

1. INTRODUCTION

The purposes of this catalogue are to provide a convenient means for the identification of gadiform species most likely to be encountered by fishery workers, to summarize fisheries, distributional, and other biological information, to guide users to the most relevant literature and to illustrate the wide diversity of this important group of fishes. It does not purport to present a definitive classification of the order at this stage.

This catalogue includes accounts of all species of gadiform fishes of present interest for fisheries, including those used for human consumption, for animal food, or for industrial purposes; abundant species of present minimal fisheries importance, which may have resource potential with the introduction of improved fishing or processing techniques or with the expansion of fishing areas; and species that are exemplary of various deep-sea or rare genera. In all, accounts are presented for 184 species of the approximately 500 placed by ichthyologists in the order Gadiformes. Although keys include nearly every recognizable gadiform genus and all genera in the keys are illustrated, full accounts of some genera and many species are excluded from this work. More than half of all gadiform species live in the deep sea beyond commercial fishing depth; many are small or are apparently rare in nature, are widely dispersed, or are problematically known taxonomically.

Much of the information here included has been selectively compiled from the literature. Taxonomic descriptions and keys have been verified to the extent possible, using both preserved museum and, for some, freshly caught specimens.

The treatment of the various families in this catalogue is necessarily somewhat unbalanced, as a result of the numerous gaps in the knowledge of many of the genera, of the need to concentrate mainly on species of value to fisheries, and of the fact that the material was prepared by three different authors.

1.1 General Remarks on Gadiformes

In this catalogue, the order Gadiformes is restricted to the cods, hakes, grenadiers, and their more immediate relatives as indicated by Nelson (1984). An expanded order Gadiformes, including the ophidioids (cusk eels, brotulas, and relatives), and in some instances the zoarcoids (eelpouts) has been proposed by many ichthyologists (see for example, Rosen & Patterson, 1969). As here treated, the order comprises eight families.

It is both astonishing and unfortunate that neither external nor internal characters can be listed that uniquely define the order Gadiformes. Descriptions have been written (for example, Marshall & Cohen, 1973; Nelson, 1984) which apply to virtually all species that are generally accepted as belonging to the order, but all of the descriptive characters are not unique to all of the included species. The assignment to the order of many species is presently as much a matter of ichthyological convention as it is a result of logic.

The above situation is bad enough; however, gadiform taxonomy suffers from additional weaknesses. There is no great measure of agreement with respect to the hierarchical arrangement of genera into suborders, families and subfamilies. The problem of classification within the gadiforms is presently a topic of intensive investigation by ichthyologists, and the absence of a consensus has been documented by a number of systematists in a recent publication (Cohen, 1989). Because the present work is not concerned with phylogeny, an alphabetical arrangement is followed, suborders are not considered, and the number of families recognized is to a large degree conservative and arbitrary.

Families and genera

The **Family Bregmacerotidae** contains a single genus, easily recognized by a distinctive fin pattern of a single long ray on the back of the head, bilobed dorsal and anal fins, and long, free pelvic rays. It includes a dozen or more species of small, pelagic fishes found in tropical seas, ranging from close-to-shore to mid-ocean waters. Some species are locally abundant.

The **Family Euclichthyidae** includes a single species trawled from the temperate waters of New Zealand and Australia. It is an interesting fish to the taxonomist, as it does not fit the definition of any gadiform family and recently has been accorded one of its own. Its nearest relatives may be the morids or the macrourids. ***Euclichthys*** is of little interest to the fishery biologist as it does not seem to be abundant enough to support a fishery.

