FAO Fisheries Synopsis No. 35 Rev. 1

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FRm/S35 (Rev. 1)

SAST - *P. typus* - 1,70(37),457,01
P. senegalensis - 1,70(37),457,02
P. elongatus - 1,70(37),457,03

SYNOPSIS OF BIOLOGICAL DATA ON WEST AFRICAN CROAKERS

Pseudotolithus typus, P. senegalensis and P. elongatus

Prepared by

A.R. Longhurst

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

ROME, 1969

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Special groups of synopses are identified by symbols followed by classification numbers based on indexed code of " Current Bibliography ":

SAST Data concerning certain species and fish stocks.

MAST Information on methods and subjects.

OT Oceanographic data.

IT Limnological data.

and

CART Information concerning fisheries and resources of certain countries and regions (FID/S).

FAO Fisheries Technical Paper FR /T (No.)

Special groups of Technical Papers are identified by:

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MAST Renseignements sur des méthodes et des sujets.

OT Données océanographiques.

IT Données limnologiques.

et

CART Renseignements sur les pêcheries et les ressources de certains pays et régions (FD/S).

Des catégories spéciales de documents techniques sont identifiées à l'aide des symboles suivants:

RE Listes indexées d'experts et institutions tirées des registres tenus à jour par la Division des ressources et de l'exploitation des pêches.

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MFS Editions provisoires des « Manuels FAO de science halieutique ».

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SAST Datos relativos a ciertas especies y poblaciones.

MAST Sinopsis sobre métodos y materias.

OT Sinopsis sobre oceanografía.

IT Sinopsis sobre limnología.

y

CART Información sobre los recursos acuáticos vivos de algunos países y regiones (FID/S).

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SYNOPSIS OF BIOLOGICAL DATA ON

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(*Pseudotolithus typus*, *P. senegalensis* and *P. elongatus*)

Prepared by

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, November 1969

PREPARATION OF THIS SYNOPSIS

A revision of the provisional version issued in October 1966 for presentation at the Symposium on Oceanography and Fisheries Resources of the Tropical Atlantic, Abidjan, Ivory Coast, 20-28 October 1966.

The data reviewed here include some which have been published previously, some which have been included only in mimeographed reports with a limited circulation, and some previously unpublished. The author is particularly grateful to Dr. F. Williams, Director of the Guinean Trawling Survey (Joint Project 19 of CCTA, and latterly of OAU) for making available for inclusion here many unpublished data. The author also wishes to thank: Mr. Bayagbona (Lagos, Nigeria) and MM. Poinsard and Troadec (Pointe Noire, Congo Brazzaville) for MS data on their bionomic studies; M. Tixerant (Mauritania), Mrs. Cooper-Dennis (Monrovia, Liberia), Dr. Zei and Mr. Kwei (Accra, Ghana), M. Paraiso (Dahomey), M. Marchal (Abidjan, Ivory Coast), Mr. Niven (Lagos, Nigeria), M. Lemaresquier (Cameroun), M. Magombo (Congo-Kinshasa), M. Poinsard (Pointe Noire, Congo Brazzaville) and Sg. de Sousa e Andrade (Angola) for their ready response to a questionnaire concerning landing statistics. Finally, the author wishes to thank Dr. Trewavas (London, U.K.) for information on taxonomy; Prof. Th. Monod for vernacular names; and wishes to record the assistance he received from the late Mr. T.E. Aggo.

The following abbreviations have been used in the text: GTS = Guinean Trawling Survey; CCTA = Commission for Technical Co-operation in Africa; OAU = Organization of African Unity; ORSTOM = Office de la Récherche Scientifique et Technique Outre-mer; FFS = Federal Fisheries Service of Nigeria; WAFRI = West African Fisheries Research Institute.

Distribution

FAO Department of Fisheries
FAO Regional Fisheries Officers
Regional Fisheries Councils and Commissions
Participants in the Abidjan Symposium
Author
Selector SM

"Current Bibliography" entry

Longhurst, A.R. (1969) 16-6M544
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Synopsis of biological data on West African croakers (*Pseudotolithus typus*, *P. senegalensis* and *P. elongatus*)

ASE. Mauritania. Senegal. Guinea. Sierra Leone. Liberia. Ivory Coast. Ghana. Dahomey. Nigeria. Cameroon. Congo - Brazaville. Nomenclature. Taxonomy. Morphology. Distribution. Reproduction. Hybridization. Nutrition and growth. Behaviour. Population - structure, density. Exploitation - areas, gear, seasons. Protection and management. Ci 11-22787.

C O N T E N T S

* As no information was available to the author these items have been omitted from the text.

1 IDENTITY

1.1 Nomenclature

1.11 Valid names

The original combinations under which the three species were first described appear to be the following:

1 - Pseudotolithus typus = Pseudotolithus typus Bleeker, 1863. (Not Sciaena dux Bowdich 1825, nor Otolithus senegalensis Valenciennes 1833; the first is a species dubia, the second refers to species 2 below.)

2 - P. senegalensis = Otolithus senegalensis Valenciennes, 1833; now considered to be congeneric with 1 above.

3 - P. elongatus = Sciaena elongata Bowdich, 1825.

Thus, since these species are now considered to be congeneric the valid names are the following:

1 - Pseudotolithus typus Bleeker, 1863

2 - Pseudotolithus senegalensis (Valenciennes, 1833)

3 - Pseudotolithus elongatus (Bowdich, 1825)

1.12 Objective synonymy

The following are the most important of the synonyms used for the three species:

1 -	Otolithus dux (Bowdich)	Fowler, 1936 Collignon, 1959
	Otolithus senegalensis C. and V.	Cadenat, 1950 Poll, 1954
2 -	Otolithus macrognathus (Bleeker)	Fowler, 1936 Cadenat, 1950 Poll, 1954 Collignon, 1959
	Cynoscion senegalla Cuvier	Norman in Irvine 1947
3 -	Johnius elongatus Bowdich	Fowler, 1936
	Sciaena nigrita (C. and V.)	Norman in Irvine 1947
	Corvina nigrita C. and V.	Cadenat, 1950 Poll, 1954
	Larimus elongatus (Bowdich)	Collignon, 1959

1.2 Taxonomy

1.21 Affinities

- Suprageneric

Vertebrata, Craniata, Gnathostomata, Pisces, Teleostomi, Actinopterygii, Perciformes, Sciaenidae, Pseudotolithini.

The above statement is based on the demonstration by Trewavas (1962) that the tropical West African members of the family Sciaenidae consitute a tribe within this family, named by her Pseudotolithini; the tribe is characterised by the structure of the air bladder which consists of a carrot-shaped vesicle extending the length of the body cavity, to the anal fin in some species. From its anterior end arise a pair of hollow tubules which subdivide into between 3 and 21 smaller tubules. There is no barbule in any species; in Pteroscion peli the mandibular lateral line opens by 2 anterior pores, in the remainder by 3 pores, on each side.

Trewavas (1962) gives convincing reasons for considering that the tropical West African Sciaenidae form a single tribe as defined above, within which trophic adaptations have caused evolution of body-forms convergent with those of other genera and tribes in other marine zoogeographic regions; she considers that adaptive radiation of the tribe accounts for the form to be seen in the nine present-day species she recognises. Her findings are following throughout this account and form a most excellent systematic basis for further studies of the group.

- Generic

The three species are included by Trewavas (1962) within two subgenera of the genus Pseudotolithus Bleeker, 1863. (Type: Pseudotolithus typus Bleeker, 1863). The situation within this genus may be tabulated as below:

Pseudotolithus Bleeker, 1863

Subgenera - Pseudotolithus Bleeker; type as genus
- P. typus Bleeker
- P. senegalensis Cuvier and Valenciennes
- P. brachygnathus Bleeker

Fonticulus Trewavas. Type = Corvina nigrita Cuvier
- P. (Fonticulus) elongatus (Bowdich)

Pinnacorvina Fowler. Type = Rhinoscion epipercus Bleeker
- P. (Pinnacorvina) epipercus (Bleeker)

Hostia Trewavas. Type = Corvina moori Günther
- P. (Hostia) moori (Günther)

- Specific

The type specimens, their present location, and the type locality for the three species are listed below; some of this information is given in a note by Boesman (1963).

1 - Pseudotolithus typus Bleeker, 1863. Type now in the Rijkesmuseum van Natuurlijke Historie, Leiden, Netherlands, where it is labelled (Holotype, Registered No.752); the type locality appears to be Ghana, labelled 'Ashantee'.

2 - Pseudotolithus senegalensis (Valenciennes, 1833). Type now in Museum Nationale d'Histoire Naturelle, Paris, numbered 7512. It was collected by Rang at Gorée, Senegal.

3 - Pseudotolithus elongatus Bowdich, 1825. Types not collected by Mrs. Bowdich, who described the species as if from Porta Praya, Cape Verde Islands, where the species does not occur; there was most likely an error in labelling for Gambia, their next port.

The three species may be diagnosed briefly in the following terms, by reference to external characters; the species are illustrated in Fig. 1.

Pseudotolithus typus: Head and body long, compressed, profile of top of head slightly concave, eyes supralateral, mouth large and lower jaw projecting; head 3.2-3.3, depth 3.75-4.6; dorsal X,29,1; anal II,7,1; pectoral II,14-15; ventral I,5. Anal spine weak. Colour greyish brown above, paler below, fins pale or whitish; at times of silt-laden water may take on golden hue over all paler parts of body.

P. senegalensis: Head and body moderately long, profile of head and snout convex, eyes lateral, mouth large, lower jaw projects only very slightly; head 3.5, depth 3.1, dorsal X,I,26,1; anal II,7,1; pectoral II,14. Anal spine weak. Colour greyish brown above, paler below and on fins.

P. elongatus: Head and body well compressed, body elongately ovate, highest at spinous dorsal base, caudal peduncle stronger and caudal relatively larger than in species 1 and 2; snout and head convex, eyes large, mouth large, lower jaw projects only very slightly; head 2.4-3.2, depth 2.8-3.3; dorsal X,I,32,1; anal II,6; colour as species 1, with tendency to golden hue over all lighter coloured parts at times of turbit water very marked. Anal spine II very strong and sharp.

Field identification can be accomplished from the following abbreviated definitions of the nine species of the tribe Pseudotolithinae occuring on the tropical West African coastline:

Pteroscion peli (Bleeker, 1863). Head large, mouth oblique, anal spine strong, body soft so that scales fall very readily. To 24 cm.

Pseudotolithus typus Bleeker, 1863. Mouth terminal, head long and up-curved, small anal spine, 10 hard dorsal spines. To 98 cm.

P. senegalensis (Valenciennes, 1833) Mouth terminal, head not as in previous species, small anal spine, 11 hard dorsal spines, long pectoral fin. To 80 cm.

P. brachygnathus Bleeker, 1863. Distinguished from P. senegalensis by silvery flanks, short pectoral fin, large eye, prominent lines of dark spots running transversly across upper flanks. To 90 cm.

P. elongatus (Bowdich, 1825). Head large, mouth oblique, anal spine very strong, resembles first species listed but stronger and does not lose scales and has more elongated caudal. To 42 cm.

P. epipercus Bleeker, 1863. Snout slightly overhangs mouth, anal spine strong, greyish-brown colouration, black spots along base of dorsal fin. To 38 cm.

P. moori Günther, 1865. Snout prominent rounded, mouth ventral, anal spine weak, uniform dark purple-brown colouration. To 40 cm.

Pentheroscion mbizi (Poll, 1950). Head and eyes large, black interior to mouth, body soft, 11 hard dorsal spines. To 32 cm. Habitat deep water, sub-thermocline.

Miracorvina angolensis (Norman, 1935). Head large, eyes large, resembles previous species but no black within mouth and 10 hard dorsal spines. Deep water, Angola to Congo.

1.22 Taxonomic status

The taxonomic status of the three species is little understood, and there are no breeding data and little information on geographical morphological races, though see 1.31.

1.23 Subspecies

None described, but see 1.31.

1.24 Standard common names, vernacular names

Common names in relevant European languages and in the languages of the coastal countries of the Gulf of Guinea seaboard are set out in Table I; these are based on a

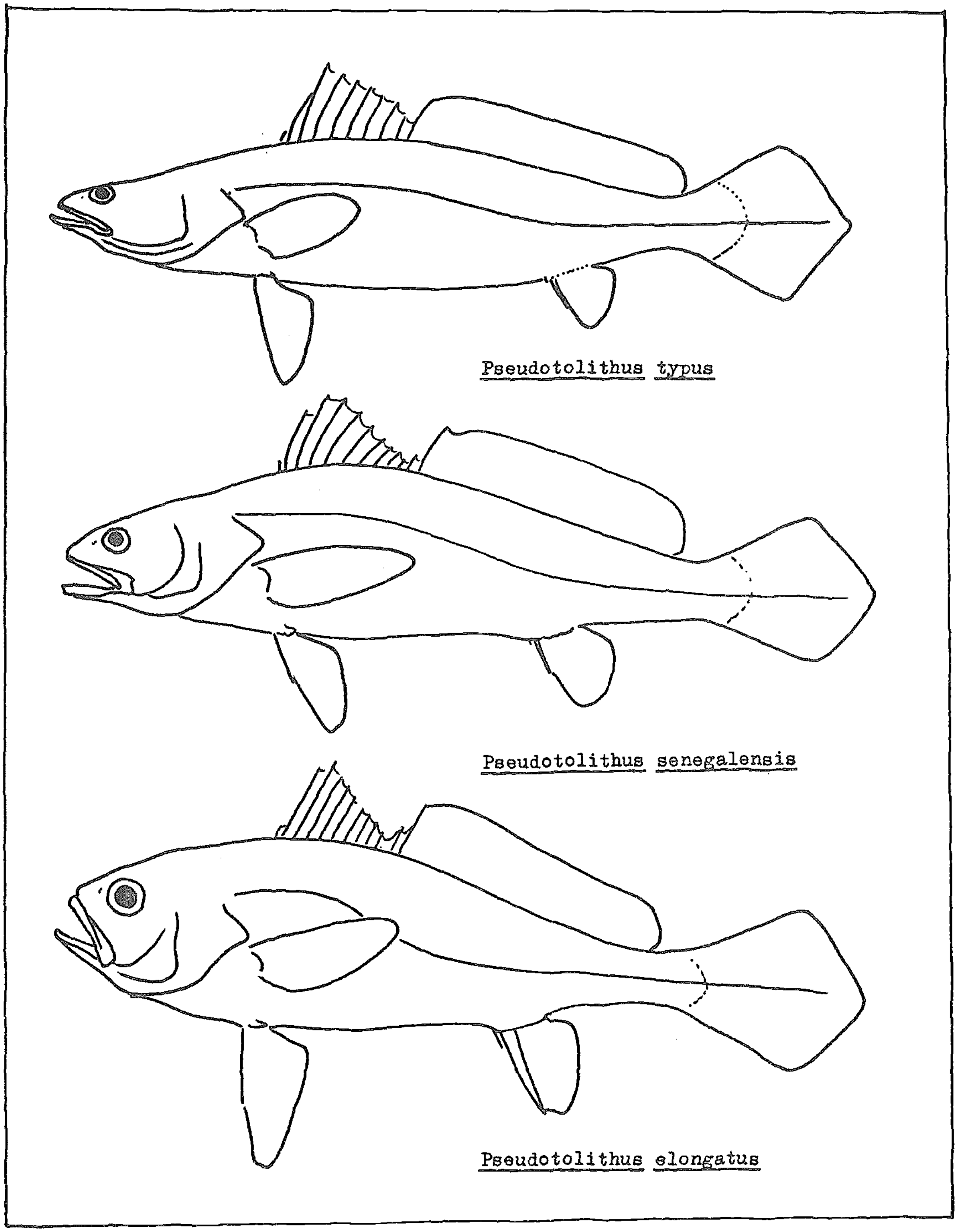

Fig. 1 Outline drawings of the three species of *Pseudotolithus* under review.

