. When she had been sitting more than 20 minutes, her mate approached and perched close by, remaining there for several minutes and calling *tsip* continuously. When he had finished his low calling, he flitted away among the darkening cypress saplings, leaving the female sitting quietly in her nest; and I saw him no more that evening. As the dusk deepened, one of the oxen that hauled logs to the neighboring sawmill pushed through the bushes close to the nest, noisily snapping dead twigs and branches. I feared that the flower-piercer would be frightened from her nest when it was too dark to return; but she remained firm. When the ox had finally lumbered out of the way, it was nearly dark.

When I returned to the tent, next morning before dawn, the mountain was darkly

robed in drenching rain clouds. As daylight began to penetrate this sombre mantle, the male flower-piercer commenced to sing among the bushes beyond the nest. While he continued his somewhat melancholy little trill, the Violet-eared Hummingbirds set up their squeaking. After the male flower-piercer had sung without cessation for 13 minutes, his mate left her eggs and greeted him with a trill higher in pitch and simpler than his. Then the pair went off together to forage among the wet bushes. In five minutes the female returned to her eggs, and when she had covered them the male came close beside her and trilled twice. As during the preceding afternoon, the female alone warmed the eggs, but now she sat for shorter periods and took more frequent, but shorter recesses.

In the early part of the morning, the pair united in driving away a strange female flower-piercer, who had invaded their territory and approached too near the nest. A little later I began to hear an unfamiliar call issuing from the vegetation near the ground on the slope behind the tent. After much peering through the side windows, I at length saw the author of the strange sounds, a young flower-piercer apparently just out of the nest and scarcely able to fly. Its low, rather harsh note was so different in quality from the lispings call of the adult that I had not recognized it. The intruding flower-piercer which had been driven from the nest was probably the parent of the fledgling, which could not have been hatched later than the end of November. Afterward, both the father and mother approached the little bird, but because of interfering foliage I could not see them feed it. The incubating female was altogether indifferent to the presence of the youngster so near her nest. After I had listened to the fledgling's incessant calls of hunger for nearly two hours, they passed out of hearing and did not return. Meanwhile the sun had dissolved the clouds and begun to illuminate the mountain-side.

At one o'clock, the hour at which I had begun the watch on the preceding day, I took down the tent and departed. I had made a continuous schedule of the female's periods on and off the nest for a cycle of 24 hours. During the forenoon, when she had been somewhat restless, her sessions ranged from 4 to 33 minutes, her recesses from 4 to 14 minutes. In the afternoon she sat more steadily. Her shortest period on the nest was then 23 minutes, and twice she incubated continuously for 62 minutes—a long time for so small a bird to sit still. To compensate for her longer sessions, she now took longer recesses, ranging from 10 to 24 minutes. For the entire day, her 22 sessions on the nest averaged 19.1 minutes and her 22 recesses averaged 10.5 minutes. Counting from her first departure from the nest at 6:23 in the morning until her final return at 5:17 in the evening, she devoted a total of just 7 day-time hours to warming her eggs and spent 3 hours and 51 minutes away from the nest. She incubated for 64.5 per cent of the day.

#### THE NESTLINGS

This nest was too many miles distant from my residence to visit it daily. When I returned to "The Hummingbirds' Hillside" a week later, I found that the flower-piercer's eggs had hatched. The nestlings, which appeared to be no more than two days old, bore long, soft, light gray down, so sparse that it failed to conceal their pink skin, and certainly it was of no appreciable value in protecting them from the cold. Their eyes were tightly closed, and their mouths, when opened, were bright red inside.

Again I set my brown wigwam in front of the nest, and devoted a morning to watching the parents attend their nestlings. The day again dawned with the clouds enveloping the mountain in their gray mist and with the air exceedingly chilly. As before, in the dim first light, the male flower-piercer began his song among the cypress saplings and rajón bushes beyond the nest. He repeated it slowly, over and over, but he did not continue so long as on the previous morning. After only six minutes he became silent.