ORDER	FAMILY	SUB-FAMILY	GENUS
G A D I F O R M E S	BREGMACEROTIDAE (15)		<i>Bregmaceros</i> (15)
	EUCLICHTHYIDAE (1)		<i>Euclichthys</i> (1)
	GADIDAE (53)	Gadinae (22)	<i>Arctogadus</i> (2), <i>Boreogadus</i> (1), <i>Eleginus</i> (2), <i>Gadiculus</i> (1), <i>Gadus</i> (3), <i>Melanogrammus</i> (1), <i>Merlangius</i> (1), <i>Microgadus</i> (2), <i>Micromesistius</i> (2), <i>Pollachius</i> (2), <i>Theragra</i> (2), <i>Trisopterus</i> (3)
		Lotinae (4)	<i>Brosme</i> (1), <i>Lota</i> (1), <i>Molva</i> (2)
		Phycinae (27)	<i>Ciliata</i> (2), <i>Enchelyopus</i> (1), <i>Gaidropsarus</i> (13), <i>Phycis</i> (3), <i>Raniceps</i> (1), <i>Urophycis</i> (7)
	MACROURIDAE (>289)	Bathygadinae (25)	<i>Bathygadus</i> (14), <i>Gadomus</i> (11)
		Macrourinae (>257)	<i>Albatrossia</i> (1), <i>Coelorinchus</i> (>76), <i>Coryphaenoides</i> (61), <i>Cynomacrus</i> (1), <i>Hymenocephalus</i> (21), <i>Lepidorhynchus</i> (1), <i>Macrourus</i> (4), <i>Malacocephalus</i> (7), <i>Mataeocephalus</i> (5), <i>Nezumia</i> (46), <i>Sphagmacrus</i> (6), <i>Trachonurus</i> (6), <i>Ventrifossa</i> (22)
		Macrouroidinae (2)	<i>Macrouroides</i> (1), <i>Squalogadus</i> (1)
		Trachyrincinae (5)	<i>Idiophorhynchus</i> (1), <i>Trachyrincus</i> (4)
	MELANONIDAE (2)		<i>Melanonus</i> (2)
MERLUCCIIDAE (19)	Merluccinae (18)	<i>Lyconus</i> (2), <i>Macruronus</i> (3), <i>Merluccius</i> (13)	
	Steindachneriinae (1)	<i>Steindachneria</i> (1)	
MORIDAE (89)		<i>Antimora</i> (2), <i>Auchenoceros</i> (1), <i>Austrophycis</i> (1), <i>Eeyorius</i> (1), <i>Eretmophorus</i> (?), <i>Gadella</i> (8), <i>Halargyreus</i> (1), <i>Laemonema</i> (18), <i>Lepidion</i> (9), <i>Lotella</i> (4), <i>Momonatira</i> (2), <i>Mora</i> (1), <i>Paralaemonema</i> (3), <i>Physiculus</i> (31), <i>Pseudophycis</i> (3), <i>Rhynchogadus</i> (?), <i>Salikola</i> (2), <i>Tripterochycis</i> (2)	
MURAEÑOLEPIDIDAE (4)		<i>Muraenolepis</i> (4)	

Fig.1 Arrangement of Gadiformes followed in this catalogue. Entries under each taxonomic category are alphabetical. Figures in brackets refer to the number of species.

The **Family Gadidae** is a diverse assemblage of about 50 species, many of which have been known since the time of Linnaeus or earlier. Even so, ichthyologists cannot agree on their classification. Most of these fishes live on continental shelves around the North Atlantic, but a few are found in deeper waters, are pelagic, or are caught in other areas, and one, *Lota*, is a fresh-water fish. Gadids are divided into three subfamilies that are rather different from each other. The subfamily Gadinae with 22 species divided into 12 genera is characterized by having three dorsal fins and two anal fins. It includes some of the most abundant and important fishes in the sea, the true cods, genus *Gadus*, the haddock, *Melanogrammus*, and the Alaska pollock, *Theragra*. The subfamily Lotinae, with four species including the cusk and ling, in three genera, are long-bodied fishes with one or two dorsal fins and a single anal fin. There are two dozen or more species in the subfamily Phycinae, including the rocklings and the non-*Merluccius* hakes, divided into six genera in the present arrangement.

The **Family Macrouridae** is sometimes divided into two or more families. It is here treated as one, on a rather arbitrary basis. The grenadier family is the largest one in the Gadiformes, with over 300 species classified in 34 genera, which are here arranged in four subfamilies. Virtually all grenadiers live on or near the bottom in deep water, although a few are pelagic. All macrourids have long tapering tails (hence the widely used name rattails), and all but a very few lack any vestige of a caudal fin. The subfamily Bathygadinae has 25 species in two genera, which are externally characterized by having a large terminal mouth. In nearly all other grenadiers, in contrast, the mouth is located on the undersurface of the head and the snout protrudes beyond the front of the upper jaws. The subfamily Macrourinae is the largest one in the order, and in fact contains more species than all other gadiforms combined. Macrourines are easily enough recognized in having the rays of the long-based second dorsal fin shorter than the rays of the anal fin. The subfamily Macrouroidinae, sometimes considered to be a separate family, has two species, each in a separate genus, with but a single dorsal fin and a greatly inflated head. The subfamily Trachyrincinae has four or five species in two genera, which have a long flattened snout, rough scales and short rays in the first dorsal fin.