TABLE I

Names in common use in various countries, in both local and European languages used by local fishermen

	P. senegalensis	P. typus	P. elongatus
Mauretania	Melusa	-	-
Senegal			
Lebou	Nguku	Tunun	
Wollof	Law	Foto, Fetteu	Khal
Mandingo		Bosoro	Dioto
(Fowler)	Tabasé	Laborjh	Egojh
Casamance			
Mandingo		Tabasé	
Guinea			
Conakry	Soso Bofu Futu Buka	Konkuyé	Bobo firé Boboé
Ivory Coast			
Abidjan	L'ombrine	L'ombrine	Bobou, bobo
Sierra Leone			
Temne	Lady		
Sherbro	Sus		Tul
Creole and English	Ladyfish	Longneck	Gwangwa
Ghana			
Ga	Ekan, Nkantia	Nkantatfa	Nkanle, Dale
Fante	Ekan	Kampu	
Axim	Akan, Ekanye, Ekan		
Ewe	Notsa		
Adanme			Afe
English	Cassava	Cassava	
Nigeria			
Ilaje (Lagos Yoruba)	Apo	Apo	Awo
Efik	Oniok	Oniok	Oniok
Okrika	Gbun	Gbun	Ona
Kalabari	Gbu	Gbu	Ana
Bonny	Ngbu	Ngbu	Ana
Western Ijaw			Ona
Urhobo	Okhovo	Okhovo	Okhovo
English	Croaker	Croaker	
Cameroons			
Doula		Nendi ma souga	Nendi
Bakoko		Mboki	
Malimba		Nendi ma houga	Nendé
Batanga		Epu a moé (j); Moe njomolad	Nendé, Nent
Yassa		Epui ja wei (j); Njomo	Nindi
Bassek			Nendi
Soubou			Nendi
Bas Congo	Makalala	Bilaudo	
French	Le maigre Le bar	Le maigre Le bar royal	Le bossu

number of sources, chiefly the following: Cadenat (1950); Irvine (1947); Fowler (1936); Anon (1958); MacLaren (1948); Aggo (pers.comm.). The English names given in the table are those in use in the countries concerned; the best formal equivalents, if such have any value, are those given to similar forms on the Atlantic coast of North America, since in general Sciaenidae are not known around Britain, and these terms appear to be weakfish or croaker. There is no value in coining artificially formal English names as did Irvine (1947) for instance. The same problems do not occur in France, where le maigre is an established term for Sciaenidae similar in appearance to those considered here.

1.3 Morphology

1.31 External morphology

Biometric studies have been completed on two populations of each of the two species P. senegalensis and P. typus; Collignon (1960) studied these species at Pointe-Noire, while Bayagbona (1963) studied the population off Lagos. Unpublished studies by Stauch on the stocks of the Bight of Biafra are referred to by Crosnier (1964). No biometric studies are known on stocks of P. elongatus.

The variation in some meristic characters is shown in Bayagbona's data for western Nigerian stocks:

P. senegalensis

Vertebrae, urostyle included ...26 (n = 122)

Soft dorsal fin rays

Rays	Frequency	%
28	2	0.57
29	8	2.29
30	95	27.14
31	170	48.57
32	72	20.57
33	3	0.86

Mean = 30.89
Mode = 31

P. typus

Vertebrae, urostyle included ...26 (n = 125)

Soft dorsal fin rays

Rays	Frequency	%
29	11	3.47
30	54	17.03
31	144	45.43
32	94	29.65
33	14	4.42

Mean = 31.145
Mode = 31

The number of hard, spinous rays in the dorsal is almost constant at 10 in P. typus and 11 in P. senegalensis; bionomic studies at Lagos involved the handling of 147,918 specimens of these two species (Longhurst, 1964a) during which examination was made of this character to check identification on a very high percentage of specimens; only a single fish was anomalous - this being an apparent P. senegalensis having only 10 hard spines.

The two species have rather different body dimensions, P. typus being the longer species, having a lower depth/length ratio; however, Bayagbona (1963) shows that the variation in the two species is such that the extremes overlap - hence the reason for the small number of specimens which are puzzling to the eye and in which numerical characters must be checked to ensure accurate identification. These data of body depth as percentage of total length are given below:

P. senegalensis	24.6 ± 3.0	i.e. 21.6-27.6
P. typus	21.8 ± 2.5	i.e. 19.3-23.3

Some observations by Bayagbona (Nigeria, 1961) indicate the extent to which variation in morphometric characters in preserved specimens can be related to the same measurements in fresh specimens; the results indicated that if great care is taken during the preservation, in particular in ensuring that the snout region does not dry and shrink and that the abdominal cavity is injected with formaldehyde, there is no significant difference between fresh measurements of the main characters when fresh and after 19 days in 4% formaldehyde.

Geographical variation

The biometric study by Bayagbona (1963) on the stocks of P. typus and P. senegalensis off Lagos included a comparison of his results with those of Collignon (1960) on the stocks off the Congo mouth; the methods used in the two studies were compatible. Bayagbona showed that the regression coefficients obtained from the two stocks for most of the investigated characters were very close; small differences in the coefficients for some characters were, however, demonstrated, and these are shown in Table II.

Bayagbona (1963) suggests that these minor differences are insufficient to demonstrate on biometric grounds that two stock units are involved: he suggests that in at least some of the characters the observed differences may be due to the different size-ranges of specimens in his and in Collignon's samples and shows that if this is taken into consideration in, for instance, the length of the ventral fin then the values of the regression coefficients are very close from the 2 areas.

TABLE II

Values of biometric indices for various characters for the Nigerian and Congo stocks respectively to illustrate the characters in which the stocks differ most from each other (Bayagbona, 1963)

Pseudotolithus senegalensis:

Character	Pointe-Noire (Collignon)	Lagos (Bayagbona)
Length of head Pre-dorsal distance	LG = 0.29 LS LD = 0.325 LS	LG = 0.277 LS LD = 0.34 LS

Pseudotolithus typus:

Character	Pointe-Noire (Collignon)	Lagos (Bayagbona)
Ventral fin length	(a) $Vh = .32\ LS^{.9}$ $LT \leqslant 40$ cm (b) $Vh = .64\ LS^{.8}$ $LT \geqslant 40$ cm	(a) $Vh = .13\ LS^{1.07}$ $LT < 215$ mm (b) $Vh = .53\ LS^{.81}$ $LT \geqslant 215$ mm
Maxilla	$LJ = .47\ LG^{.97}$	(a) $LJ = .52\ LG^{.97}$ $LT < 575$ mm (b) $LJ = .925\ LG^{.85}$ $LT > 575$ mm
Orbital diameter	$OO' = .28\ LG^{.85}$	(a) $OO' = .28\ LG^{.85}$ $LT < 245$ mm (b) $OO' = .12\ LG^{.63}$ $LT > 245$ mm

However, despite this demonstration of the similarity in the Congolese and Western Nigerian stocks, there is considerable evidence that a stock unit, chiefly characterised by the small size of the individuals, occupies the Bight of Biafra between the Rio del Rey and the Rio Muni; the existence of this population has been known to trawler skippers for many years.

The three recent trawling surveys in the Gulf of Guinea confirm the existence of this stock; Tables III and IV show the data on the length frequency distribution of the populations of Pseudotolithus typus and P. senegalensis from GTS, from the Nigerian survey (Longhurst, 1965) and from the Cameroun survey (Crosnier, 1964). Such data must be used with caution, for they include both exploited and non-exploited stocks for comparison; in particular, the heavily exploited stocks off Western Nigeria have been shown to have a trend towards reduction of the percentage of large croakers during recent years (5.41) and these are adjacent to the little-exploited, small-fish stocks of the Bight of Biafra. The effects of exploitation on any stocks will include a reduction in the relative number of large fish and this will tend to reduce the natural difference between the Bight of Biafra stocks and the others in the tables of length frequency distributions.

In this tabulation of the data the small-fish area is distinguished by a high percentage of fish in the length range 10-30 cm and by a low percentage of fish above that length; this is true for both species. The GTS and the Nigerian data indicate that the whole area of the continental shelf off the Niger Delta as well as the Bight of Baifra proper is occupied by stocks of fish smaller than those to the west or to the south of this area. The Nigerian data show particularly clearly the change in length composition in the population, especially of P. senegalensis, at the junction of the Niger Delta with the non-deltaic coast to the west, in the region of Igbosheri; these data indicate that in this species there are two stages in the reduction

TABLE III

Length frequency distributions for P. typus from various sources to demonstrate small-fish area(s) in Bight of Biafra; data are percentages and are of total length (LT)

LT cm

	Area		<10	10-19	20-29	30-39	40-49	>50	N	Eastern boundary of each area
GTS I	1			1.3	25.8	49.7	23.1	1.1	298	Sherbro R.
	2			15.1	66.4	16.4	1.3	0.3	596	C. Palmas
	3			37.6	52.7	7.7	0.6	1.2	311	Sekondi
	4			14.7	75.1	10.2	-	-	225	C. St. Paul
	5			1.3	8.9	32.9	10.1	46.8	79	Lagos
	6a	S		47.7	29.2	17.4	2.2	3.4	1658	Kulama R.
	6b	S		28.5	59.5	8.6	1.3	-	1345	Douala
	7			-	-	-	-	-	-	C. Lopez
	8			4.2	44.3	32.3	15.5	3.2	994	Congo R.
GTS II	1									
	2			5.7	32.8	30.0	24.2	7.1	70	as above
	3			-	-	-	-	-		
	4			-	-	-	-	-		
	5				16.2	54.8	17.7	11.3	62	
	6a	S		19.8	72.4	6.2	1.1	0.5	373	
	6b	S		23.0	61.1	14.5	1.1	0.5	352	
	7			-	-	-	-	-		
	8			0.5	7.8	30.8	45.2	15.8	500	
FFS	I			26.1	56.5	10.2	5.6	2.8	69	Lagos
	II			4.3	41.3	39.4	8.7	4.3	46	Igbosheri
	III	S		37.9	45.2	12.5	0.5	0.0	749	Benin R.
	IV	S		32.1	60.7	5.9	0.5	0.0	813	Kulama R.
	V			16.8	31.1	41.2	10.1	0.7	885	Opobo R.
	VI	S		51.9	43.8	5.9	0.1	0.0	331	Fernando Po
ORSTOM	-	S		21.0	62.9	15.5	0.6	0.0	1633	Muni R.

in average size, for a further reduction occurs in Nigerian area VI to the east of Opobo and between Fernando Po and the mainland, where more than 40% of the individuals were less than 20 cm in length. The correspondence between the length frequency distribution of the population found by the Nigerian survey in this area and that found by the ORSTOM Cameroun survey in the areas immediately to the east is very close.

Bayagbona (in Nigeria, 1961) found that a small sample of 25 individuals taken at Opobo was indistinguishable on meristic or morphological grounds from specimens from the population off Western Nigeria; he has found also (pers. comm.) for both P. senegalensis and P. typus that patterns obtained from electrophoresis of blood haemoglobins are identical between the two same populations; on the other hand, Crosnier (1964) states that the Bight of Biafra populations can be distinguished on morphological grounds from neighbouring populations and may be considered to be local geographical sub-species. It seems possible that these apparent contradictions may be a consequence of the complex situation revealed by the Nigerian data for P. senegalensis; the large-fish stock of the coast to the west of the Niger Delta and those off the delta itself may belong to the same stock-unit, despite the small size of the individuals off the Delta, while in the Bight of Biafra the stock of very small fish may represent a discrete unit.

Outside the Nigerian-Cameroun area the populations of both species are rather uniform in length composition from one area to another; the Congo population appears to be very similar in size of individual to those between Nigeria and Senegal.

TABLE IV

Length frequency distributions for Pseudotolithus senegalensis from various sources to demonstrate small-fish area(s) in Bight of Biafra; data are percentages and are of total length (LT)

LT cm

	Area		<10	10-19	20-29	30-39	40-49	>50	N	Eastern boundaries of areas
										Roxo
GTS I	1		-	5.1	38.6	47.9	8.4	-	941	Sherbro
	2		-	27.4	50.4	19.1	3.1	0.1	5631	Palmas
	3		-	7.9	24.0	39.2	25.7	2.8	632	Sekondi
	4		-	27.6	57.5	20.0	1.5	-	1107	St. Paul
	5		-	6.9	43.5	41.6	7.7	0.2	1566	Lagos
	6a	S	0.1	27.1	51.3	20.7	1.1	-	4981	Kulama
	6b	S	-	22.0	58.4	19.0	0.6	-	2848	Duala
	7	S	-	0.3	83.9	15.2	0.4	-	845	Lopez
	8		-	5.8	23.7	57.4	9.9	0.4	8346	Congo
GTS II	1		-	-	15.9	62.0	21.9	0.1	1547	
	2		-	6.3	15.3	69.5	15.2	0.1	2253	
	3		-	-	14.8	45.8	31.4	6.9	229	
	4		-	-	-	-	-	-		
	5		-	-	8.8	76.5	14.7	-	68	as above
	6a	S	-	22.7	66.6	11.4	0.3	-	4805	
	6b	S	-	38.4	57.0	4.4	0.1	-	2602	
	7	S	-	14.3	67.2	17.1	1.4	-	720	
	8		-	6.5	44.9	39.9	9.3	0.7	6565	
FFS	I			17.0	34.7	41.5	9.4	-	615	Lagos
	II			5.0	41.0	48.5	3.2	-	431	Igbosheri
	III	S		25.1	63.4	9.7	0.3	-	2327	Benin
	IV	S		33.5	59.4	4.4	0.1	-	2367	Kulama
	V	S		14.1	74.2	8.4	0.5		717	Opobo
	VI	S		41.8	54.9	4.0	-	-	324	Fernando Po
ORSTOM	-	S	-	30.6	57.8	10.4	1.2	-	968	Fernando Po Rio Muni

Allometric growth

Considerable change in form occurs between the generalised sciaenid larval form and the adult, particularly with regard to the relative size of head and of some of the fins; a simple inspection shows that, compared with the adult the sciaenid larva (Fig.2) has a very large head and a very long caudal fin. In these characters, P. elongatus retains the larval form with rather little modification in the adult.

In Tables V and VI are given the regression coefficients derived by Bayagbona (1963) for P. senegalensis and P. typus for those morphometric characters which he investigated on the population off Western Nigeria; this shows that the majority of the characters grow allometrically, the major exceptions being certain proportions of the body itself. Bayagbona restricted himself to specimens larger than 60 mm in the case of P. senegalensis and 72 mm in P. typus, so that his smallest specimens were considerably larger than the larval forms figured here, and consequently the very strong allometry which must occur in the growth of the head, for instance, in the larval forms was not demonstrated.

It can be seen from these tabulated data that in a number of the characters a break in the growth occurs at a standard length of between 20 and 25 cm, and this is thought to be indicative of the attainment of first maturity.

1.33 Protein specificity

Only the unpublished work of Bayagbona, referred to above, on the electrophoretic patterns of blood haemoglobin is known. It is to be hoped that serological studies can be undertaken to determine stock-units now that the techniques are available.