Four minutes after he ended his song, he approached the nest, from which the mother bird had just flown, and fed the nestlings, by regurgitation. In the next four hours he was the chief provider and brought food to them twelve times in all. The mother found it necessary to devote much time to protecting her young from the chill mountain air, and she delivered food only five times. When her mate approached to feed the nestlings, she always left to make way for him, but she never remained absent long. When she returned to the nestlings, she usually had nothing to give them.

The female flower-piercer's periods of brooding ranged from 5 to 11 minutes; her absences varied from less than 1 to 18 minutes, becoming slightly longer as the sun warmed the cool mountain side. In the 4 hours of my watch, she covered the nestlings for a total of 94 minutes and left them exposed to the chill mountain air for a total of 146 minutes.

In the cloud-dimmed dawn on January 1, I once more took my place in the tent before the flower-piercers' nest. When the light was sufficient to reveal details, I saw that the mother sat in the nest, in which she had slept covering the two nestlings. At 6:15 she roused herself, took wing from the nest, and disappeared into the dense cloud that enveloped the mountain side. After eight minutes she returned, fed a nestling, and vanished once more into the fog. A minute later the father first appeared and delivered food to one of the nestlings. This morning he did not sing near the nest in the dawn as he had done on the two previous mornings when I watched.

Although nine days earlier the male flower-piercer had brought food far more frequently than his mate, this morning, because she did not brood, the mother came to feed the nestlings more often than he. She delivered food 13 times in the course of 4 hours, whereas he brought it only 8 times. Now that the young birds were larger and more active, they stretched up well above the rim of the nest, their red mouths gaping widely to receive their meal; and I could see in more detail how this was delivered. The parent, which came with no visible food, inserted its short bill well down into the throat of the nestling and by muscular action, externally evident in the movements of the neck, forced the food upward from its own crop into the throat of the recipient. Once or twice I glimpsed fine blackish material passing in a stream through the half-opened bill of the parent. From this observation and the dark color of the contents of the sac on the neck of the nestlings, I inferred that the food consisted in large measure of minute insects, such as the parents caught by means of short, rapid darts among the bushes.

The sac just mentioned is an enlargement of the oesophagus of the nestlings which serves to receive and hold for a time the food pumped rapidly and in relatively large quantity into their mouths. When full, it forms a conspicuous black swelling, which looks like a deformity, on the right side of the neck. A similar protuberant crop is very evident in young nestling hummingbirds, which also receive their food by regurgitation; but the nestlings of most passeriform birds that receive discrete particles of solid food do not have it. Here again it is interesting to find that the flower-piercers possess peculiarities in common with the hummingbirds, which originate from similar modes of feeding.

The female flower-piercer usually delivered all that she had to offer into the throat of a single nestling in one continuous process. Only once did I see her feed both nestlings on a single visit. The father, on the contrary, usually delivered the food in successive installments, to either one or both nestlings. Most often he gave all to one nestling by means of two distinct acts of regurgitation, with a pause between, when he withdrew his bill from the throat of the recipient. Once he pumped a little food into the mouth of one nestling, then delivered the remainder to the other in five separate portions. I cannot affirm that the male flower-piercer's manner of delivering the food indicated that he

brought more than his mate, but it is not impossible that he compensated for his less frequent visits to the nest by bringing a more liberal offering each time.

When I left the tent and went up to the nest, the nestlings for the first time crouched down in the bowl—their first manifestation of fear. Their fear was, however, short-lived, and soon they stretched up their mouths for food when I held my hand above them. I found them covered with feathers, at least when they kept their necks down and their wings folded; but their plumage still seemed sparse to afford them sufficient protection on a damp, cold morning such as this was; for I was not over-warm in the tent despite much heavy clothing. Yet they gave no indication of suffering from exposure, although their mother no longer warmed them by day. While I was at the nest, the parents lurked out of sight among the bushes, uttering weak *tsips* as their only remonstrance.

My sojourn on the Sierra de Tecpán came to an end before the young flower-piercers were ready to leave their nest. On the morning of my departure I went out at dawn to visit them and found that their mother still brooded them by night, although they were about two weeks old and well feathered.