The **Family Melanonidae** consists of a single genus and two species of dark-coloured, oceanic, meso- to bathypelagic fishes with a very slender caudal peduncle and distinctive nerve-end organs on the head. They are small and not abundant.

The **Family Merlucciidae** is variously considered a separate family or a subfamily of Gadidae. Aside from the 13 species of hakes and whiting of the genus *Merluccius*, fishes with a prominent tail fin, a capacious mouth, two dorsal fins, the second bilobed, and a single bilobed anal fin, there is no great measure of agreement about the assignment of other genera to the family (or subfamily). Three other genera are here grouped with *Merluccius*, and because all of them have long tapering tails and lack a tail fin, all have at one time or another been classified among the grenadiers of the family Macrouridae. *Macruronus*, living only in the Southern Hemisphere, most resembles *Merluccius* in many anatomical characters, and two of the three named *Macruronus* species are like many of the *Merluccius* species in being large enough and sufficiently abundant to support fisheries. The oceanic genus *Lyconus* is rare, with an unknown taxonomy; it contains two or more species. *Steindachneria*, which has also been classified by some authors in its own family, has a single small locally abundant species which is found only on the continental slopes of the Gulf of Mexico and Caribbean.

The **Family Moridae** includes about 100 species, most of which are poorly known and there is not even substantial agreement as to how many genera should be recognized in this family. They are relatively elongate fishes, many with a narrow caudal peduncle, and with a distinct caudal fin. Many species have soft flesh, occur in rather deep waters, and do not form large aggregations, and hence they are probably of less potential value to fisheries than either Gadidae, Merlucciidae or Macrouridae.

The **Family Muraenolepididae** consists of a single genus containing an unknown number of species, perhaps a half dozen, of which 4 have been described to-date. They live in far southern seas, mainly around Antarctica, and are rarely encountered. Muraenolepidids have the dorsal, anal, and caudal fins all joined, and the elongated body scales arranged at oblique angles to each other.

Developmental stages

The eggs and larvae of gadiform fishes are a source of information useful for the study of population dynamics and systematics. Considerable information is available for some species. However, the taxonomy of the early life history stages of gadiforms is known for fewer than a third of the species. A comprehensive summary, including extensive literature citations, is presented for gadiforms in general by Fahay & Markle (1984), according to whom, "The gut of gadiform larvae coils early in ontogeny and, combined with a tapering postanal region and rounded head, contributes to an overall tadpole-like appearance. Although it has not been documented in all families and is not always easily observed, yolk-sac and first-feeding gadiform larvae have an anus that exits laterally through the finfold rather than medially as is usual in teleost larvae. Some secondary caudal rays develop before some primary in forms with a caudal fin. A rather widespread trend is for the pelvic fin to be the earliest forming fin.

There does not seem to be any character unique or diagnostic for young gadiforms. The features of body shape, anus morphology and pelvic fin development in combination with specific familial characters appear to be the most useful for initial identification. Transformation is gradual and direct with no striking change in morphology." The development of species of the Family Gadidae is treated by Dunn & Matarese (1984), and by Dunn (1989) and that of bregmacerotids by Houde (1984). Representative gadiform larvae are shown in Fig. 2.

Geographical distribution

The distribution of gadiforms has been discussed by Marshall & Cohen (1973), from which the following account is paraphrased and amended. Although gadiforms are found throughout the world ocean and also in fresh water, they are predominantly marine benthopelagic fishes of cool waters, be they shallow in high and mid-latitudes or deep in the tropics. It is obvious that historical events as well as temperature have shaped present-day distribution patterns of gadiform fishes, as many patterns are characteristic for particular taxonomic categories.

The dozen or more species of Bregmacerotidae are all pelagic in the tropics. Some are mesopelagic and thus live in cool water, but others are found in warm, shallow, coastal seas and are the only truly warm-water gadoids known. The taxonomy of the species is not well enough studied to describe their distributions.

The single species in the family Euclichthyidae is restricted to New Zealand and southern and western Australia.

The Family Macrouridae has the most species of any gadiform family, and many of them have restricted ranges; although deeper dwelling ones seem to be more widely distributed. Even though most kinds of grenadiers live on tropical continental slopes where they may be very abundant, fewer of their distinctive eggs and young than might be expected are found in the plankton. There are several centres of endemism for macrourids, for example the Gulf of Mexico and Caribbean, the Hawaiian Islands, and the Sulu Sea. A few species of grenadiers live in far northern seas (e.g. *Coryphaenoides rupestris*, *C. longifilis* and *Macrourus berglax*), a few in the Southern Ocean (e.g. *Macrourus holotrachys*, *M. whitsoni* and *Coryphaenoides lecointe*), and others are pelagic, but in general, macrourids keep their noses to the tropical bottom.