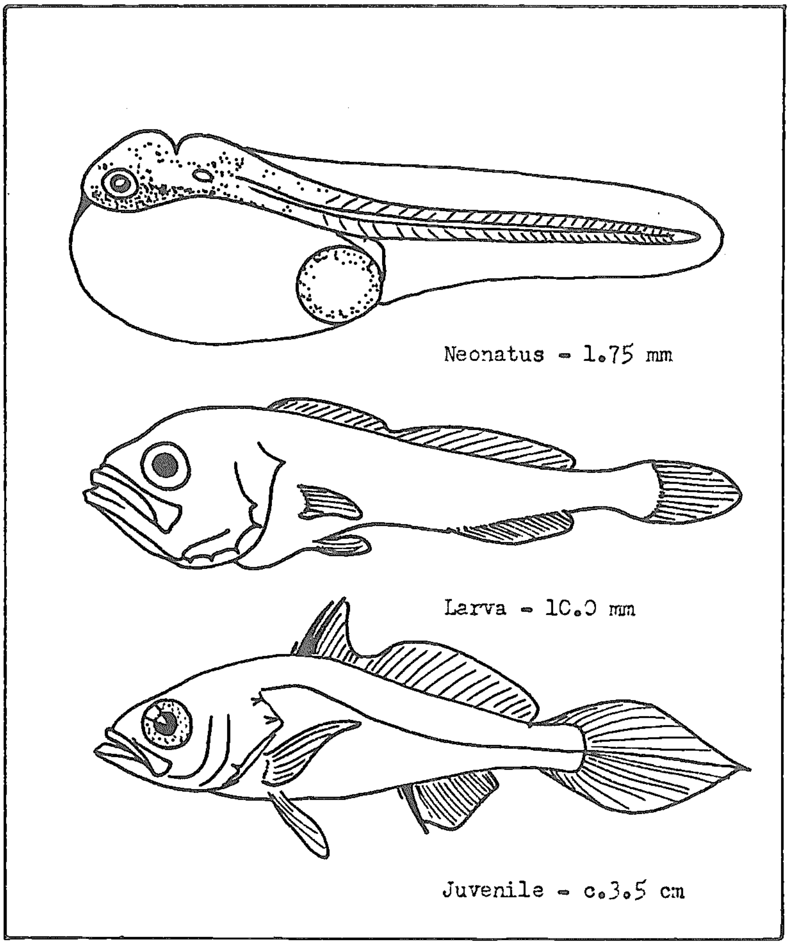

Fig. 2 Generalised form of the Sciaenid neonatus, early larva and early juvenile.

TABLE V

Allometric characters: equations relating them to the standard lengths, and their biometric indices. (Modified from Bayagbona, 1963)

i) Pseudotolithus senegalensis

Allometric Characters	Regression Equation	Type of Allo-metry*	Rise and fall of mean indices	Variation ±
Total length ...	$LT = 1.3\ LS^{.94}$	-	135 (LT = 88 mm) to 122 (LT = 430mm)	1
Pre-anal distance	$LA = .59\ LS^{1.034}$	+	68.2(LT = 90 mm) to 72.1 (LT = 430mm)	1
Pectoral fin length	$Ph = .11\ LS^{1.15}$ LT<230mm	+	21.3(LT = 90 mm) to 25 (LT = 230mm)	1
	$Ph = .63\ LS^{.83}$ LT>230mm	-	25 (LT = 230mm) to 24.4 (LT = 430mm)	1
Ventral fin length	$Vh = .19\ LS^{1.003}$ LT<230mm	+	18.9(LT = 90 mm) to 19.2 (LT = 230mm)	1
	$Vh = .3\ LS^{.91}$ LT>230mm	-	19.2(LT = 230mm) to 17.2 (LT = 430mm)	1
Pre-orbital (snout) distance ...	$LO = .16\ LS^{1.08}$	+	19.4(LT = 90 mm) to 22.8 (LT = 430mm)	1.1
Diameter of the eye	$OO' = .53\ LG^{.72}$	-	22 (LT = 90 mm) to 14.5 (LT = 430mm)	1
Inter-orbital distance	$OO = 3.1\ LG^{.83}$ LT<163mm	-	18.8(LT = 90 mm) to 17.2 (LT = 163mm)	1.1
	$OO = .16\ LG^{1.026}$ LT>163mm	+	17.2(LT = 163mm) to 17.7 (LT = 430mm)	1.1

ii) Pseudotolithus typus

Allometric Characters	Regression Equation	Type of Allo-metry*	Rise and fall of mean indices	Variation ±
Total length ...	$LT = 1.7\ LS^{.94}$	-	133 (LT = 102mm) to 115.8 (LT = 846mm)	1.2
Length of head ...	$LG = .315\ LS^{.96}$	-	27.1(LT = 102mm) to 24.7 (LT = 846mm)	.3
Pre-anal distance	$LA = .62\ LS^{1.02}$	+	70 (LT = 102mm) to 73.2 (LT = 846mm)	.5
Pectoral fin length	$Ph = .89\ LS^{1.04}$ LT<215mm	+	19.6(LT = 102mm) to 20.3 (LT = 215mm)	.2
	$Ph = .54\ LS^{.82}$ LT>215mm	-	20.3(LT = 215mm) to 16.4 (LT = 846mm)	.2
Ventral fin length	$Vh = .13\ LS^{1.07}$ LT<215mm	+	18.3(LT = 102mm) to 18.9 (LT = 215mm)	.5
	$Vh = .53\ LS^{.81}$ LT>215mm	-	18.9(LT = 215mm) to 14.75 (LT = 846mm)	.5
Pre-orbital distance	$LO = .17\ LG^{1.07}$	+	21.7(LT = 102mm) to 26.5 (LT = 846mm)	1.4
Diameter of the eye	$OO' = .28\ LG^{.85}$ LT<245mm	-	19 (LT = 102mm) to 15.3 (LT = 245mm)	1
	$OO' = .12\ LG^{.63}$ LT>245mm	-	15.3(LT = 245mm) to 8.8 (LT = 846mm)	1
Inter-orbital distance	$OO = .39\ LG^{.71}$ LT<245mm	-	16 (LT = 102mm) to 12 (LT = 245mm)	1
	$OO = .15\ LG^{.94}$ LT< 245mm	-	12 (LT = 245mm) to 11.4 (LT = 846mm)	1
Maxilla length ...	$LJ = .52\ LG^{.97}$ LT>575mm	-	46.4(LT = 102mm) to 45.3 (LT = 575mm)	1
	$LJ = .925\ LG^{.85}$ LT<575mm	-	45.3(LT = 575mm) to 42.8 (LT = 846mm)	1

* - means negative allometry, and + means positive allometry. Variation ± = variation about the mean biometric index.

TABLE VI

Isometric characters: equations relating them to the standard lengths, and their biometric indices. (Modified from Bayagbona, 1963)

i) Pseudotolithus senegalensis

Isometric Characters	Regression Equation	Mean Index	Variation ± (Mean)
Body depth	H = 0.246 LS	24.6	3.0
Length of head	LG = 0.277 LS	28	1.0
Pre-dorsal distance ...	LD = 0.34 LS	33.65	1.5
Pre-ventral distance ...	LV = 0.31 LS	31	1.5
Peduncle depth	φ = 0.077 LS	7.7	0.6
Maxilla length	LJ = 0.45 LG	45.5	2.0

Variation ± (mean) = variation about the mean index expressed as plus or minus.

ii) Pseudotolithus typus

Isometric Characters	Regression Equation	Mean Index	Variation ±
Body depth	H = .208 LS	20.8	2.5
Pre-dorsal distance ...	LD = .327 LS	32.7	1
Pre-ventral distance ...	LV = .295 LS	29.5	1.3
Peduncle depth	φ = .068 LS	6.8	0.6

2 DISTRIBUTION

2.1 Total area

With only two exceptions, the species of the Tribe Pseudotolithini occur in the eastern Atlantic along that part of the African coast which is under the influence of the Equatorial Counter-Current, known in this ocean as the Guinea Current; to the north and south of this area, and below the wind-mixed homogenous layer of tropical surface water, other Sciaenidae occur but do not enter the habitat occupied by the Pseudotolithini.

The three species reviewed here have typical Pseudotlithine distribution patterns and appear to occupy all suitable habitats the length of the African coast from 21°N (Cap Blanco) to 13°S (Baie des Elephants).

P. elongatus has not been recorded north of the mouth of the Senegal River at St. Louis or south of the mouth of the River Congo (Boulenger, 1915; Poll, 1959) and these two rivers may well be the normal extremes of the latitudinal range of this brackish water species (2.3 below). In the south, the best data on the limits of the range of the other two species come from the surveys of the trawler NOORDENDE III (Poll, 1954) and show that south of the Congo mouth, where both are very abundant and occur in a high proportion of the shallow hauls, the data indicate the existence only of isolated stocks extending as far south as the Baie des Elephants, at 13°S.

In the north, there is no single survey which has provided data from which to determine the northern limit of the species' range, but isolated records in the literature indicate that P. typus occurs at times as far north as the Baie du Levrier (Pellegrin, 1905; Metzelaar, 1919; Chabanaud and Monod, 1926) and occasionally as far as Morocco (Postel, 1959; 1960), while P. senegalensis does not appear to have been recorded north of St. Louis in Senegal (Boulenger, 1915; Arnoux, 1957).

Within these latitudinal limits the distribution of all three species is limited to the shallow water of the continental shelf; in Table VII the data from the GTS survey show that the bulk of the records for both P. senegalensis and P. typus occurred in less than 50 m of water, and that there were no records deeper than this for P. typus for which species the majority of occurrences were in water of less than 30 m deep.

The continental shelf on the tropical west African coast is generally rather narrow and the 50 m contour is within 10 miles or even less of the beach; only on the Great Jeba Flat at the southern end of the Senegal shelf is there a wide expanse of shallow shelf and here the 50 m contour is about 30 miles from the coast.

These two limits to the distribution of the species, latitudinal and bathymetric, render the area of distribution narrowly linear; perhaps an average of 10 miles wide along a stretch of coastline about 4,000 miles long.

2.2 Differential distribution

2.21 Spawn, larvae and juveniles

So far there has been no definite identification of ova or juveniles (see 3.2) and nothing is known of their distribution save that ova and larvae of Sciaenidae, apparently of the genus under review, are abundant on the Lagos trawling grounds in mixed-layer plankton hauls, especially during the dry season (Eziuzo, pers. comm.) and there is no reason to suppose that special spawning grounds occur over which the ova and larvae would be especially abundant.

In fact, larvae of P. senegalensis and P. typus of from a few mm to a few cm long can be taken on the trawling grounds off Lagos during the dry season, while larvae of P. elongatus can be taken on the bottom of the Sierra Leone estuary along with the adults; larvae of this last species may be taken far up the river systems (to Rokupr in the Scarcies River, for instance, during the dry season) and this is the only evidence known to the writer of any differential distribution between adults and juveniles for any of the three species.

2.22 Adults

Within the main area of distribution, between but not including the northern and southern oceanographic transitional zones, there is very little evidence to show the existence of seasonal movements or migrations, although spawning movements of limited extent may occur, as Lowe (1962) has shown for similar croakers in the western tropical Atlantic where she found that spawning fish only occur very close inshore, generally in untrawlably shallow water; observational evidence at Lagos suggests that the same may occur there since it is very rare to find a fish on the point of spawning in the trawl catches and it is possible that the increased percentage of adult females present on the trawling grounds during the rainy season (at which time breeding is at a minimum) may represent the effect of an offshore movement of resting females. This is to an extent supported by the daily observations at Victoria Beach, Lagos, by Dowson (MacLaren, 1949, and unpublished diary in FFS library) who showed a very clear cycle in the catches of croakers in the beach seines in which high catches between November and April correspond approximately to the normal period of peak spawning (see 3.16).

There is also some evidence from the daily catches on the trawling grounds off Lagos of a comparable movement of the two species which tend to be found in brackish water; during the rainly season there appear in the trawl catches for a few days at a time unusual numbers of unusually large individuals of P. elongatus and P. typus together with other estuarine organisms, including various crustacea, not normally taken in the trawl on the open shelf except at this season. Such movements are a result to be expected from the very strongly fluctuating salinity and turbidity regime in estuaries along this coast of high tropical rainfall.

In the oceanographic transitional areas to the north and south of the equatorial area the variation between a winter and summer temperature regime induces annual migrations of at least P. typus and P. senegalensis, and more especially of the latter species; Collignon (1960) indicates a seasonal variation in the fishery off the Congo which is dependent upon this phenomenon, so that the catch rate declines during the winter period when the temperature of the bottom water falls to about 17°C. In the northern transitional zone, off Senegal and Mauretania, the fishery similarly occurs during the summer at which time the fish appear from the south and move into shallow water of less than 10 m, at temperatures of between 18 and 28°C (Blanc, 1957; Arnoux, 1957).

2.3 Determinants of distribution

The three species are distributed somewhat differently within the total area outlined above (2.1): P. elongatus is an estuarine species, being taken on the open continental shelf only during the height of rainy seasons except in areas where estuarine conditions occur throughout the year; P. typus is a species occurring commonly both in estuaries and lagoons and also on the open shelf throughout the year; P. senegalensis is a species of the open shelf, almost never enters estuarine systems, and occurs deeper than either of the two other species. Thus within the mixed layer water above the permanent thermocline, forming the Tropical Surface Water, the environmental parameters of deposit, salinity, temperature, oxygen, turbidity and biological associations (which are those which have been measured in ecological work on these species) have different significances for each species. However, in general it can be said that all three are relatively euryhaline, stenothermic, and occur on deposit substrata of muddy rather than sandy composition.

TABLE VII

Frequency distribution of depths of occurrence for two species during the two campaigns (GI and GII) of the Guinean Trawling Survey

	P. senegalensis			P. typus		
Depth (m)	GI	GII	Σ	GI	GII	Σ
0-5	-	-	-			
6-10	1	-	1	1		1
11-15	15	5	20	15	2	17
16-20	8	22	30	6	11	17
21-25	8	3	11	4	1	5
26-30	24	19	53	8	3	11
31-35	1	9	10	-	-	-
36-40	17	11	28	5	2	7
41-45	3	4	7	1	1	2
46-50	11	6	17	1	1	2
51-55	1	-	1			
56-60	-	-	-			
61-65	-	-	-			
66-70	3	-	3			
71-75	1	1	2			
Range	GI 10-72 m GII 15-72 m			GI 10-48 m GII 15-50 m		

The occurrence of P. elongatus in estuarine conditions along the tropical coast is indicated by the following references: Senegal (Cadenat, 1950); Sierra Leone (Longhurst, 1963); Ghana (Irvine, 1947); Nigeria (Boesman, 1963); Dahomey (Gras, 1961); Cameroon (Collignon et al., 1957) and Congo (Poll, 1954). Within the estuarine regions the mosaic of environmental parameters is of very small scale and no direct investigations have been made on their effect on the distribution of the species. It is only possible to say that it occurs in the areas of soft deposits, rather than on stony or sand scours in estuaries, and extends rather high up the estuarine systems - the juveniles referred to in section 2.21 being taken in water of about 1-3 parts per mille salinity. In the Sierra Leone estuary in which the species is regularly fished Watts (1958) has shown that the bottom water has the following characteristics:

Dry season: 22-32 °/oo salinity
27-28°C temperature
Wet season: 9-26 °/oo salinity
27°C temperature

The species extends on to the continental shelf whenever estuarine conditions themselves extend beyond river mouths; in Sierra Leone the opening of a number of rivers on to the shelf within a few miles of each other, and the very heavy run-off from the high precipitation causes soft mud and brackish, turbid water over much of the area around Sherbro Island, Yawri Bay and the Melakori flats, and here the trawler landing statistics show that P. elongatus is regularly a significant part of the landings; similar conditions and the occurrence of this species at sea may be expected in such areas as the Bissagos Islands to the north of Guinea, and in the Bight of Biafra.

The distribution of P. typus and P. senegalensis on the open shelf in relation to environmental parameters has been directly investigated a number of times and more satisfactory data are available than for the preceding species.