#### SUPPLEMENTARY INFORMATION ON THE SLATY FLOWER-PIERCER OF COSTA RICA

##### *Diglossa baritula plumbea*

Lacking pale cinnamon under plumage, the Costa Rican form of the Slaty Flower-piercer is even more plainly attired than the Guatemalan race. The females of the two forms are more similar, olive-gray on the upper parts, with the under plumage a more yellowish shade of the same color. Their attire is extremely plain and undistinguished.

The flower-piercer is distributed over all the higher parts of Costa Rica and neighboring regions of the Republic of Panamá. I have found it on the páramo near the summit of El Cerro de la Muerte, at 11,000 feet, and high up on the Volcán Irazú. It nests at least as low as 5300 feet and has been recorded as far down as 4000 feet above sea level, but it is only an occasional straggler in regions so low and warm. Carriker (1910: 824) states that it is most abundant between 8000 feet and timberline on the high volcanoes. The flower-piercers appear never to flock in the manner of some of the brighter honeycreepers of lower altitudes, but live singly or in pairs. Their favorite resorts in Costa Rica are the treeless summits and sunny openings far up on the mountain slopes that are covered with nearly impenetrable thickets of flowering shrubs, among which members of the heath family are abundant. They are fond of mountain pastures where the surviving trees are heavily burdened with air-plants of the most varied kinds and where every rotting stump upholds a garden of epiphytic growths, many of which display bright flowers rich in nectar. They prefer the edges and openings of the forest to its sunless depths where flowers are less abundant.

The period of song in Costa Rica, like the nesting season, is peculiar. During the year I dwelt in the Costa Rican highlands, near Vara Blanca at an altitude of 5500 feet, I heard the flower-piercers sing from late June through July, August, and September. In the last three months of the year they were silent or nearly so, but in windy, stormy January they sang occasionally. In March, April and May, when the chorus of other birds was fullest, they sang little or not at all. The song is much like that of the Guatemalan race.

In the region where I studied the Costa Rican race it was too low for frost, and it was exposed to the northwest winds which at all seasons brought more than enough rain and mist to keep the vegetation green and flourishing. Here seasonal fluctuations in the abundance of flowers were not so marked as in other highland regions subject to killing frosts, or to a long dry season, or to both of these influences working in conjunction.

Hence at Vara Blanca the correlation between the nesting season of these nectar-loving birds and the flowering of plants was not so clear as I had earlier found it in western Guatemala at a greater altitude, or even as it probably is at greater elevations in neighboring parts of Costa Rica. But the independence of flower-piercers and hummingbirds from the influences which determined the season of reproduction of practically all other birds was equally clear in both regions. Possibly the breeding season of the birds of any small area is determined by the climatic conditions generally prevailing over the



Fig. 68. Edge of sub-tropical rain-forest along the headwaters of the Río Sarapiquí, near Vara Blanca, Costa Rica, about 5600 feet altitude. In the forests occur the Quetzal, Bellbird, Andean Solitaire, Prong-billed Barbet, and Blue-throated Toucanet.

larger region where the species, or at least the race, as a whole is distributed, rather than by the strictly local climate, which in tropical highlands may exhibit surprising changes within short distances.

In the course of my year at Vara Blanca, I found 6 nests of the flower-piercer, only 4 of which were completed. The first, discovered on September 24, 1937, then contained nestlings ready to depart. The second was built at the end of January, 1938, and the last nestling left it on March 2. The third and fourth nests, although discovered at different times, both contained eggs which hatched on March 10. A half-finished nest found on March 15 was never completed, nor was one discovered when newly begun on July 15. Hence in April, May and June, when the breeding season for the bird population as a whole was at its height, no evidence of nesting by the flower-piercer was discovered, although this was the period when I was most actively engaged in watching birds. The silence of the flower-piercers during April, May and early June was further testimony that they were not then engaged in breeding. Between the end of August and

the beginning of March I saw no occupied breeding nests of any birds except the flower-piercers and hummingbirds of three species. In early March, when the nesting season of the flower-piercer was coming to an end, the early nesters of other species were just beginning to build or to lay.