The Gadidae proper is virtually unique among fish families in having its headquarters on the continental shelf of the temperate North Atlantic (Svetovidov, 1956), a region and habitat with a fish fauna comprised chiefly of the tag ends of groups having their main centres of diversity farther to the south or in the temperate North Pacific. Gadid diversions such as those of *Lota* into fresh water, and a few species of *Gadus*, *Microgadus*, *Theragra*, and *Eleginus* into the Pacific derive from Atlantic or Arctic sources. Only a few gadids live in the southern hemisphere; the pelagic genus *Micromesistus* is antitropical as is the rockling genus *Gaidropsarus*. Species of the hake genus, *Urophycis*, found along the coasts of the western Atlantic from Canada to Argentina apparently live in deeper water throughout the tropics.

The family Melanonidae has but a single genus with two species, both meso- to bathypelagic; one of them *Melanonus gracilis*, is restricted to temperate and subantarctic latitudes.

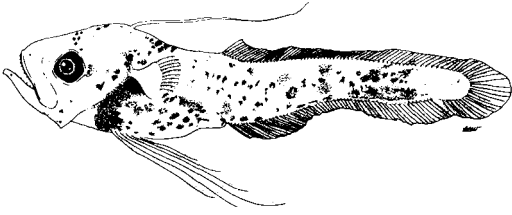
The family Merlucciidae displays tropical submergence in the genus *Merluccius* and a south temperate distribution in the related genus *Macruronus*. *Steindachneria*, with a single species, is found only in the tropical and subtropical western North Atlantic.

The Family Moridae is found chiefly on continental slopes in the tropics, where *Physiculus* and *Laemonema* are the largest genera. A few morids of the genera *Antimora*, *Lepidion* and perhaps *Physiculus* have reached abyssal depths, and a sizable number of species is found at New Zealand, where morids live in habitats ranging from nearshore to the deep sea (Paulin, 1983). Morids are also found along the continental slopes of temperate southern South America and South Africa.

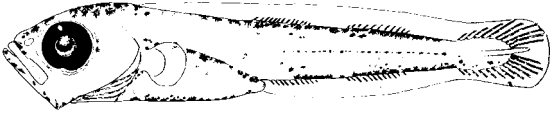
The Muraenolepididae, with only a few described species, is found in far southern seas around Antarctica or some of its cold water island outliers.

1.2 Information on Fisheries

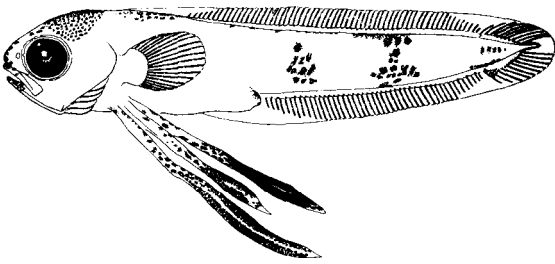
Most gadiforms are benthopelagic and are taken in bottom trawls. A number of species (especially in the families Gadidae and Merlucciidae) are the object of very large, directed fisheries that have been operating since the last century. Others (especially many species in the family Macrouridae) have become accessible to fisheries only in the course of the last few decades and are not yet fully exploited.



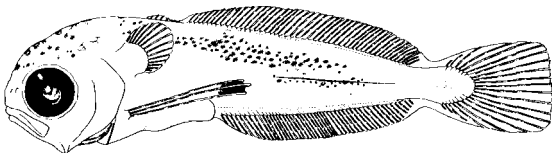
a. Family **Bregmacerotidae**,
Bregmaceros mclellandi, 7.0 mm



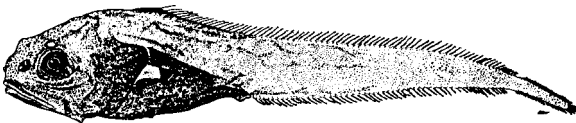
b. Family **Gadidae**, subfamily **Gadinae**,
Gadus morhua, 11.0 mm