Deposit type. In general, muddy deposits are preferred over sandy or corally substrata; this is shown in the eastern Gulf by the data from the ORSTOM survey (Crosnier, 1964) and by Poll (1954), and for the western Gulf by the WAFRI surveys (Longhurst, 1963), the charts of which indicate the correspondence between the distribution of the two species and that of muddy deposits. In Tables VIII and IX are set out the quantitative data from the FFS and GTS surveys, and these again show clearly the restriction to muddy deposits. Also shown is the apparent avoidance of the very soft reducing muds frequently encountered in the eastern Gulf of Guinea.

Temperature. The distribution of these two species in the Gulf of Guinea appears to be restricted to water warmer than about 17-19°C; in the western Gulf, the WAFRI surveys showed that P. senegalensis occurred down to 17.5°C, while off the coast of Nigeria the FFS surveys indicated the 19°C isotherm as the lower limiting temperature. The most comprehensive data, those from GTS, show P. typus to be limited to temperatures above 18.0°C, and P. senegalensis above 16°C (Tables VIII and IX). GTS data show that over most of the tropical coastline the latter species was limited by the 18°C isotherm and in only a restricted area off the Western Niger delta, and only during one cruise of the two made, did the bottom water temperature fall to 16°C at stations at which P. senegalensis occurred.

In the Gulf of Guinea the Tropical Surface Water is bounded below and to the north and south by temperatures very close to those discussed above; the 18°C isotherm is commonly associated with the base of the thermocline which separates the mixed layer of the tropical surface water from the colder deep water, and is commonly incorporated in the cold side of the frontal region which separates the tropical surface water from the water of the eastern boundary currents to the north and south. On those occasions when the lower limit of the distribution of these species has been investigated directly and with reference to bathythermograms it has been found within the tropical areas that the lower limit of distribution is in fact coincident with the base of the permanent thermocline. The situation at the oceanographic transition zones is more complex; for instance, off the Gambia River the WAFRI surveys indicated that the limiting depth (and hence lowest temperature) was above that of the thermocline, but even so, it was close to those indicated above, since the thermocline incorporated a different and lower fasces of isotherms. The data referred to in section 2.2 indicate that the latitudinal migrations in these areas may be related to the apparent migration of isotherms at about 17-18°C.

Salinity. Data on the salinity of bottom water at stations at which P. senegalensis and P. typus occur is available only for the FFS and GTS surveys (Table VIII) and these indicate the extent of the range; within the tropical surface water there is considerable dilution of the mixed layer, particularly in the Sierra Leone-Liberia and in the Biafra-Congo sectors, and this is reflected in the data from both surveys.

From the distribution of salinity in the water column it is unlikely that this parameter plays any role in determining bathymetric limits, for though a salinity maximum occurs in the thermocline, the difference between thermocline salinities and those below are so small as to be negligible in comparison with the difference between thermocline and mixed layer salinities.

Oxygen. It has been suggested (FAO, 1963), but not confirmed observationally, that the oxygen content of the bottom water in the Gulf of Guinea may fall to values low enough to be limiting for these species, and that during coastal upwelling conditions a tongue or wedge of low-oxygen subthermocline water may obtrude across the continental shelf and drive these and other demersal species off the bottom into mid-water; this phenomenon has been observed off the Bombay coast in the Arabian Sea (Carruthers, 1959) and may very well occur off Ghana and Togo during upwelling conditions. Similarly, the very shallow thermocline in the Bight of Biafra (Longhurst, 1965) which places much of the mud deposits over the continental shelf within the influence of the immediately sub-thermocline water, may have a similar effect, and the postulated wedge of low-oxygen water in this situation may account for the vast areas of reducing mud over much of the shelf in this area. However, as Tables VIII and IX indicate, neither the GTS nor the FFS surveys confirmed these suppositions. In the GTS data the oxygen content is seen to vary inversely with depth, but is still at levels unlikely to be limiting at depths at which the occurrence of the two species is falling off rapidly.

Biome, or associated species. It is well recognised that there is an assemblage of demersal fish species in the Gulf of Guinea which occurs above the thermocline, on soft deposits, and having a distribution very similar to that described above for P. typus and P. senegalensis and which is characterised by the occurrence of Pseudotolithine sciaenids, principally these two species. This assemblage was first recognised in the descriptions by Postel (1955) of the continental shelf fauna off Guinea. Crosnier (1964) has listed three assemblages of demersal species in the Bight of Biafra of which one, the "peuplement des fonds vaseux ou sablo-vaseux baignés par des eaux chaudes et dessalées", corresponds very closely to the "Sciaenid community" described by Longhurst (1963, 1965) off Sierra Leone, Gambia and Nigeria. The objectivity of these assemblages has recently been tested and confirmed by computer analysis of the GTS data by the method of Fager and McGowan (1963) for the determination of recurrent species groups in fauna lists and station data.

Pseudotolithus elongatus does not appear in the GTS analysis since it forms part of the estuarine fauna, formalised as the "Estuarine sciaenid sub-community".

This fauna of demersal fish is the Gulf of Guinea representative of a fauna comprising the same families (dominated by Sciaenidae, Cynoglossidae, Ariidae, Polynemidae, Pomadasyidae) which occurs in tropical regions wherever there are warm mixed layer temperatures of over about 20°C, high turbidity, and soft deposits; this fauna may be traced from the southern Gulf of Mexico to the southern coast of Brazil in the western Atlantic, and in the Indo-Pacific occupies very large areas.

This fauna of demersal fish is accompanied by a number of large and characteristic mobile invertebrates: the cephalopods Sepia officinalis hierreda and Sepia ornata; the gastropods Cymbium spp; and especially the swimming crabs Callinectes gladiator and Neptunus validus. The commercially important penaeids Penaeus duorarum and Parapenaeopsis atlantica are commonly associated with the fauna, the former species usually rather deep, at or near thermocline depths, while the latter together with Callinectes latimanus are particularly associated with the estuarine sub-community.

The benthic infauna of the grounds on which the sciaenid community occurs has been investigated only off Sierra Leone and the Gambia (Longhurst, 1957a) and Ghana (Buchanan, 1954). In the western Gulf of Guinea the

TABLE VIII

Frequency distributions of occurrences of P. senegalensis according to four environmental parameters. N_1 = GTS data, N_2 = FFS data. Deposit types: PM = putrid, reducing muds; GM = green mud; SM = sandy mud; MS = muddy sand; S = sand; R = corals, rocks, reefs and other hard substrata

Bottom temp. (°C)	N_1	N_2	Bottom sal. (°/oo)	N_1	N_2	Bottom O_2 (mg/at/l)	N_1	Deposit type	N_1
16	2		27.5	2		1.4	1	PM	23
17	3		28.0	1	2	1.6	1	GM	55
18	12		28.5	1	2	1.8	1	SM	66
19	17		29.0	2	1	2.0	7	MS	24
20	20	2	29.5	-	1	2.2	9	S	16
21	27	7	30.0	3	1	2.4	11	R	1
22	23	10	30.5	2	4	2.6	7		
23	18	7	31.0	2	1	2.8	9		
24	4	7	31.5	-	5	3.0	8		
25	9	1	32.0	3	2	3.2	15		
26	17	4	32.5	2	7	3.4	17		
27	6	11	33.0	3	7	3.6	17		
28	5	8	33.5	3	4	3.8	16		
29	9	17	34.0	16	3	4.0	18		
			34.5	8	2	4.2	25		
			35.0	26	10	4.4	13		
			35.5	89	13	4.6	2		
			36.0	7	-	4.8	2		
			36.5	-	-	5.0	-		

Range GI 16.6-27.8 GI 27.75-35.75 GI 1.46-4.9
GII 17.7-29.6 GII 27.78-36.09 GII 2.06-4.87

distribution of the Amphioplus community, composed of species of Amphioplus, Ochetostoma, Sipunculus, Callianassa, Upogebia, Tellina, Cultellus and Aloidis, is distributed in a manner very similar to that of the sciaenid community. Two sub-communities have been recognised, one in the estuaries and one on the continental shelf, and each has its counterpart in the two subdivisions of the sciaenid community. This community, the Gulf of Guinea counterpart of the Amphiura communities familiar in European seas, consists mostly of soft-bodied burrowing organisms and probably has only limited significance to the three species of croakers reviewed here since these are largely predators on mobile crustacea and small fish (section 3.42).

TABLE IX

Frequency distribution of occurrences of P. typus according to four environmental parameters; deposit types as legend for Table 8

Bottom temp. (°C)	N	Bottom sal. (°/oo)	N	Bottom O_2(mg.at/l)	N
16		27.5	1	1.4	
17		28.0	1	1.6	
18	2	28.5	1	1.8	
19	5	29.0	1	2.0	1
20	8	29.5	1	2.2	1
21	8	30.0	2	2.4	4
22	8	30.5	1	2.6	1
23	5	31.0	2	2.8	4
24	2	31.5	-	3.0	2
25	1	32.0	3	3.2	2
26	9	32.5	-	3.4	11
27	5	33.0	1	3.6	8
28	1	33.5	1	3.8	9
29	5	34.0	5	4.0	8
		34.5	2	4.2	7
		35.0	8	4.4	3
		35.5	18	4.6	1
		36.0	4	4.8	1

		Temp.	Sal.	O_2
Range	G I	18.9–27.8	28.3–35.8	2.19–4.9
	G II	20.3–29.4	27.9–36.1	2.44–4.5

3 BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.11 Sexuality

All three species are bisexual, and no hermaphrodites have been recorded.

Collignon (1960) indicated that there was no external sexual dimorphism in P. senegalensis or P. typus, and this has been confirmed by Bayagbona (1963) by a study of 50 specimens of each sex of each species; the variation in the biometric indices of the characters examined within each sex was very much greater than the differences between the mean values for each sex. The differences between the sexes were statistically insignificant.

3.12 Maturity

The size at which sexual maturity is attained has been determined in these species by two methods; in the first, the values of the biometric indices during growth have been studies by Bayagbona (1963) and the observed change in the values of several of these has been taken as confirmation of the more direct method of examination of gonad stages in a population throughout a year (Longhurst, 1964); there is good agreement between the two methods. It must be remembered that attainment of maturity is not a knife-edge process but extends over a period of time and over a size range within a single brood of fishes, and the value of L_m, the length at which first maturity is attained, should be qualified as being at the 1%, 10% or 50% level.

The values obtained for L_m at various levels for P. elongatus in the Sierra Leone river and for P. typus and P. senegalensis off Nigeria and the Congo are given in the following tabulation:

L_m	1%	10%	50% (LT cm)
P. elongatus	19.0	24.0	32.6
P. typus	30.0	38.0	48.3
P. senegalensis	22.0	25.0	35.0(Nigeria)
P. senegalensis	-	24.5	28.0 (Congo)

The changes in the values of biometric indices for various fin lengths and for orbital diameter in the latter two species occurs at lengths corresponding with L_m between the 1% and 10% levels. There are no data presently available to indicate whether the spread in lengths at L_m at each level is due to the process lasting for some while in individual fish or whether to the range in lengths-for-age in a brood which attain maturity at comparable ages but different lengths. Current work on otolith growth marks may clarify this (see section 3.43).

3.13 Mating

By analogy with what is known for other warm-water sciaenids (e.g. Hildebrand and Cable, 1934) this may be presumed to be promiscuous.

3.14 Fertilisation

Presumably external.

3.15 Gonads

The only available data are from a very small number of manual counts on P. typus and P. senegalensis at Lagos (unpublished) and on P. elongatus at Freetown (Longhurst, 1963) which gave the following results:

P. typus (30-46 cm, N=5)......573 ova/gm body wt
P. senegalensis(43-54cm N=7)..623 ova/gm body wt
P. elongatus (N=6) .... 96 ova/gm body wt

An even smaller number of fish examined at Pointe-Noire by Collignon (1960) gave the result for P. senegalensis of 336 ova/gm body weight. Current use at Lagos of an electronic particle counter will add more useful data (Bayagbona, pers. comm.).

3.16 Spawning

It has been shown for all three species that there is a cycle in spawning intensity during the year, and that while in the tropical region ripe females occur in the population throughout the year, in the oceanographic transitional zones there may be complete cessation of spawning during the cool period of the year.

P. elongatus in the Sierra Leone River has been shown on the basis of three years observations on the gonadial stages in the population during the year to have reduced spawning activity from August to October and peak spawning from December to February, this peak corresponding with the dry season and hence (Watts, 1958) to least river effluent and highest temperatures.

The spawning cycle of the populations of P. typus and P. senegalensis off Nigeria, based on the same type of observations, is shown in Fig. 3a together with the temperature of the mixed layer water on the trawling grounds; it can be seen that although some ripe females occurred throughout the period of the investigations there was a very clear peak spawning period in which there was a remarkable coincidence between the two species, both of which followed very closely the temperature cycle, even to following the small depression of temperature which occurs in January-February due to the reduced incident radiation at this period (Longhurst, 1964a). To compare with this type of cycle, which is

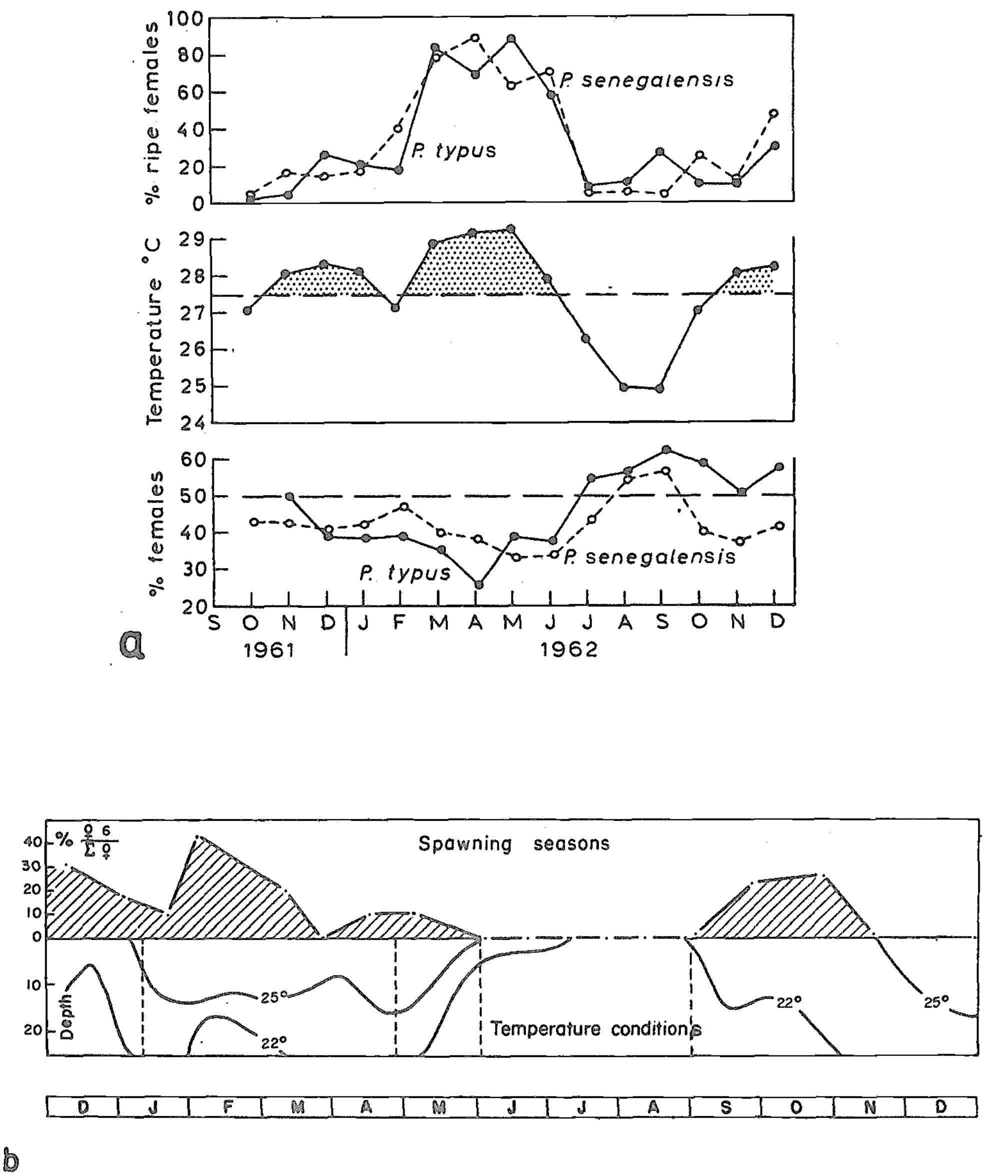

Fig. 3 a - Reproductive cycle off Lagos. Broken line = P. senegalensis, complete line = P. typus. The percentage of females over L_m at the 10% level which are ripe; the mean monthly temperature of the water above the thermocline; and the percentage of females in the landings.

b - Reproductive cycle of P. senegalensis in relation to the variations of sea temperature off Pointe-Noire (slightly modified from Troadec 1969).

probably typical of the whole intertropical region, there are data available from the southern transition zone (Collignon, 1960; Poinsard and Troadec, 1966; Troadec, 1969) which show a more complete cessation of breeding activity that occurs when the temperature of the mixed layer falls below a critical level (Fig.3b); Collignon found peak spawning in October to April when the water temperature was over 22.5°C and Poinsard and Troadec, (1966) found that during the period December to May there were high percentages of ripe females and in May to June that there were very high percentages of spent females in the Congo population. The latter authors related the cycle they described to the depth of the 25°C isotherm on the trawling grounds and showed that spawning occurred only during the periods when the bottom water on the grounds was warm. As off Nigeria, the warm period is broken by a minor cooling (though for different hydrographic reasons) and this is likewise marked by a reduction in the percentage of breeding females.