*Nest building.*—All six of the nests found at Vara Blanca were in a pasture bordered on three sides by forest, which was fifty yards distant from the one farthest within the pasture. Two were in clumps of small huiscoyal palms bristling with long, sharp, black thorns, one supported between the upright stems of the palms, the other between the basal pinnae of a frond. The others were in tussocks of the tall, coarse pasture grass. Those placed in the grass were low, from 15 inches to 3 feet above the ground; the two in the palms were higher, at 4 and 9 feet, respectively.

I was fortunately able to watch the construction of two of these nests; for in my earlier studies of the Guatemalan Slaty Flower-piercer I had missed this stage of the nesting operations. The higher of the nests in the spiny palms was discovered on January 24, when the outer shell of green moss and shreds of decaying leaf had been completed and the female was busy bringing finer material for the inner layers. The morning was already far advanced when I found the nest, and the female soon suspended her labors; but the following morning I watched her for a longer period. The day, as so many at this season, had dawned dark and gloomy, with the north wind driving dense masses of gray cloud over the mountain and drenching everything with the fine drizzle that descended from them. An hour and a half after daybreak the clouds lifted, and I went out to watch the nest. The sun was now making itself felt through a veil of higher clouds, from which a spray of fine droplets continued to fall, sparkling in the cloud-filtered sunshine.

Amid this beautifully illuminated falling mist, the female flower-piercer was working very actively at her nest, bringing billfuls of fine material from the edge of the forest 40 feet away, placing them within the green cup, then flying back to the forest for more, taking very little time to arrange what she brought. She labored in silence; or rarely, when she left the nest, she perched on a lower frond of the palm, nervously flitted her wings and uttered a fine, sharp *chip* before she flew off to seek more material. Very rarely she delivered a short, weak, high-pitched trill. She toiled with a will. In the half-hour from 7:40 to 8:10 she brought material 26 times. In the following half-hour (8:10 to 8:40) she came to the nest with material 19 times; and in the third half-hour (8:40 to 9:10) she also came 19 times. In the fourth half-hour (9:10 to 9:40) she relaxed her efforts and came only 9 times. By the end of the first hour the brief period of brightness had passed; the morning grew increasingly dark, and the drizzle augmented to almost a rain. The bird continued to work in the fine shower—to complete a nest at this season, she could hardly do otherwise.

The male flower-piercer did not help to build. During the brighter part of the morning he repeated over and over his weak, high-pitched, somewhat trilled song, but at a distance from the nest. Once, when he came to the huiscoyal palm where his mate worked, she flew at him as though she disliked his presence there. He promptly retreated, and I did not again see him come to the clump of palms where the nest was placed.

On February 19, I surprised a flower-piercer at work on a half-finished nest, excellently concealed amid the tall, coarse grass that nodded over the bank above the path that separated the pasture from the adjoining forest. It was about eight o'clock in the morning, with a bright sun rising above the crest of the ridge in the pasture, when I found the flower-piercer building; and for the next hour and a half I watched her. She worked quite alone; and her mate did not even show himself or sing within my hearing. She carried to the nest many soft, partly decayed fragments of the blades or sheaths

of the grass leaves, tufts of moss from neighboring trees, and fine fibers or other bits of vegetation picked up from the pathway at the edge of the woods. She also tugged at the finest terminal twiglets of some cut brush lying in the path, and finally, with much effort, she succeeded in breaking loose a few short fragments, which she carried up to the nest. From time to time she, too, delivered a faint little song.