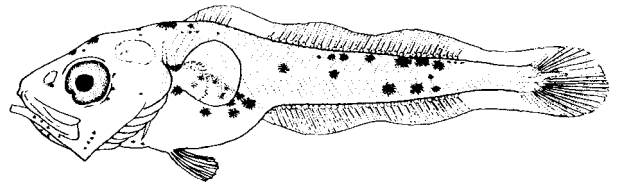
c. Family **Gadidae**, subfamily **Lotinae**,
Brosme brosme



d. Family **Gadidae**, subfamily **Phycinae**,
Urophycis chuss, 9.5 mm



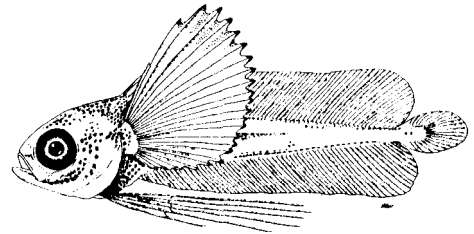
e. Family **Melanonidae**, *Melanonus* sp., 30.6 mm



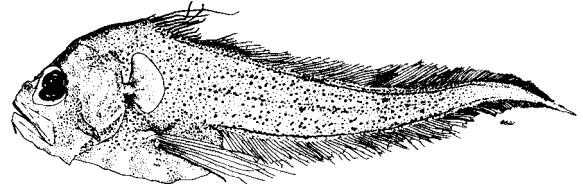
f. Family **Merlucciidae**, subfamily **Merlucciinae**,
Merluccius productus, 10.1 mm



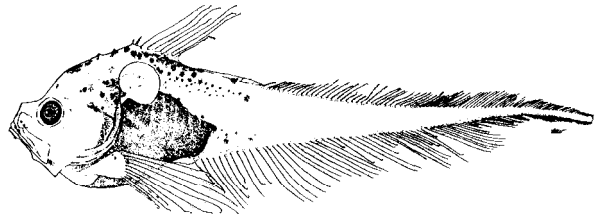
g. Family **Merlucciidae**, subfamily **Steindachneriinae**,
Steindachneria argentea, 24 mm



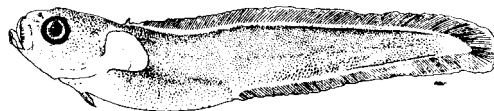
h. Family **Moridae**, *Gadella maraldi*, 18.8 mm



i. Family **Macrouridae**, subfamily **Bathygadinae**,
Gadomus sp., 30 mm



j. Family **Macrouridae**, subfamily **Macrourinae**,
Coryphaenoides sp., 30 mm



k. Family **Muraenolepididae**, *Muraenolepis* sp., 32.5 mm

The global catch of Gadiform fishes (ca. 13 700 000 metric tons in 1987) represents about 17% of the total world landings from marine waters (80 500 000 t in 1987). Over 95% of these landings correspond to a single family, the cods or Gadidae (ca 11 700 000 t in 1987), followed by the hakes or Merlucciidae (ca. 1 900 000 t), the grenadier fishes or Macrouridae (51 000 t), the moras or Moridae (ca. 20 000t) and the codlets or Bregmacerotidae (ca. 2 000 t). These catches provene mostly from temperate waters of both hemispheres, i.e. fishing area 61, N.W. Pacific (5 300 000 t), 27, N.E. Atlantic (3 600 000 t), 21, N.W. Atlantic (800 000 t), 41, SW. Atlantic (700 000 t), 81, SW. Pacific (200 000 t), and 87, SE. Pacific (200 000 t). More detailed information is given under the respective families.

1.3 Plan of the Systematic Catalogue

Eight gadiform families are presented: Bregmacerotidae, Euclichthyidae, Gadidae, Macrouridae, Melanonidae, Merlucciidae, Moridae and Muraenolepididae. For each family are given general descriptive remarks, notes on biology and fisheries, and a key to the subfamilies and/or genera. Families and genera, and species within them, are arranged alphabetically. For each genus treated, a brief diagnosis is given, which supplements the data in the key; also included are references to junior synonyms (some of which may still be in current use or entrenched in the older literature), notes on biology and fisheries, a key to species where possible, a list of species, remarks on particular taxonomic problems, and literature. The information given for each species is arranged in the following paragraphs:

- (1) **Scientific Name** : Reference is given to the first valid name applied to the species and its accompanying description. Earlier but invalid names appear under synonyms (where necessary).
- (2) **Synonyms** : All names that have been applied to the species are given, as well as some different name combinations (if significant) with author and date. The complete synonymies (i.e. all references in the literature) of some gadiform species are enormous and no purpose would be served in citing them in full; in any case, there is often grave doubt whether the material studied was really identified correctly.
- (3) **FAO Names** : For many species, only English names have been chosen for use within FAO and to serve as the recommended names for fishery, marketing and other purposes. Some French and Spanish equivalent names for gadiform fishes already used on [FAO Identification Sheets](#), are also included. It is considered premature to attempt this for all species until fishery workers and other specialists in countries using French and Spanish can be consulted.
- (4) **Diagnostic Features** : Distinctive features are given, accompanied where necessary by diagrams, as an aid to identifying species within a genus (after using the keys to families, subfamilies and genera).
- (5) **Geographical Distribution** : The general range of the species is given in the text and in the map (areas between scattered records may merit a question mark if a continuous range seems doubtful). Distributions plotted on the maps are rough and usually based on the filling in of areas between scattered capture points. In many instances, the distributions shown extend well beyond actual capture localities and are "expected" distributions based on knowledge of the group and on the topography and oceanography of the area. No attempt was made to precisely follow depth contours, although it is recognized that the benthic species in particular occur along relatively restricted isobaths.
- (6) **Habitat and Biology** : The true identity of many species is often in doubt, especially in the older literature, so that much apparently useful biological information has had to be omitted here. For very many of the species, however, almost nothing is known of feeding habits, spawning seasons and migrations, etc.
- (7) **Size** : The maximum known size and where possible, the common adult size are given (as total length in centimetres, when not otherwise stated).
- (8) **Interest to Fisheries** : Partly based on the statistics by species and by Fishing Area given in the [FAO Yearbook of Fishery Statistics](#) for 1987. Since only a few gadiform species (39 out of over 500 described species) are given individual statistics, and since identifications are sometimes doubtful (i.e. more than one species probably included), only a general impression of the relative importance of a species is possible in many cases. However, from fisheries literature for particular areas or particular species considerable information on fisheries is available and has been used. Also, any information on possible fisheries potential of the species has been included.
- (9) **Local Names** : These are only occasionally given, usually when a particular species is the basis for a major fishery and its identity is certain. In very many cases, however, a local name is applied to several species and means no more than that the fish is a kind of cod, hake or grenadier.

- (10) **Literature** : Reference is made to the most important (not only taxonomic) books or papers on the species, with a brief indication of their relevance in parentheses.
- (11) **Remarks** : Taxonomic or other problems are outlined here, e.g. explanations for unexpected name changes, doubtful status of species, indications of further work in progress or needed, and presence of subspecies (which are given a brief diagnosis and geographical range).

1.4 Problems with Identification

It is not always easy to identify a fish as a gadiform or to classify it in a family, genus or species. Some of the most important diagnostic characters are internal. Examples are the shapes and positions of various bones, the shape of the swimbladder and some of its parts, and the shape and number of vertebrae; examining these kinds of characters may require skilled dissection or the use of x-ray photographs. Other characters, although not strictly internal as they are not technically in the body, are in the mouth or gill cavity. Examples are the location, size and shape of teeth or patches of teeth, and the number and size of the gill rakers; accurate identification may require focused light used with a microscope or hand-lens. Obtaining information from completely external characters may also present problems. Ascertaining the number of dorsal and anal fins may seem simple; however, for many genera care must be exercised as the prominent fin lobes of some genera, for example *Merluccius* and *Mora*, are separated by very short rays and the lobes may appear to be separate fins; in genera such as *Trisopterus* and *Molva* fins that are structurally separate are immediately adjacent at their bases and may appear to be lobes of a single fin. Fins may be covered with thick, pigmented skin so that dissection or x-ray photographs are required in order to obtain precise counts of rays. Many gadiforms have minute scales and in those species for which scale counts are required for identification, it may be necessary to use a lens. The same equipment may be needed to investigate the presence or absence of head pores. In order to accurately count the branchiostegal rays it may be necessary to manipulate the cheek flap in order to spread out the branchial membrane that connects the rays. Although the keys have been designed to use as few as possible of these difficult characters, their total exclusion has not been possible in many instances. A final difficulty in identifying these fishes results from poorly known taxonomy. Many of the species included in the catalogue could not be examined personally by the authors who, in such cases, had to rely on incomplete or inadequate descriptions and illustrations from the literature. This applies particularly to some of the keys and descriptions in the family Macrouridae (see page 90 for further details). No matter how expert the identifier or how much equipment is available, unanswered questions of taxonomy, which exist at all levels of classification among the gadiforms, will prevent accurate identification.

All of the above notwithstanding, the best method of identification is to look at the illustrations, most of which have been drafted to emphasize diagnostic features. Check distributions to see if the illustration that resembles your specimen is of a species that lives where your specimen has been caught. Then check the written section on Diagnostic Features, and finally, try to key out your specimen.