The problem of the pattern of individual spawning within the stock spawning cycle remains obscure and it is only from current studies of the growth marks on otoliths as revealed by the burnt otolith technique that any progress may be expected.

Bayagbona (1969) and Poinsard and Troadec (1966) have studied P. typus and P. senegalensis off Nigeria and the Congo respectively by means of this technique. In each area the otoliths show alternation between white opaque and dark clear zones and study of the nature of the otolith margin in each area monthly indicates that the dark zones are laid down during warm periods, and thus at the period of peak spawning, while the white zones are laid down during cool, low spawning rate periods.

There is a relationship between the environment, the spawning cycle, the condition factor cycle, and the nature of the otolith material which is laid down. In both Lagos and Pointe-Noire populations of P. senegalensis and P. typus the above authors have demonstrated a cycle in which the condition factor falls during active spawning, reaching a low value at the end of the season of spawning and then rising again during the subsequent non-spawning season to a high value just prior to the resumption of spawning; thus, falling condition factors are associated with high environmental temperatures, the spawning season and with the laying down of otolith material that darkens on heating, while conversely, rising condition factors are associated with cool temperatures, lack of spawning activity and opaque, white otolith material.

There are apparently a major pair of dark and light otolith zones corresponding to each years growth; the dark zone is frequently interrupted by a secondary light zone which represents the minor cooling around the turn of the year at both Lagos and Pointe-Noire, reflecting temporarily rising condition factors and a temporary cessation of spawning.

Bayagbona suggests that occasional fish in which the first dark zone is unusually narrow and not interrupted by a light line may have been spawned very late in the season and attain maturity only late in their first year of spawning, a fact made up for in the subsequent year by two very heavy spawnings indicated by very broad dark zones.

Poinsard and Troadec (1966) found both large white and large dark nuclei; the first they ascribe to fish spawned in the major warm season (sometimes represented by a dark nub at the centre of the nucleus) while the latter they ascribe to fish spawned at the time of the 'petit saison chaud' so that this and the following main warm season form the large dark nucleus in which the minor cooling separating the two warm seasons appears as a fine white line.

Le Guen (MS) has studied P. elongatus otoliths from Congo and Sierra Leone and finds that they follow the same pattern as described above; he finds on many individuals two dark rings on the otoliths prior to the attainment of first maturity, indicating that the effect of the environmental temperature and condition factor alone, without the act of spawning, suffices for the change from light to dark otolith material.

3.3 Adult phase, mature fish

3.31 Longevity

This is better expressed as L_{max} or T_{max} the maximum length or age in the observed population rather than as average life expectancy which is clearly very small in fish with a high rate of mortality (see 4.4).

In the case of P. elongatus the data from Sierra Leone indicate that very few fish older than three full years or larger than LT = 42 cm are found in the population; off Lagos the largest fish are of about LT = 44 cm, while off the Congo the maximum size is about the same as off Sierra Leone. Probably few fish in any of the populations investigated exceeds the T_{max} quoted above.

The values for these parameters derived from a number of sources are given in Table X.

3.32 Hardiness

All three species have proved to be very delicate and easily damaged during experimental handling; Watts (1959) in a tagging experiment off Sierra Leone on all available demersal fish taken in trawls found very high mortality during handling in all the sciaenids he tested,

TABLE X

Values for maximum length (L_{max}) and age (T_{max}) for various populations of two species of sciaenids

Locality	T_{max} (years)	L_{max} (mm)	Method	Author
P. senegalensis				
Congo	8	55	Otoliths and length frequencies	Poinsard and Troadec(1966)
Congo	-	55	Length frequency	Collignon (1957)
Lagos	5-6	66	Otoliths	Bayagbona(1969)
Lagos	5	60	Length frequency	Longhurst (1964a)
P. typus				
Congo	7	70	Otoliths and length frequencies	Poinsard and Troadec(1966)
Congo	-	63	Length frequency	Collignon (1957)
Lagos	6-7	98	Otoliths	Bayagbona(1969)
Lagos	5	93	Length frequency	Longhurst (1957)

and a very low rate of recovery of those few that were successfully marked and released, although low mortalities and reasonable recovery rates were obtained with other families. In attempting to acclimate the same species into experimental aquaria Longhurst (1963) was unsuccessful, though other families (e.g. Pomadasyidae, Polynemidae) were found to be relatively hardy.

3.4 Nutrition and growth

3.42 Food

All the evidence indicates that these three species are essentially active predators on epibenthic crustacea, principally penaeid prawns, and on fish with increasing frequency during growth.

The change in diet during growth, and the major components are shown in the tabulated data. (Table XI).

Longhurst (1957) showed that there was no demonstrable cycle of feeding intensity during the year in the Sierra Leone river in *P. elongatus.*

Soaga (MS) confirms this finding for *P. senegalensis* at Lagos, but perhaps not for *P. typus* at the same place.

3.43 Growth rate

Growth has been studied by both Petersen and otolith methods in these species and both methods give good results, though the studies have not so far progressed far enough for the results with the two methods to be finally conciliated.

The earliest studies were those of Collignon (1960) on *P. senegalensis* at Pointe-Noire by the Petersen method for a period of 19 months, and these were followed by those of Longhurst (1963, 1964) on *P. elongatus* in the Sierra Leone river and P. typus and *P. senegalensis* off Western Nigeria, these studies extending over 24-month periods.

The data presently available from all sources are tabulated in Table XII and the results appear to show disagreements of the type to be expected where different techniques have been used on different stock-units of the same species; it is too early to attempt a detailed comparison between the results of the various authors, which must await the final publication of the otolith studies. It can be remarked, however, that neither otolith study quoted above used the back-calculation method; Poinsard and Troadec aged each specimen examined by

TABLE XI

The diet of three species of Sciaenidae, based on various sources: the categorisation of crustacea in the headings is as follows: small crustacea - Mysidacea, Cumacea; natant crustacea Penaeidae, Caridea; benthic crustacea Brachyura, Anomura, Stomatopoda. Numbers are percentage occurrences in stomachs and may therefore total more than 100%

Species	N	LT cm	Small Crustacea	Natant Crustacea	Benthio Crustacea	Polychaetes	Cephalopods	Fish	Locality	Author
P. typus	50	0-10	78	18				4	Lagos	Longhurst (1964a)
	33	11-20	42	44				3		
	111	21-30	22	60			1	14		
	68	31-40	22	48			3	36		
P. typus	-	-	5	75	5			15	Congo	Collignon (1960)
P. senegalensis	61	0-10	75	11			5	5	Lagos	Longhurst (1964a)
	35	11-20	33	46				14		
	97	21-30	21	55				22		
	26	31-40	16	54				23		
P. senegalensis	-	-		40-50	10			30-40	Congo	Collignon (1960)
P. elongatus			38.1	44.5	6.0	5.4		24.6	Sierra Leone	Longhurst (1964)
			16.7	50.0				33.3	W.Africa	" "

TABLE XII

Growth rate data: all lengths as LT cm
(LF = by length frequency method; Ot = by otoliths)

		L_1	L_2	L_3	L_4	L_5	L_6	K	L_∞	Author
P. senegalensis										
Congo	LF	24.0	35.0	44.5	–	–	–	.20	–	Collignon (1960)
Nigeria	LF	29.4	39.6	44.2	46.3	47.3	–	.66	47.8	Longhurst (1964a)
Nigeria	Ot	22.3	39.8	51.5	59.8	65.7	–	.34	80.0	Bayagbona (1969)
Congo	Ot	24.5	32.7	38.8	43.0	45.3	–	.35	52.7	Troadec (1966)
Ghana	Ot	29.0	39.5	45.0	49.0	51.0	–	.44	54.0	Poinsard and Troadec (1966)
P. typus										
Nigeria	LF	30.3	41.7	48.8	53.5	56.4	–	.37	61.2	Longhurst (1963)
Nigeria	Ot	29.1	47.6	61.4	71.8	79.6	–	.29	103.0	Bayagbona (1969)
Congo	Ot	24.9	37.6	45.7	50.6	54.8	–	–		Poinsard and Troadec (1969)
P. elongatus										
Sierra Leone	LF	15.0	24.5	31.5	36.0	39.2	41.2	0.38	45.0	Longhurst (1961)
	Ot	16.1	23.9	30.9	–	–	–	0.31	46.9	Le Guen (MS)
Congo	Ot	13.0	24.0	30.0	33.0	37.5	41.0	0.37	42.0	Le Guen (unpubl.)

back-calculation from growth marks, while Bayagbona (1969) obtained mean lengths for each age group throughout periods of one year and calculated his growth parameters from these mean ages.

The data are in general agreement that P. typus, the species which attains the greatest maximum length, grows faster than the other two species, though it does not approach the asymptote of the growth curve faster and has a value of the von Bertalanffy growth coefficient close to the two smaller species. All the data are in agreement in giving a value for this parameter high relative to the values usual in demersal fish of temperate waters.

The relationship between growth in length and growth in weight, which is illustrated in Fig. 4 for some of the length frequency studies, is dependent to an extent on the seasonal variation in the condition factor of P. typus and P. senegalensis by Bayagbona and for P. elongatus by Watts (1962); the seasonal fluctuation in this index which Bayagbona (unpublished) determined in the populations off Western Nigeria shows that both species follow the same seasonal cycle in condition, in which the fish become progressively lower in condition throughout the spawning season and recover rapidly thereafter. Watts' results showed a similar pattern in P. elongatus in which the oil-content of the flesh varied inversely with the spawning cycle, the oil stores becoming progressively used up with the advance of the spawning season.

3.5 Behaviour

3.52 Schooling

There are no direct observations on schooling in these species, and it is unlikely from what is known of their biology that dense schools are formed; rather, loose aggregations may wander over the trawling grounds appearing and disappearing from day to day in a manner confusing and difficult for the trawlers. This is very clearly a factor in the operations of small trawlers operating daily out of a port such as Lagos, on either side of which lie the trawling grounds. A trawler going out in the morning will try first on one side of the port and then on the other if no fish are found at first, and during the morning the boats gradually work together into the area in which the fish are to be found - sometimes to the east, sometimes to the west, and seldom in the same place two days in succession. The daily length frequency distributions taken from the catch of one such trawler daily for 24 months (Longhurst, 1964) show that the length composition of the exploited population may vary considerably from day to day, though within one days catch the modes in the distribution appear to be modes in normal distributions, suggesting that different broods of fish shoal together and that the loose aggregations tend to be of similar sized fish.

Sciaenidae are vocal fish and produce a variety of grunting noises by means of their air-bladders, which are well developed: some

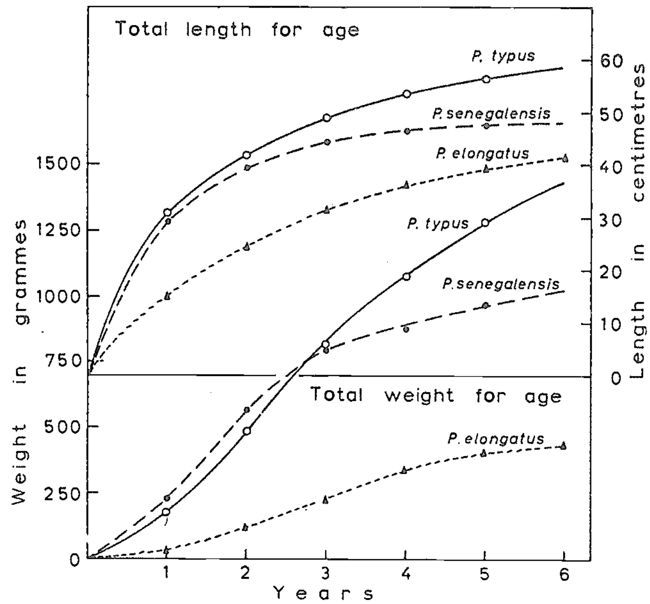

Fig. 4 Growth curves in LT and WT, modal values at each birthday.

experiments have been done off Lagos with a sonic fish-detector consisting of a submerged transducer and an amplification system. Sounds from Sciaenidae were readily and abundantly detected and local fishermen claimed to recognise individual species by their sounds. Use of sound production might be an important tool in the study of shoaling and local movements in these species.

4 POPULATION

4.1 Structure

4.11 Sex ratio

This is always close to unity in a population as a whole and suggests nothing unusual in the gonadial cycle of the three species.

Collignon (1960) examined at Pointe Noire 7882 individuals of P. senegalensis and 2656 of P. typus. The latter species had a ratio of almost exactly 50% while the former showed 52.2% males. However, the ratio in individual samples of P. senegalensis varied considerably; up to 86.6% of males were found in offshore samples, while in shallow water off river mouths up to 71.5% of females were encountered. Off Lagos, the ratio for both species was similar to that found for P. senegalensis by Collignon (1960). Here, this species had 56.56% males in the population (N=22,416) while P. typus had an overall ratio of 52.88% males (N=21,061) in the same samples. Figure 3a indicates, as has already been discussed, the way in which the percentage of females in the population changes seasonally, and the relationship of this change has been discussed above in section 2.22, and the data of Collignon appear to support the suggestion that spawning occurs normally in very shallow water close to the beach and that ripe females normally congregate there, moving further offshore during the wet season, when breeding ceases. For all three species it has been found (Collignon, 1960; Longhurst, 1963; 1964) that when the sex ratio is plotted against length that there is a preponderence of males at mid-ages and a preponderence of females toward the end of life, though the value of L_{max} is similar for each sex. An example of such a distribution is given in Fig. 5.