While building, the flower-piercer was worried by a female Chestnut-bellied Mountain Gem, who was incubating two white eggs in a mossy cup attached near the end of a long, nodding grass haulm that hung over the edge of the bank, only sixteen feet distant from the flower-piercer's nest. This hummingbird apparently did not wish the honeycreeper to become such a near neighbor, perhaps looking upon her as a competitor, since both drank nectar. During the hummingbird's absences from her eggs she darted upon the flower-piercer time and again, sometimes almost striking her, if not actually doing so. But the flower-piercer seemed not to be seriously incommoded by these swift onslaughts and paid no attention to them, going about her business in disregard of her adversary, whose body was at least as big as her own, while the assailant's sharp bill was far longer than her little hooked one. When the flower-piercer was actually at her nest, the long-winged hummingbird could not reach her through the clustered grass stems. Once when the flower-piercer was hunting material in the pathway beneath the hummingbird's nest, the latter darted straight down from her eggs to drive the trespasser away.

I watched the flower-piercer at work while standing or sitting in the open pathway only three or four yards from her nest; yet she seemed utterly indifferent to my presence. Before departing, I approached the nest and stood within arm's length of it; yet even then the little bird continued to fetch material and to arrange it in the structure, revealing not the slightest distrust.

The finished nest of the flower-piercer was a bulky, substantial, open cup. The nest in the huiscoyol palm had a loose foundation composed of moss and large pieces of decaying leaf. Within this were thick, compact walls made of coarse vegetable fibers, finer shreds of decaying leaf, and flakes of papery bark. The lining was of finer fibers, those in the bottom finest and black. In the bottom were also many large, chestnut-colored scales from the fronds of tree-ferns. The external dimensions of the nest were 4 inches in diameter and  $3\frac{1}{2}$  inches high. The interior measured 2 by  $1\frac{3}{4}$  inches in diameter by  $1\frac{1}{2}$  inches in depth. A nest built amid the grass was composed chiefly of coarse grass blades, with a small admixture of moss, and was lined with fine rootlets, chiefly light in color, but with a few that were black in the bottom.

The construction of the nest appears to be fairly uniform in the genus *Diglossa*. A nest of the White-sided Flower-piercer which I found above Baños, Ecuador, at an altitude of 7000 feet, on October 20, 1939, was situated 31 inches above the ground, in the midst of a cluster of fine ascending shoots of a bamboo growing on the bushy mountain side. It was a compact, solidly constructed open cup. The outer layer was composed of green moss and pieces of Selaginella; the middle layer was made largely of coarse straws and dry grass blades; the thick lining was of fine pieces of grass inflorescence, light-colored fibers and pieces of filamentous lichen, some gray and others yellow. It measured externally 3 inches in diameter by  $2\frac{3}{4}$  inches high. The interior was  $1\frac{7}{8}$  inches in diameter by  $1\frac{3}{8}$  inches deep.

*The eggs and young.*—Four nests of the Costa Rican race of the flower-piercer contained each 2 eggs or nestlings. In two of these nests the eggs were laid on consecutive days. They are light blue, finely speckled with brown. On some, the markings are most crowded in a wreath about the thicker end, but on others they are rather uniformly sprinkled over the entire surface. The measurements of four eggs varied from 16.7 to 17.5 millimeters in length and all were 12.7 millimeters in transverse diameter.



The nest of the White-sided Flower-piercer in Ecuador contained two eggs which were very similar in appearance to those of the Slaty Flower-piercer, and both of which measured 17.5 by 13.5 millimeters. At one of the Costa Rican nests the last egg hatched after 14 days of incubation.

The nestlings are fed with regurgitated food delivered to them by both parents. When visiting the nest in the high grass leaning over the bank, I was in the habit of raising a mirror above it to view the contents. While there were still eggs, the female usually delayed in the nest until the mirror was almost above it, then skulked through the low grass nearby, rapidly repeating a weak, sharp, scolding note. But two days after one egg hatched (the other failed to do so), she returned while the mirror was above the nest and twice struck it with her bill. Next I held my hand above the nest to see what she would do, but she would not touch that. Yet despite the boldness of her attack on the mirror, she became increasingly reluctant to approach the nest in my presence. Although she had built while I stood within arm's length of the nest, she would hardly go to feed her nestling if she saw me watching, even from a good distance away. At the nest in the spiny huiscoyol palms, too, the female flower-piercer became less confident in my presence after her eggs hatched. She had gone about her building, paying no attention to me, while I sat without concealment on a log about twelve yards from the nest, but she would not feed her nestlings while I watched from the same position. This great increase in shyness after the hatching of the nestlings seems quite unusual among birds.