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T. Inada

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The bulk of the manuscript was completed before my visit in 1988 to the USSR, where tremendous collections of macrourids from the Indian Ocean were examined in Moscow and Leningrad. The results of my studies there could not be included to any great extent, but I was able to incorporate some refinements to the keys and descriptions of several species. I thank the respective academies of sciences of the USA and USSR for their support of my visit. N.V. Parin, Y.N. Shcherbachev, Y.I. Sazonov, E. Karamovskaya (PPSIO); I. Verghina (MMSU); A. Neyelov and V. Barsukov [deceased] (ZIL) are thanked for their hospitality and assistance.

T. Iwamoto

1.5 Illustrated Glossary of Technical Terms and Measurements

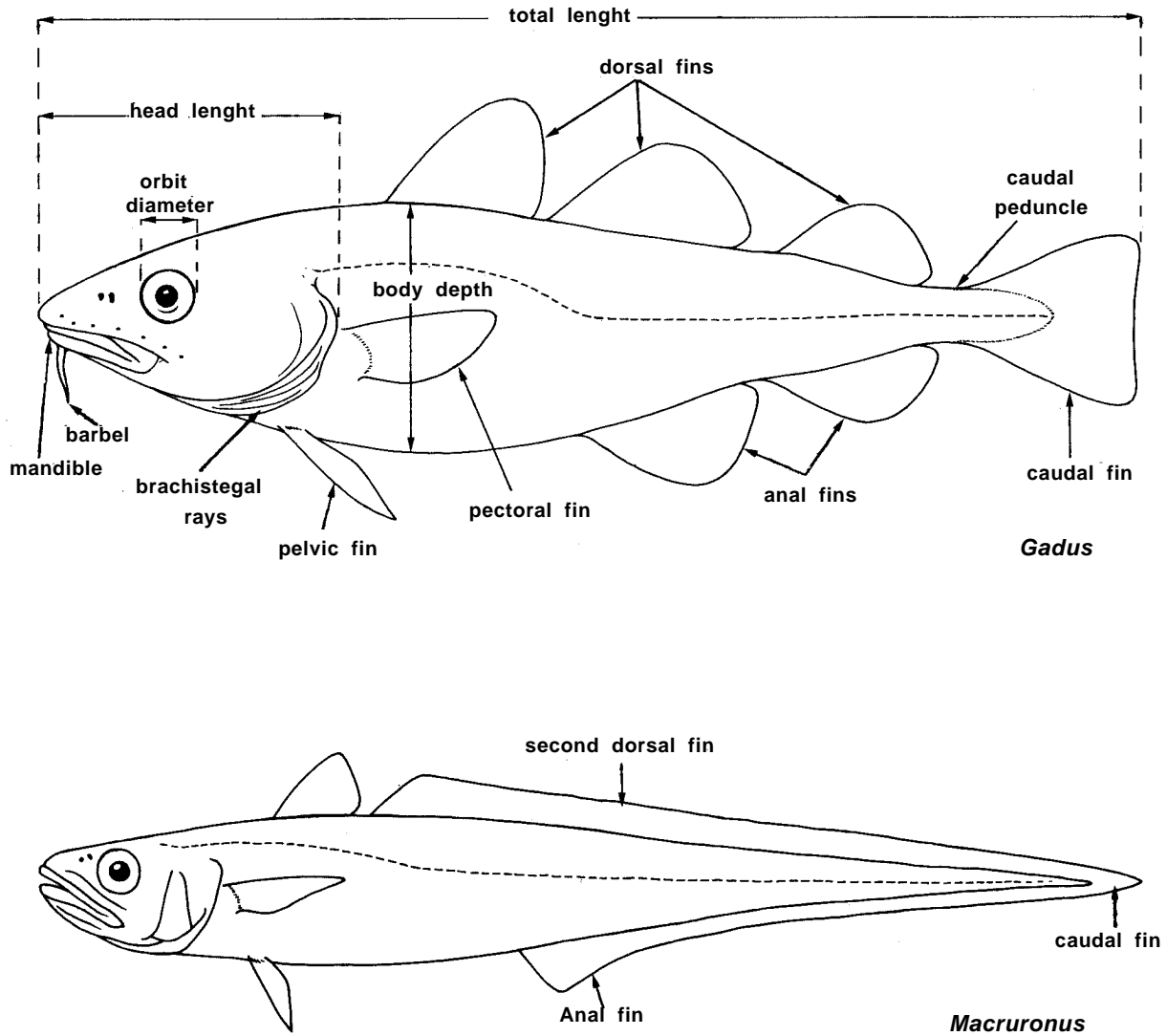


Fig.3 External morphology and measurements

Barbel - A fleshy filament of variable size. In many gadiform species, one barbel is present on the chin (Fig. 3) and a variable number on the snout (Fig. 4).