4.12 Age composition

The age structure of the population has only been estimated from research vessel landings using fine-meshed linings inside the cod-end (Longhurst, 1963; 1964) and this method produces data that are biassed by young fish escaping through the cod-end meshes, and by older fish escaping from the mouth of the trawl (see section 5.42). Recruitment to the research vessel catches is virtually complete by LT=10 cm, and to the commercial catches by LT=20 cm. The data for P. typus and P. senegalensis off Lagos and for P. elongatus in the Sierra Leone River from research vessel samples and for the latter species from commercial vessel landings at Freetown are shown in Table XIII.

The difference between P. elongatus and the other two species in the relative importance of the first year in the commercial landings is, of course, simply an effect of the smaller size of this species and the fact that consequently the size attained at the first birthday (L_1 = 15.0 cm) is yet smaller than the fish normally taken in commercial trawlers landings, as can be seen from the commercial catch histograms given by Longhurst (1963) for the Freetown trawlers.

4.13 Size composition

The data considered in section 1.31 are the only presently available on the size composition of populations over the range of the two species P. senegalensis and P. typus; there are no comparable data for the third species.. No evidence exists of significantly different size compositions between any of the parts of the range of these species except for the demonstration of stocks of small fish in the Bight of Biafra. Examination of the same data with reference to depth, and hence distance from the coastline reveals no indication of differential size-distribution correlated with depth.

4.2 Abundance and density of population

Following the failure of early marking experiments (Watts, 1959) with a variety of tags, the only data yet available on density and abundance are derived from catch per unit effort figures of research trawlers.

4.21 Average abundance

The data from the Guinean Trawling Survey, summarised in Table XIV give an indication of the density of the stocks, or abundance on a quasi-synoptic basis over the greater part of the range of P. senegalensis and P. typus. These show that the catch-rate for each species was highest at the latitudinal extremes of the range, and that the stocks are densest, though they do not necessarily occupy relatively large areas of the continental shelf, off the Guinea-Sierra Leone and Congo sectors of the coast. The FFS survey of Nigeria (Table XIV) indicated that densities were higher off the coast of the Niger delta than to the west, where exploitation has been heavy, or to the east, where the Bight of Biafra is known to contain sparse stocks of many species.

The relationship between catch-rate of P. senegalensis and depth is illustrated in Fig. 6, which is derived from the GTS data; catch-rate tends to fall off towards the extreme depth limits of the species and to be highest close inshore in shallow water, though the pattern is confused by the occurrence in all depths of hauls at which the species was taken, but in very low numbers.

4.23 Average density

This has been attempted on only one occasion, and that by the very unsatisfactory method of 'swept area' from trawl data (Longhurst, 1964);

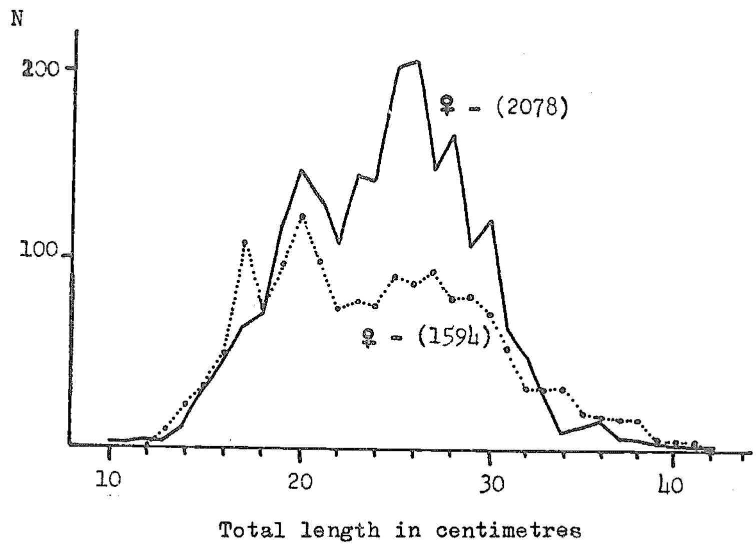

Fig. 5 Total length frequency distributions of the two sexes of P. elongatus at Freetown, summing samples taken over a period of about one year.

for P. senegalensis off the Nigerian coastline this gave an average density of 12.22 fish per hectare for individuals of more than 10 cm total length, or a standing population at the time of the investigation along 450 miles of continental shelf of 16.36×10^6; for P. typus the comparable figures were 5.54 per hectare and a population of 8.29×10^6.

4.24 Changes in density

The only known changes are those which have resulted from the effects of the exploitation of the stocks by mechanised trawlers within the last decade; these are discussed fully in section 5.4

4.3 Natality and recruitment

4.31 Reproduction rates

Calculation of the annual egg production rates per female or stock would be premature in the present state of knowledge of fecundity; the data presented in section 3.15 would allow only a first approximation to be made for this value. Nothing is known of the survival of eggs or larvae.

4.32 Factors affecting reproduction

The seasonal reproduction cycle and its possible correlation with the seasonal oceanographic cycle has been discussed above; nothing is known of the effects of other factors on reproduction and reproductive rates.

4.33 Recruitment

Some evidence of the pattern of recruitment can be obtained from knowledge of growth rates, the mesh used in the fishery, and on selection factors describing escapement from a net.

The nets used in the fishery for these three species are commonly of 50 mm stretched mesh, measured internally, or smaller; the 50% escapement length (and age) for such a mesh is approximately:

Pseudotolithus typus	22.7 cm (7 months)
P. senegalensis	22.0 cm (8 months)
P. elongatus	19.6 cm (12 months)

These figures indicate that the 50% escapement length on the selection ogive falls very far below the length at first maturity in the case of P. typus, and somewhat closer to this length in the other two species, but still below it. The length frequency distributions of commercial landings of P. elongatus indicate that recruitment to the catches does indeed begin at close to 17-18 cm and is complete by 20-22 cm.

The pattern of reproduction of P. typus and P. senegalensis, in which high spawning rates occur in the months February to June leads to high recruitment rates in the months October to February and that the main broods produced during the previous dry season will be fully recruited to the fishery between about November

TABLE XIII

Age and weight composition of the lanaings (%); in the case of research vessel landings these figures are modified from the original data by the ommission of all fish below LT = 20 cm, except in the case of P. elongatus where the percentage weight figures include these small fish, since the original data are not now available for modification. The intention of this is to render the data from research vessels comparable with those from commercial trawlers.

	I	II	III	IV	V	
P. elongatus (Freetown)						
Individuals	0.3	57.6	40.2	1.6	0.3	(Commercial catch)
Weight	47.2	30.5	14.8	4.9	2.6	(Research boat)
P. senegalensis (Lagos)						
Individuals	71.3	27.0	0.14	0.01	0.01	(Research boat)
Weight	60.5	27.3	7.6	3.0	1.6	" "
P. typus (Lagos)						
Individuals	79.8	18.2	1.54	0.19	0.27	" "

TABLE XIV

Catch-rate within statistical areas, GTS and FFS surveys; the data from the GTS cruise are expressed as kg/hr, and from the FFS cruise as N/hr

Area GI	P. senegalensis	P. typus GII	P. senegalensis	P. typus	Area
1	103.0	143.0	62.0	-	Roxo-Sherbro
2	93.0	25.0	62.0	6.0	- Palmas
3	57.0	14.0	19.0	-	- Sekondi
4	21.0	6.0	-	-	- St. Paul
5	47.0	29.0	10.0	-	- Lagos
6	39.0	46.0	38.0	14.0	- Douala
7	72.0	-	29.0	15.0	- Lopez
8	94.0	30.0	134.0	37.0	- Congo
FFS	Pseudotolithus spp				
I	72.6				Cotonou-Lagos
II	77.5				- Igboshere
III	226.4				- Benin
IV	402.6				- Kulama
V	188.8				- Opobo
VI	43.2				- Fernando Po

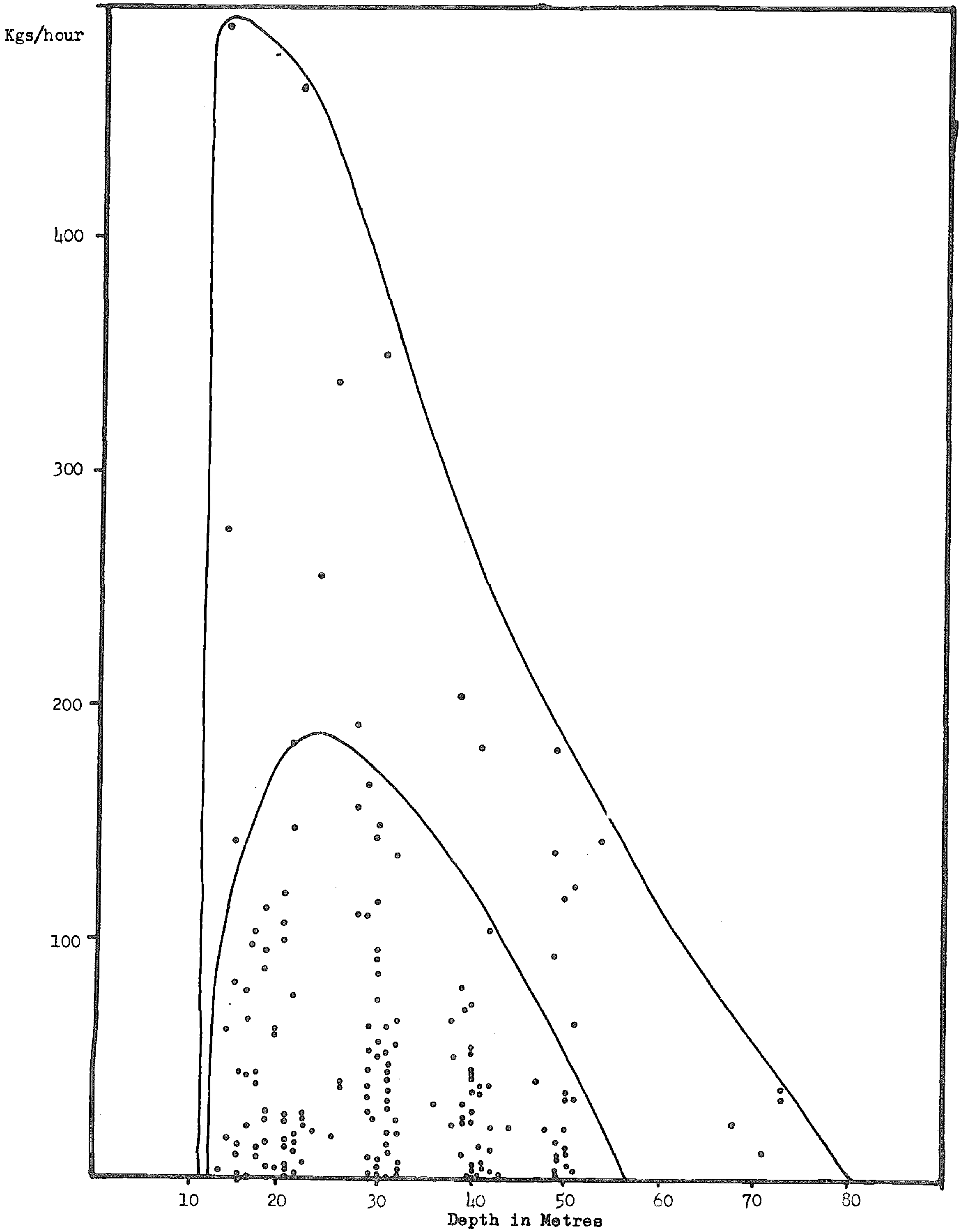

Fig. 6 Regression of catch per hour of P. typus and P. senegalensis combined against depth of haul, for all GTS stations, both cruises combined. Envelopes drawn to illustrate trend for high catch rates to be in rather shallow water.

TABLE XV

Mortality rates for three species of *Pseudotolithus* (Longhurst, 1964); the first two from data from the Nigerian trawling grounds, the third from data from the population in the Sierra Leone area.
(i = instantaneous rate, a = annual rate of mortality and s = annual survival rate; all are calculated in terms of Z, the total mortality rate under levels of fishing effort existing at the time of the investigations)

Year	*P. senegalensis*			*P. typus*			*P. elongatus*		
	i	a	s	i	a	s	i	a	s
1	7.45	0.99	0.01	7.18	0.99	0.01	-	-	-
2	1.73	0.82	0.18	2.33	0.90	0.10	2.05	0.87	0.13
3	1.55	0.79	0.21	1.05	0.65	0.35	1.45	0.76	0.24
4	1.04	0.65	0.35	1.17	0.69	0.31	1.45	0.76	0.24
5	0.69	0.50	0.50	0.44	0.36	0.64	0.99	0.62	0.38

and March; it will be shown below (section 5.3) that this is the season of highest catch-rates in many fisheries for these two species. Since the first year fish make up so high a proportion of the total landings (section 4.12), it seems likely that the patterns of recruitment and catch-rate are causally connected and the heavy landings experienced during the dry season are a consequence of the recruitment at this season of the yearlings produced towards the end of the previous dry season.

4.4 Mortality and morbidity

4.41 Mortality rates

The only available data on rates of mortality are summarised in Table XV; these were derived in a similar way to a simple catch-curve, from the numbers of individuals in each age-class in a sample, or in a series of samples. It has not been possible to separate natural and fishing mortality in any case.

The rates for the three species, two on the same trawling grounds off Lagos, and the third in the Sierra Leone area, are reasonably consistent, and higher than is normal in temperate zone species and therefore consistent with the high values for the von Bertalanffy growth parameters.

5 EXPLOITATION

5.1 Fishing equipment

5.11 Indigenous gear

The three species are taken by a variety of methods by the fisherfolk of the coastal fishing villages the length of the tropical West African coastline: by hand-lines from canoes; by small long-lines from canoes; by various forms of fish-trap in estuarine areas; by set or trammel nets; and by beach-seines set by large canoes. In general, these are not fisheries specialised for the capture of sciaenids, which are taken together with other members of their ecosystem - sharks, rays, soles, grunts, threadfins, and so on.

5.12 Mechanised methods

During the early 1950's trawl fishing on the tropical West African continental shelf began, in some cases (mostly abortive) by direct government initiative, but for the most part on the initiative of owner-operators of small trawlers of Mediterranean origin. Almost all the successful boats have been rather small, of up to 20 m and 250 hp and larger vessels with more complex machinery and higher operating costs have generally failed and left the fishery.

A special development occurred in Ghana in the late 1950's when a fleet of small open trawlers of about 9 m were built locally and introduced by a government loans scheme to local fishermen; these were simple boats in which the trawl warps were hauled by hand and were marginally successful.

The commercial trawlers which established themselves successfully were, and are, of very diverse origin and type, and have generally employed the type of trawling gear normal in their place of origin and with which their expatriate deck-officers are familiar. Thus, the list of trawlers registered at Lagos in 1961 included Spanish, Italian, Dutch, British and Nigerian-built vessels; there is an increasing trend for vessels to be built locally, as for instance in Ghana and Senegal in recent years.

5.2 Fishing areas

5.21 General geographic distribution

Corresponds with the range of the species, discussed in section 2.1.

5.22 Geographic ranges

Within the general area determined by the range of each species the actual locations of fishing operations have been determined by the locations of ports (which are not abundant along some sections of the coast) and by the differential distribution of the three species within this area (sections 2.2 and 2.3). Precise limits cannot be set for the areas of activity of trawlers at each port but the following notes give an indication of the activities of vessels which are mainly interested in making catches from the "Offshore sciaenid sub-community" (section 2.3) and in which the two species *P. typus* and *P. senegalensis* form a large part of the catch (section 5.43).

- Senegal

Trawlers from Dakar have in recent years extended their operations as far south as the coast of Guinea; the Great Jeba Flat is one of the largest areas inhabited by *P. typus* and *P. senegalensis* within their geographical range and this is regularly fished by Dakar trawlers. Postel (1949) pointed out that they are not found in depths greater than 50 m.