The nestlings are clothed with feathers at the age of about 11 days. At the age of 13 days one of the youngsters jumped from the nest in the huiscoyol palm when frightened by the mirror that I raised above it to look in. It could scarcely fly. Three days later, in the afternoon, the second young flower-piercer fled from the nest under the same circumstances. It flew several yards on a descending course and hid in the low weeds. When taken in hand, it uttered low, harsh, rasping notes. It resembled the adult female in plumage; but the hook at the end of the upper mandible was less pronounced than in mature birds. If undisturbed, this fledgling would most probably have remained in the nest at least until the following morning, which would have made its nestling period 16 days.

#### SUMMARY

The genus *Diglossa* differs from typical honeycreepers in its prevailing dull coloration, the peculiar form of the bill, and its highland rather than lowland distribution. In Guatemala, the Slaty Flower-piercer ranges from about 5500 to 11,000 feet above sea level, in an altitudinal zone where no other honeycreeper occurs. It inhabits bushy areas and forest openings where flowers abound, and it never flocks like more typical honeycreepers. It usually forages at no great height.

The flower-piercer's bill is a highly specialized instrument for extracting nectar from flowers with tubular corollas. While the abrupt hook at the end of the upper mandible fits over the tube and holds it firm, the awl-like, uptilted lower mandible pierces the tissue on the side toward the perching bird. The nectar is removed through the narrow slit, apparently by the tongue. The whole process takes only a moment, and many flowers are treated so in the course of a minute. Although species of *Salvia* are much sought, the flower-piercer treats in the same fashion a great variety of flowers with tubular corollas, some nearly as large as itself. It was never seen to remove the nectar by inserting its bill in the open throat of a flower, in the manner usual in hummingbirds. It also catches many small flying insects, and it is aided in this mode of feeding by its prominent rictal bristles.

The male's weak and plaintive song is sometimes delivered so rapidly that it becomes a trill. The female utters a similar but still weaker trill. On the Sierra de Tecpán in Guatemala, between 8000 and 10,000 feet, the flower-piercer sings chiefly in the second half of the year, when most other passerine birds were nearly songless.

Here the flower-piercer nests in the early part of the dry season, from November to January, when there is a great profusion of nectar-bearing blossoms at high altitudes even though frost forms on open fields almost every clear and windless night. After January, continued heavy frosts and increasing drought greatly diminish the number of flowering herbs and shrubs, and the breeding season comes to an end. The flower-piercer nests at the same time as the hummingbirds, which like itself subsist largely on nectar, but at a period when no other passerine bird seems to be breeding. On the other hand, no nest of the flower-piercer was found in April, May, and June, when nearly all the other passerines at the same altitude were rearing their broods.

The two nests at about 9500 feet in Guatemala in December were built in shrubs and saplings in bushy clearings, at heights of four and five feet above the ground. They were substantial, open cups.

In 12 daylight hours at one nest the females' incubating sessions ranged from 4 to 62 minutes and averaged 19.1 minutes, and her recesses varied from 4 to 24 minutes and averaged 10.5 minutes. She spent 64.5 per cent of the day on her eggs. Apparently only the female incubates.

The nestlings bear long but sparse gray natal down and the inside of their mouths is red. They are brooded by the female alone, but they are fed by both parents with food that is pumped up from their crops with pronounced muscular movements, much as in hummingbirds. Minute insects seemed to form an important part of this regurgitated food, which is received and temporarily stored by the nestling in an oesophageal sac. The sac forms a conspicuous swelling on one side of the neck, much as in a hummingbird. Undisturbed nestlings remain in the nest until 16 days old.

In Costa Rica a dull-colored race of the Slaty Flower-piercer ranges from about 4000 feet to the open páramos at 11,000 feet, but it is more abundant at the higher levels. In habitat, voice, and manner of piercing flowers it resembles the northern form of the species.

At Vara Blanca, 5500 feet above sea level, the flower-piercers were observed over a period of a year in an exceedingly humid region that has no definite dry season and is too low for frost. Here where the climate is more uniform through the year the flower-piercer's breeding season is not so sharply delimited as it seems to be at higher altitudes farther north; but it is significant that no suggestion of breeding was found in April, May, and June, when the great majority of the local birds nested. Of the four occupied nests of the flower-piercer that I found, eggs were laid in one in August and in three in February. Nests begun in mid-March and mid-July were never finished. Here again, the flower-piercer nested at the same time as the hummingbirds.

These nests were found in a pasture nearly surrounded by forest. They were situated in tall, coarse grass or clumps of spiny palms, at heights of from 15 inches to 9 feet. In two cases, the female alone built the bulky, substantial, open cup.

Five nests found in Guatemala and Costa Rica each contained two eggs, whereas one contained a single egg which was abandoned. In one instance, the eggs hatched after 14 days of incubation. The eggs are bright blue, spotted with brown.

## GENERAL SUMMARY OF INFORMATION ON THE COEREBIDAE

The honeycreepers are an exclusively New World family containing about 36 species of small birds, practically confined to the tropics. The species are most abundant in the warm lowlands and here they display the brightest colors. Blue in many lovely shades is perhaps the outstanding color of the males; but green, yellow, black, and at times even red and white, are present in the plumage of various species. When the males are very brilliant, the females are far more modestly attired in dull green; and sexual differences in plumage are even found in the generally dull genus *Diglossa*, which occurs only at higher altitudes, ranging from the Upper Tropical Zone up to or beyond tree line on lofty tropical mountains. In the genus *Coereba* the sexes are similar in their fairly bright yellow, olive, and black plumage. So far as known, the honeycreepers are sedentary or perform at best limited migrations determined by the seasonal abundance of flowers at various altitudes. Seasonal changes in plumage occur in the male Blue Honeycreeper but have not been found in other species.

The food of the several genera of honeycreepers varies considerably and is correlated with striking differences in the structure of the bill. Despite their slender, sharp, and at times rather long bills, *Cyanerpes*, *Dacnis* and *Chlorophanes* do not have narrowly specialized feeding habits, but consume a variety of soft and sometimes even rather hard fruits. Members of these three genera are especially fond of bananas. They pluck insects from the foliage. The long-billed Blue Honeycreeper probes flowers and catches small insects on the wing. *Coereba* is especially addicted to nectar, probing blossoms of many kinds or sometimes piercing the bases of tubular corollas with its sharp curved bill, always while clinging—never while hovering in the fashion of hummingbirds. The bill of *Diglossa*, with sharply hooked, up-tilted upper mandible and short, awl-like lower mandible, is a highly specialized apparatus for piercing tubular corollas and extracting nectar through the perforation. Members of this genus also catch small insects on the wing; and in Ecuador I have seen *Diglossa cyanea* pressing the rich purple juice from the small berries of *Coriaria* and letting the skin fall to the ground.

Voice is very poorly developed in this family. *Coereba* is a most persistent songster, and some species of *Diglossa* sing rather freely, but the songs of both genera are weak and lacking in compass. The Blue Honeycreeper has a very simple dawn-song, but it almost never sings later in the day. I have never heard any song from the Green Honeycreeper, Turquoise Dacnis or Scarlet-thighed Dacnis, although I have watched them at the nest. Voice is used as a means of settling disputes by the Blue Honeycreeper. The female Slaty Flower-piercer has a song resembling that of the male but weaker.

Nuptial feeding has apparently never been observed in the family.

Polygamy is unknown in the family.