- Sierra Leone

The fleet of largely Italian trawlers based in Freetown fish between the Rio Pongo on the coast of Guinea and the northern Liberian coast at Cape Mount: landings from each statistical area in 1963 were:

Area	*P. senegalensis*	*P. elongatus*
Rio Pongo	1304	171
Isles de Los	7877	1719
Melakori	13972	3642
Sierra Leone River	1815	872
Banana Islands	9527	2324
Sherbro	10286	2676
St. Ann	652	130
Shebar River	5014	2545
Sulima	15293	6529
Cape Mount	8464	3064

(Numbers are cases landed; data from Sierra Leone, 1964).

- Liberia

The small fleet at Monrovia (until forced out of business by Japanese frozen imports) occupied themselves on the local grounds and as far north as the Sulima grounds on the Sierra Leone border.

- Ivory Coast

Many of the trawlers based at Abidjan make rather longer trips (of 15 days) than is usual for trawlers on the tropical coast, and much of their effort is now expended off the Sierra Leone and Guinean coastlines, rather than on the grounds close to their home port as formerly.

- Ghana

The fleet of small open trawlers referred to above confine themselves to the local grounds immediately adjacent to their home ports. The larger units range along the coast between Togo and the Ivory Coast.

- Dahomey

The few trawlers based at Cotonou have until now fished only off the coast of Dahomey itself, very rarely entering the Nigerian grounds to the east; this situation may be expected to alter with the recent establishment of a fishing port at Cotonou.

- Nigeria

The commercial fleet has been up until the time of writing confined to the port of Lagos and has fished as far to the west as Cotonou and to the east as far around the Niger Delta as the Benin River. Establishment of trawlers in Port Harcourt in the eastern Delta may be expected in the near future.

- Fernando Po

Several Spanish trawlers out of Santa Isabella are known to fish the grounds along the southern coast of the Niger Delta, and probably also enter the Cameroons inshore areas.

- Cameroons

The Douala fleet occupy themselves almost entirely with the fishery off the Cameroon coast.

- Congo Brazzaville

The Pointe Noire trawlers fish for these species of sciaenids mainly in the Cape Lopez area and on the banks at the entrance to the Congo River.

The activities of the various trawler fleets outlined above should not be confused with the activities of the fleets of distant water trawlers operating out of many of the above ports; these are freezing and factory trawlers of Soviet, Polish, Rumanian or Japanese origin or ownership based in or landing in West African ports and the rapidly growing fleet of modern factory trawlers owned by Ghana. All these vessels occupy themselves with the demersal fisheries of the Benguela and Canary Currents, and land few, if any, of the species under review here, though their activities bid fair to destroy the fishery for tropical sciaenids by cheap importation of frozen fish; this has happened in Liberia and is happening in Sierra Leone and Nigeria.

5.3 Fishing seasons

5.31 General pattern of season(s)

The seasonal cycle which has been referred to already (sections 2.22 and 4.33) can be demonstrated in almost all the landing statistics which are stated on a monthly basis, and it may be said that along the whole coastline of the Gulf of Guinea higher catches may be expected during the dry season from December to May; this coincides with the warm-water period in the southern transitional zone, when migration leads to high catches, and only in the northern transitional zone to the north of Cape Verde is the pattern reversed - for here the warm water season is, of course, six months out of phase with the southern counterpart. (Sierra Leone, 1964; Johnson, 1958; Longhurst, 1964b; Crosnier, 1964).

5.4 Fishing operations and results

5.41 Effort and intensity

Table XVI summarises the available statistics concerning the development of the near-water fishery at the tropical West African ports; the first vessels arrived around the year 1950, perhaps the first vessels fishing out of the ports of Abidjan (Ivory Coast) and Point-Noire (Congo Brazza). By 1955 about 25 vessels appear to have been operating, by 1960 about 75 vessels, and by the current year, 1965, the total has probably reached about 150. In view of the uncertainty of the statistics, and their total unavailability from certain important countries, the above estimates are in fact little more than educated guesses. To these figures must be added the fleet of around 200 small boats in Ghana, 80 small sailing boats off Mauretania, and an uncounted number of canoes in each country.

In a few instances a measure of fishing effort is available and these also are set out in Table XVI.

Except in the case of Ghana, a common pattern can be seen in these data: after the first arrival of trawlers in each country, a period of rapid expansion of the fleet occurred, lasting for perhaps five years, after which the fleet tended to remain about the same size. In some ports, as Freetown, the same vessels have remained a conservative fleet for many years, while at others, as Lagos, a very rapid turnover of vessels has occurred in the fishery.

There are very few data concerning the catch per unit effort in these fisheries; it has been shown that there is a relationship between catch and the horse-power of the trawlers (Longhurst, 1964a) which is described, for the Lagos fleet, by the expression ($y=60+0.886x$) where y is the catch in pounds and x is the brake horse-power

TABLE XVI

(a) Number of units in the near-water trawler fleets including the Canarian sailing vessels under Mauretania, and the small open trawlers under Ghana;
(b) the fishing effort of certain of the fleets given in the following units: Sierra Leone = days fishing; Dahomey = number of trips; Nigeria horsepower/hours at sea divided by a factor of 10^3; Congo = trips; Ghana = trips (a. of trawlers >36 feet; b. of all trawlers)

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
(a) Number of near-water trawlers										
Mauretania									(80)	(80)
Senegal										
Guinea										
Sierra Leone	2	-	-	5	10	10	10	12	19	16
Liberia	5	1							5	5
Ivory Coast		14	12	12	18	22	29	29	29	30
Ghana (a)		1	5	8	12	20	30	51	-	-
Ghana (b)	26	54	84	114	154	197	227	227	251	192
Dahomey			1	1	1	2	1	1	3	5
Nigeria		1	3	9	13	11	10	10	16	14
Cameroon								14	15	14
Congo Leo										
Congo Brazza	7	6	6	7	6	6	8	7	6	7
Fernando Po									3	
(b) Fishing effort										
Sierra Leone						1.7	1.6	2.5	3.7	($x10^3$)
Dahomey			163	231	259	176	286	314	204	495
Nigeria		0.6	1.7	5.2	8.1	6.4	5.8	5.4	6.7	4.9* ($x10^3$)
Congo Brazza	0.6	0.9	1.0				0.7	1.7	1.4	($x10^3$)
Ghana	2.3	5.7	8.0	13.1	14.4	12.9	14.8	12.7	10.4	5.8 ($x10^3$)

(* - Nigeria, 1965=2.5)

of the vessel. The unit of effort used in the Lagos statistics is therefore a measure of the horse-power of each individual vessel and the time each spends at sea in hours in the period under consideration; in other fisheries the effort data consists of a more simple unit, usually the total number of trips made out of the port in the period.

Such data as are available on the trends over a period of years are set out in Table XVII. There are indications of an irregular decline in catch per unit effort over the years 1956 to 1964 at Lagos, and on a shorter time-scale and on more restricted grounds, the Ghana data show a very clear decline in return for effort expended as the fleet of small boars built up over a four year period between 1951 and 1954.

Bayagbona (1965) has shown that the regression of catch per unit effort against effort in the Lagos fishery (total catch, not merely sciaenids) gives a line of negative slope indicating that the catch per effort is reduced at increasing levels of effort, and that from this may be derived a parabola (Figs. 7 and 8) of catch for effort; above approximately 750 x 10^3 hp hours a month the catch begins to decline for increasing effort. Bayagbona (1965) shows that the Lagos fleet has not, in fact, exerted a level of effort at which this would be the case in the few years for which statistics are available, but that they have at times come rather close to it.

5.42 Selectivity

The escapement of all three species from trawl nets has been studied (Longhurst, 1959; 1960a; Mann, 1962) and it is evident from direct investigations and observations that this occurs in two ways; there is the expected escape of small fish through the meshes of the cod-end and other parts of the net, studied directly by the above authors, and there is the escape from the mouth of the net of large individuals of *P. typus* and *P. senegalensis* which has been deduced from the frequent observation that the only large individuals taken in a trawl are meshed in the wings and upper batings and is confirmed by the demonstration of the presence on the trawling grounds of fish larger than those taken in trawls but which routinely form a large part of the catch of canoe set-nets (Longhurst, 1964).

The data accumulated from the various mesh-escapement experiments are set out in Table XVIII.

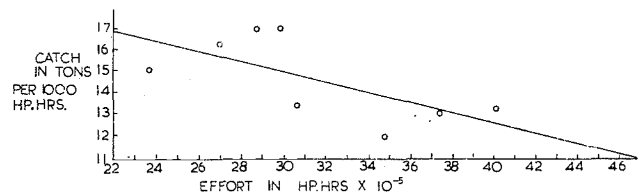

Fig. 7 Regression of catch per unit effort against effort for 6 months periods.

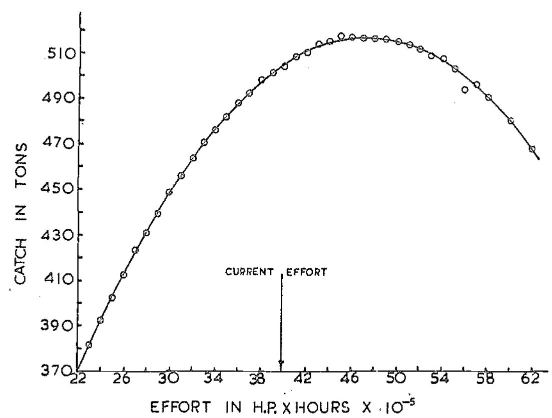

Fig. 8 Plot of estimated catches against corresponding efforts for periods of 6 months (from Bayagbona, 1965).

Those for P. typus, based on a very few fish ($N = <500$), are less satisfactory than the others, and in this species the original predicted value may be nearer the actual value than the experimental values. The predicted values, based on length/girth data, proved for a range of species of varying body form to be within about 7% of the values subsequently determined experimentally for the same species. It seems unlikely that the value for sf would in fact be lower for P. typus than for P. senegalensis in view of the longer body-form of the former species.

Two factors may be expected to raise the value of S within a species: increased size of mesh aperture, when the relative flexibility of the twine will increase; increased flexibility of the actual twine used to knit the net. Both these effects are demonstrated in the data: the larger the value of M, for the same type of twine, the larger the value of sf; the more flexible the material (spun nylon versus natural fibres), the higher the value of sf.

It has been shown that the range of the selection ogive (R) and hence the degree to which knife-edge selection is approached is dependent upon the relative 'liveliness' of species when taken in a trawl; Longhurst (1960a) showed that the sciaenids under review rarely survived being brought on deck in a trawl and hence that the value of the ratio R/L_{50} is very high (the range of the selection ogive is very long) in these species compared with others which readily survive being caught in a trawl.

There appears to be very little selection on the part of the fishermen once the catch is aboard, or once a fish is taken by a canoe; though the larger the fish, the better the price per kilogram on the whole, still even the smallest fish likely to be retained by a trawl or captured by indigenous gear is marketable and will be landed and sold.

5.43 Catches

The total annual yields from the trawler fleets of a number of countries are set out in Table XIX. From these, an estimation is made in gross terms for those for which satisfactory data cannot be obtained, and from the resulting totals it appears that the commercial trawler fleet in the Gulf of Guinea is landing approximately 10.30×10^3 metric tons of sciaenids, principally of the three species reviewed here. In 1955, a few years after the start of trawling in the Gulf, the landings were probably nearer 2.0×10^3 metric tons.

The percentage which these species form of the total landings of the near-water trawler fleet varies from port to port (Table XX), but is generally between 20 and 35%; however, in those fisheries for which adequate statistics are available there is frequently a trend after a few years of exploitation towards lower percentages of croakers in the landings, with a concomitant increase in the percentage of small trash fish, or friture. Table XX illustrates this process: from 1955 to 1960 the Ivory Coast

TABLE XVII

Catch for effort statistics for certain fisheries, the figures referring to sciaenid catches only; for Dahomey the units are tons per trip and for Ghana kgs. per trip, for Nigeria kg x 100 per h.p. hours/1000, and for Sierra Leone kg per h.p./days absence (figures in brackets have been obtained by extrapolation)

	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Dahomey				-	-	-	0.39	0.28	0.32	0.50	0.35	0.36	0.49	0.47
Nigeria				-	-	21.2	11.1	10.1	9.3	13.9	18.1	13.3	12.8	7.2*
Sierra Leone				-	(14.8)	(13.2)	(12.4)	-	(11.5)	8.6	9.3	9.0	8.4	7.4
Ghana	71.3	57.1	102.1	37.8	19.5	23.6	19.4	16.2	29.1	18.1	19.7	17.7	27.6	47.1

* 1965 figure of 6.0 continued this trend.

TABLE XVIII

Statistics describing the escapement of sciaenids from trawls based on experiments at Freetown and Lagos; (1) Longhurst, 1959; (2) Longhurst, 1960a; (3) Mann, 1962

	M (mm)	R/L_{50}	sf	Material	Author
P. elongatus	-	-	3.58	predicted	(1)
	67.4	0.71	3.55	cotton	(2)
	46.2	1.05	2.96	cotton	(2)
	52.2	0.73	3.75	nylon	(2)
	45.0	0.78	3.53	nylon	(2)
P. typus	-	-	4.26	predicted	(1)
	36.3	-	3.03	hemp	(3)
	45.6	-	3.77	hemp	(3)
	57.9	-	3.79	hemp	(3)
	70.9	-	3.95	hemp	(3)
P. senegalensis	-	-	3.66	predicted	(1)
	46.2	0.82	3.76	cotton	(2)
	45.0	0.95	4.57	nylon	(2)
	36.3	-	3.77	hemp	(3)
	45.6	-	3.85	hemp	(3)
	57.9	-	4.44	hemp	(3)
	70.9	-	4.01	hemp	(3)
	39.8	0.13	3.85	nylon (covered cod-end)	Akyüz, unpublished

Range of selection ogives (cm)	M (mm)	L_0	L_{50}	L_{100}	R	Material
P. elongatus	67.4	12.5	23.9	29.5	17.0	cotton
	46.2	6.0	13.7	20.5	14.5	cotton
	52.2	9.0	19.6	23.5	14.5	nylon
	45.0	11.0	15.9	23.5	12.5	nylon
P. senegalensis	45.0	12.5	20.6	29.5	17.0	cotton
	46.2	7.5	17.9	24.5	17.0	nylon
	39.8	12.0	15.3	17.0	5.0	nylon (covered cod-end)

TABLE XIX

Total landings of tropical sciaenids in certain countries in metric tons (x 10^3) showing a total of 8.30 in 1964, to which is added an estimate for three other countries which did not return statistics and which bring the overall total to 10.30 x 10^3 tons (* note that Nigeria 1965 figure was 0.16, continuing trend)

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Mauretania	-	-	-	-	-	-	-	-	0.47	0.36
Senegal	-	-	-	-	-	-	-	-	-	-
Guinea	-	-	-	-	-	-	-	-	-	-
Sierra Leone	-	-	-	-	0.46	0.33	0.34	0.78	0.75	0.48
Liberia	-	-	-	-	-	-	-	-	-	-
Ivory Coast	0.27	0.59	0.48	0.69	0.65	0.44	1.48	2.32	-	2.91
Ghana	0.04	0.12	0.16	0.21	0.42	0.23	0.29	0.22	0.28	0.11
Dahomey	-	-	0.06	0.06	0.08	0.09	0.10	0.11	0.15	0.23
Nigeria	-	0.12	0.19	0.53	0.75	0.89	1.03	0.72	0.86	0.35*
Cameroon	-	-	-	-	0.59	0.56	0.74	0.95	1.20	1.10
Congo (Brazza)	0.36	0.56	0.54	-	-	-	-	2.00	2.08	2.76
										8.30
							+ Liberia			0.5
							Senegal			0.50
							Guinea			1.00
										10.30

landings showed a drop from around 20% croaker to around 5%, and after this year the trawlers began to exploit the grounds off Sierra Leone and Guinea and the percentage rose again to more than 20%; the Nigerian landings show a decrease from more than 25% to 16% over a five year period for which there are good statistics, while before this period the percentage is thought to have been even higher; the Dahomey landings, from no more than two trawlers, do not show this trend at all clearly which suggests that the stocks off the Dahomey coast were relatively lightly exploited during these years.

The different species of Pseudotolithus are not normally indicated separately in the landing statistics, but some indications are available (Table XXI) which indicate that, in general, P. senegalensis forms the largest percentage of the sciaenid landings and this is supported by the GTS data (Table VII) which shows that this species occurred at a great number of stations in the survey than did P. typus. Only the time-series data from the Lagos trawling grounds (Table XXI) show P. typus to be more abundant, though these data are in terms of numbers of individuals rather than weight of catch.

The indigenous canoe and beach fishery along the coast of the Gulf of Guinea is almost undescribed quantitatively, and an estimate of the landings of croakers by the units of this fishery is impossible to quantify in the majority of countries. In some countries there are reasonably satisfactory counts of canoes, villages and fishermen (e.g. Sierra Leone, Ghana, Western Nigeria) but data on the catches are very much less reliable and in most cases do not distinguish between species. For instance, the estimates for Sierra Leone from the recent National Fisheries Census (Sierra Leone, 1964) estimate that the indigenous fishery passes 15 x 10^3 tons annually into the trade routes, but this figure certainly contains a very high percentage of pelagic and brackish water species, principally Ethmalosa, and there appears to be no way of obtaining an objective estimate of croaker landings from such figures.

The impression gained by the author from a good deal of observation of fishery activity along the Gulf of Guinea coastline is that the indigenous landings of croakers in each country are unlikely to have exceeded the trawler landings in recent years, and this suggests that an outside figure of 25 x 10^3 tons may be set for the entire catch of tropical Sciaenidae in the Gulf of Guinea annually.

TABLE XX

Percentage formed by sciaenids and small miscellaneous fish (trash, fry or friture) in the landings for various countries during the fishery

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Croaker										
Sierra Leone	-	-	-	-	17.0	16.4	17.5	25.0	19.5	20.1
Ivory Coast	18.0	21.0	15.9	15.4	10.2	5.5	-	-	-	23.8
Dahomey	-	-	53.6	45.9	51.7	61.6	40.2	42.3	41.7	38.8
Nigeria	-	-	-	-	-	25.6	29.0	22.7	20.6	16.5
Cameroon	-	-	-	-	-	-	-	19.7	20.7	20.0
Congo Brazza	-	-	-	-	-	-	-	31.6	32.8	37.2
Mauretania	-	-	-	-	-	-	-	-	-	5.9
Small miscellaneous										
Ivory Coast	36.2	36.6	34.3	30.8	45.9	50.3	-	-	-	13.8
Dahomey	-	-	36.8	46.5	43.5	32.8	53.4	52.2	55.8	54.9
Nigeria	-	-	-	-	-	22.1	26.2	29.3	35.2	-
Congo Brazza	-	-	-	-	-	-	-	14.8	13.8	19.8

TABLE XXI

Proportions of the three species under review in the landings of several countries yearly and in the catches of a small research trawler monthly off Lagos.
(1= *P. senegalensis*; 2= *P. typus*; 3= *P. elongatus*; 4= *P. brachygnathus*)

(a) Percentage of species by weight in commercial landings, 1964

	1	2	3	4
Mauretania	100	-	-	-
Sierra Leone	75 (1+2)		24	1
Liberia	60	40	-	
Dahomey	54	39	-	7
Congo (Brazza)	60	40		

(b) Percentage of species by number in catches off Lagos

	1961		1962	
	1	2	1	2
Jan	69.7	30.3	59.3	40.7
Feb	67.7	32.3	65.1	34.9
Mar	67.0	33.0	27.9	72.1
Apr	36.0	64.0	55.1	44.9
May	36.1	63.9	33.8	66.2
Jun	62.9	37.1	55.4	44.6
Jul	36.0	64.0	66.9	33.1
Aug	65.6	34.4	64.2	35.8
Sept	59.5	40.5	69.5	30.5
Oct	71.8	28.2	60.7	39.3
Nov	55.6	44.4	58.0	42.0
Dec	67.3	32.7	45.9	54.1

($N = 148 \times 10^3$)
%1 = 43.7
%2 = 56.3

8 REFERENCES

Arnoux, J., 1957 Maritime fishing in Senegal. Paper presented to C.S.A. Symposium on oceanography and sea fisheries of the west coast of Africa, Luanda, 20–27th November 1957. O.C.W.27:7 p.

Bayagbona, E.O., 1963 Biometric study of two species of Pseudotolithus from the Lagos trawling grounds. Bull.Inst.fr.Afr.noire(A), 25(1):238–64

__________, 1965 The effect of fishing effort on croakers in the Lagos fishing ground. Bull.Inst.fr.Afr.noire(A) 27(1):334–8

__________, 1969 Age determination and the Bertalanffy growth parameters of *Pseudotolithus typus* and *P.senegalensis* using the 'burnt otolith technique'. *In* Proceedings of the symposium on the oceanography and fisheries resources of the tropical Atlantic, held in Abidjan, Ivory Coast, 20–28 October, 1968, organised through the joint efforts of UNESCO, FAO and OAU. Review papers and contributions, Paris, UNESCO, pp.349–59

Blanc, A., 1957 Ecology of a few species of fish of great economic interest on the northern coast of Senegal. Paper presented to C.S.A. Symposium on oceanography and sea fisheries of the west coast of Africa, Luanda, 20–27th November 1957. O.C.W.27:12 p.

Bleeker, P., 1863 Mémoire sur les poissons de la côte de Guinée. Natuurk.Verh.holland.Maatsch.Wet.Haarlem(2), 18:1–136

Boeseman, M., 1963 An annotated list of fishes from the Niger Delta. Zool.Verh.,Leiden, (61):1–48

Boulenger, G.A., 1915 Catalogue of the fresh-water fishes of Africa in the British Museum (Natural History). London, vol.3:1–526

Bowdich, S., 1825 In Excursions in Madeira. Zool.Append.,1825:221–43

Buchanan, J.B., 1954 Marine molluscs of the Gold Coast, West Africa. Jl W.Afr.Sci.Ass., 1(1):30–45

Cadenat, J., 1950 Poissons de mer du Sénegal. Init.afr.,(3):345 p.

Carruthers, J.N. *et al.*, 1959 Shorewards upslope of the layer of minimum oxygen off Bombay: its influence on marine biology, especially fisheries. Nature, Lond., 183:1084–7

Chabanaud, F. and Th. Monod, 1926 Les poissons de Port-Etienne; contributions à la faune ichthyologique de la région du Cap Blanc. Bull.Com.Etud.hist.scient.Afr.occid.fr., 1926:225–87

Collignon, J., 1959 La systématique des Sciaenidae de l'Atlantique oriental. Bull.Inst.océanogr.Monaco,(1155):1–10

__________, 1960 Contribution à la connaissance des *Otolithes* des côtes d'Afrique equatoriale. Bull.Inst.Etud.centrafr.,(19–20):57–94

Collignon, J., M. Rossignol and Ch. Roux, 1957 Mollusques, crustacés et poissons marins des côtes d'AEF. en collection au centre d'oceanographie de l'Institut d'Etudes centrafricaines de Pointe-Noire, Paris, ORSTOM, 369 p.

Crosnier, A., 1964 Fonds de pêches le long des côtes de la république Féderale du Cameroun. Cah.O.R.S.T.O.M.(Oceanogr.), No.spec.133 p.

Eziuzo, E.N.C., 1963 The identification of otoliths from West African demersal fish. Bull.Inst.fr.Afr.noire(A), 25(2):488–512

FAO, 1963 Fisheries mission to West Africa, Memorandum No.3 (mimeo)

Fager, E.W. and J.A. McGowan, Zooplankton species groups in the North Pacific. Science,
1963 140(3566):453-60

Fowler, H.W., Marine fishes of West Africa. Bull.U.S.natn.Mus., 70(2):1-1493
1936

Gras, R., Liste des poissons du Bas-Dahomey faisant partie de la collection du Laboratoire
1961 d'Hydrobiologie du Service des Eaux et Fôrets et Chasses du Dahomey. Bull.Inst.fr.Afr.noire, 23(2):572-86

Gunther, A., Ann.Mag.nat.hist.(3), 16:48-9
1865

Hildebrand, S.F. and L.E. Cable, Reproduction and development of fishes of the family Sciaenidae
1934 of the U.S. Bull.Bur.Fish.,Wash., 48(16):41-117

Irvine, F.R. et al., The fishes and fisheries of the Gold Coast. London, Crown Agents for the
1947 Colonies, 352 p.

Johnson, F.R., Report of the fisheries department, 1957. Accra, Ghana, Govt Printer, 22 p.
1958

Longhurst, A.R., Food of the demersal fish of a West African estuary. J.Anim.Ecol., 26:369-87
1957

__________, An ecological survey of the West African marine benthos. Fishery Publs colon.Off.,
1957a (11):101 p.

__________, Prediction of selection factors in a tropical trawl fishery. Nature, Lond.,
1959 184:1170

__________, A summary survey of the food of West African demersal fish. Bull.Inst.fr.Afr.
1960 noire., 22(1):276-82

__________, Mesh selection factors in the trawl fishery off tropical West Africa. J.Cons.perm.
1960a int.Explor.Mer, 25(3):318-25

__________, Report on the fisheries of Nigeria, 1961. Lagos, Govt Printer, 42 p.
1961

__________, The bionomics of the fisheries resources of the eastern tropical Atlantic.
1963 Fishery Publs colon.Off., (20):66 p.

__________, Bionomics of the Sciaenidae of tropical West Africa. J.Cons.perm.int.Explor.Mer,
1964 29(1):93-114

__________, A study of the Nigerian trawl fishery. Bull.Inst.fr.Afr.noire(A), 26(2):686-700
1964a

__________, The coastal oceanography of western Nigeria. Bull.Inst.fr.Afr.noire(A),
1964b 26(2):337-402

__________, A survey of the fish resources of the eastern Gulf of Guinea. J.Cons.perm.int.
1965 Explor.Mer, 29(3):302-34

Lowe, R.H., The fishes of the British Guiana continental shelf, Atlantic coast of South America
1962 with notes on their natural history. J.Linn.Soc.(Zool.), 44(301):669-700

MacLaren, P.I.R., Report on fisheries investigations, 1942-1948. Lagos, Govt Printer
1948

__________, The palatability of Nigerian fishes. Niger.Fld, 19(1):4-15
1949

Mann, M.J., 1962 Escape of Pseudotolithus senegalensis (C. and V.) from trawl nets in a Nigerian fishery. Nature, Lond., 193(4819):955-6

Metzelaar, J., 1919 Over tropisoh Atlantische visschen. Amsterdam, A.H. Kruyt, 314 p.

Nigeria. 1961 Federal Fisheries Services, Res.Rep.fed.Fish.Serv.Nigeria, (mimeo)

Norman, J.R., 1935 Coast fishes. Part 1. The south Atlantic - including the Cape Verde islands, West Africa, South Africa, Ascension Island, Tristan da Cunha and Gough Island. 'Discovery' Rep., (12):58 p.

Pellegrin, J., 1905 Mission des pêcheries de la côte occidentale d'Afrique dirigée par Gruvel. Poisson. Bull.Soc.Zool., 30:138

Poinsard, F. and J.P. Troadec, 1966 Détermination de l'âge par la lecture des otolithes chez deux espèces de Sciaenides ouest-africains (Pseudotolithus senegalensis C.V. et Pseudotolithus typus Blkr) à paraître. J.Cons.perm.int.Explor.Mer, 30(3):

Poll, M., 1950 Description de deux Poissons percomorphes nouveaux des eaux cotiéres africaines de l'Atlantique Sud (1948-1949). Bull.Inst.r.Sci.nat.Belg., 26(49):1-14

__________, 1954 Poissons 4. Téléostéens acanthoptérygiens. Res.scient.Expéd.oceanogr.belge Atlant.Sud, 4(1):154

__________, 1959 Poissons 4. Téléostéens acanthoptérygiens. (Deuxième partie) Res.scient.Expéd. oceanogr.belge Atlant.Sud, 4B(3):417 p.

Postel, E., 1949 La campagne du chalutier GERARD TRECA. Pêche Côtes Afr.occ., (1):1-37

__________, 1955 Les facies bionomiques des côtes de Guinée Française. Rapp.P.-v.Réun.Cons.perm. int.Explor.Mer, 137:11-3

__________, 1959 Liste commentée des poissons signalés dans l'Atlantique tropical-oriental nord du Cap Spartel au Cap Roxo, suivie d'un bref aperçu sur leur répartition balty métrique et géographique. Bull.Soc.scient.Bretagne, 34(1-2):129-70

__________, 1960 Liste commentée des poissons signalés dans l'Atlantique tropical-oriental nord du Cap Spartel au Cap Toxo, suivie d'un bref aperçu sur leur répartition balty métrique et géographique 2. Bull.Soc.scient.Bretagne, 34(3-4):241-82

Rossignol, M., J. Blache and R. Repelin, (n.d.) Fonds de pêche de long des côtes de la République du Gabon. Paris, ORSTOM

Sierra Leone, 1958 Fisheries Development and Research Unit, Report on fisheries 1957

__________, 1959 Report on fisheries 1958-1959

__________, 1964 Report on fisheries 1963. Rep.Fish.Div.Sierra Leone, 1963:18 p.

Trewavas, E., 1962 A basis for classifying the sciaenid fishes of tropical West Africa. Ann.Mag.nat. Hist.(13), 5(51):167-76

Valenciennes, M.A., 1833 Histoire naturelles des poissons. Paris

Watts, J.C.D., 1958 The hydrology of a tropical West African estuary. Bull.Inst.fr.Afr.noire, 20:697-752

Watts, J.C.D., 1959 Some observations on the marking of demersal fish in the Sierra Leone River estuary. Bull.Inst.fr.Afr.noire, 21:1236-53

_________, 1962 Relation between fat content and breeding peaks in *Pseudotolithus elongatus* Bowd. Bull.Inst.fr.Aft.noire(A) 24(4):1188-9

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SYNOPSIS OF FISHERIES BIOLOGICAL DATA

This is one of a series of documents issued by FAO, CSIRO and USFWS concerning species and stocks of aquatic organisms of present or potential economic interest. The primary purpose of this series is to make existing information readily available to fishery scientists according to a standard pattern, and by so doing also to draw attention to gaps in knowledge. It is hoped that synopses in this series will be useful to other scientists initiating investigations of the species concerned or of related ones, as a means of exchange of knowledge among those already working on the species, and as the basis for comparative study of fisheries resources. They will be brought up to date from time to time as further information becomes available either as revisions of the entire document or their specific chapters.

The relevant series of documents are:

FAO	**Fisheries Synopsis No.** replacing, as from 1.1.63 FAO Fisheries Biology Synopsis No.	FR/S FB/S
CSIRO	**Fisheries Synopsis No.** and	DFO/S
USFWS FAO	**Fisheries Synopsis No.**	BCF/S

Synopses in these series are compiled according to a standard outline described in FIb/S1 Rev. 1 (1965).

FAO, CSIRO and USFWS are working to secure the cooperation of other organizations and of individual scientists in drafting synopses on species about which they have knowledge, and welcome offers of help in this task. Additions and corrections to synopses already issued will also be most welcome. Comments including suggestions for the expansion of the outline and requests for information should be addressed to the coordinators and editors of the issuing organizations.

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