The nest is placed in trees or, especially in the genus *Diglossa*, in low bushes. Great diversity in the form of the nest is found in the family. The highland *Diglossa* builds a thick-walled, open cup, often employing much moss. The nest of the Green Honeycreeper is a shallow, open cup composed of large dead leaves and petioles bound together with cobweb. The nest of the Scarlet-thighed Dacnis is an exceedingly slight, shallow structure of fibers, covered on the bottom with pieces of living fern fronds. The Blue Honeycreeper builds a shallow, thin-walled, open cup of fibrous materials. The nest of the Bananaquit is a roughly globular closed structure with a round entrance facing obliquely downward.

The nest is built by both sexes in the Bananaquit, by the female alone in the Blue

Honeycreeper, Slaty Flower-piercer, Turquoise Dacnis (one instance) and Green Honeycreeper (one instance).

The eggs are usually two in a set in *Cyanerpes* and *Diglossa*, two or sometimes three in *Coereba*. They are white or (in *Diglossa*) blue, speckled with shades of brown.

Incubation is performed by the female alone in the Blue Honeycreeper, Bananaquit, and Slaty Flower-piercer, and presumably this is true of the other species. The Slaty Flower-piercer and the Blue Honeycreeper are impatient sitters, their sessions rarely exceeding an hour and averaging between 19 and 29 minutes. A female Bananaquit sat with a constancy surprising in so small a bird, her sessions averaging 60 minutes. The honeycreepers that were watched kept their eggs covered from 65 to 78 per cent of the time on rainless days.

Incubation periods vary from 12 to 14 days.

The nestlings bear a sparse natal down. The interior of the mouth is red in the Blue Honeycreeper and Slaty Flower-piercer, but it is yellow in the Bananaquit. The young are brooded by the female only but are fed by both parents. The food is carried conspicuously in the bill by *Cyanerpes*, but regurgitated by *Diglossa* and *Coereba*. Injury feigning has not to my knowledge been observed in this family.

The nestling period varies from 14 days in *Cyanerpes* to 16 in *Diglossa* and 17 to 19 days in *Coereba*.

Helpers at the nest are unknown in this family.

Adult plumage is acquired by the young male Blue Honeycreeper through a long, gradual change which occupies a number of months. Males have not been found breeding in transitional plumage, except possibly in the Bananaquit in Puerto Rico (Wetmore, 1927:500).

The sleeping habits of the Bananaquit are of interest. Throughout the year adults sleep singly in closed nests that resemble the breeding nests but are often smaller and of slighter construction. Many nests are built to serve as dormitories; the male helps the female with her nest but constructs his own without her aid. Fledglings are not led by their parents to sleep in dormitories but are left in the open; yet some at least soon find shelter in closed nests of their own or of other species. While still in the juvenal plumage, they may sometimes build dormitories for themselves.

Recently Beecher (1951*b*) has concluded from anatomical studies, especially of the jaw muscles and horny palate, that the Coerebidae is an artificial group, composed in part of tanagers and in part of wood warblers, which as a result of their common adaptation to feeding on nectar have become similar through convergence. He considers *Coereba*, *Conirostrum* and *Ateleodacnis* as forming a nectar-specialized tribe of the Parulidae, the Coerebini; and *Diglossa*, *Cyanerpes*, *Chlorophanes*, *Dacnis* and other genera are regarded as a nectar-specialized tribe of the Thraupidae, the Dacnini. Although I agree that as at present constituted the Coerebidae is a heterogeneous, unnatural group, I question, for example, the wisdom of placing a bird like *Diglossa* among the tanagers, thereby making that fairly homogeneous family a less compact and natural group. After all, there comes a time in the course of evolution when an offshoot of one family has become so greatly modified that it merits separation into a distinct family. At present, it seems best to allow the family Coerebidae to rest in its admittedly unsatisfactory form, awaiting field studies of other genera, which added to the anatomical evidence will lead to a fuller understanding of natural relationships. Perhaps the Coerebidae should be split up; but I should not be quite satisfied with any arrangement that placed *Diglossa* closer to *Cyanerpes* and *Chlorophanes* than to *Coereba*, which like it, feeds the nestlings by regurgitation. But here we are exceeding our bounds; for the aim of the present work is not to discuss taxonomic problems, but to furnish some of the information which will help to settle these problems.

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