Branchiostegal rays - Bony stays that support the membrane that seals the opening to the gill chamber (Fig. 3).

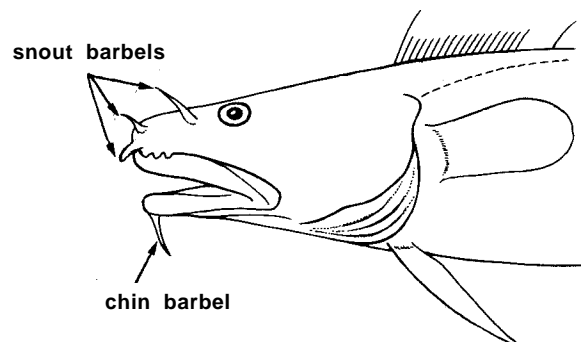


Fig. 4

Caudal fin - The shape of the hind margin of the caudal fin varies in different species, and sometimes even within species. The fin may be truncate, rounded, forked, concave, or asymmetrical (Fig. 5).

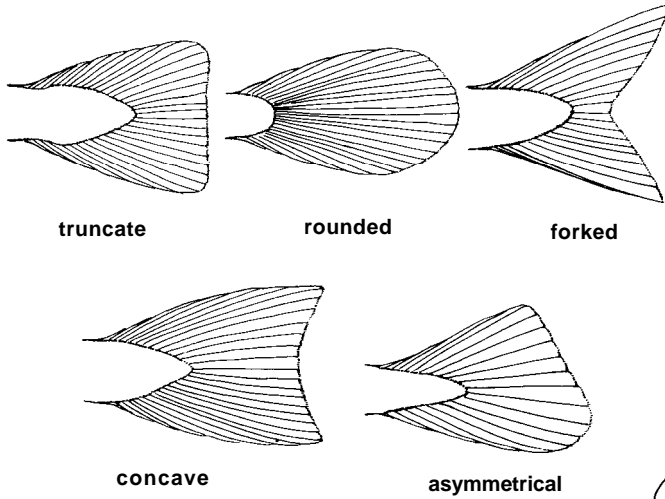


Fig. 5 Shapes of caudal fin

Caudal peduncle - The region behind the ends of the dorsal and anal fin bases and before the procurrent rays of the caudal fin (Fig. 3). Not present in macrourids and several other genera.

Dentition - The teeth of gadiform fishes vary in shape from strong, recurved canines in *Lyconus* and *Merluccius*, to compressed and closely set in *Tripterygius*, to very small, densely packed teeth in brush-like pads or rows in many other genera.

Frontals - Largest bones in the roof of the skull, bearing a V-shaped crest in merlucciids (Fig. 6).

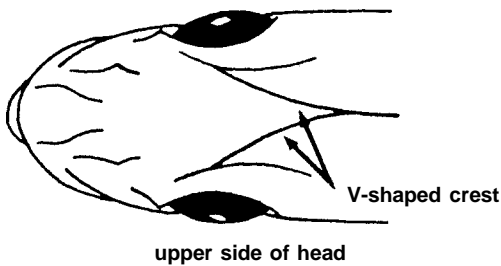


Fig. 6

Gill arch - The J-shaped structure under the gill cover (opercular flap) that carries fleshy gill filaments along the posterior outer margin and stiff bony gill rakers along the anterior outer margin (Fig. 7). Both filaments and rakers vary in size among some species. Rakers are absent along the outer margin of the first gill arch in some macrourids.

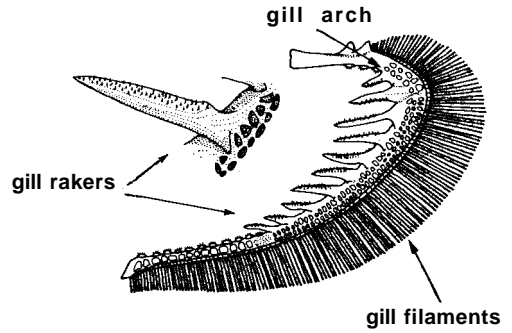


Fig. 7 Gill arch of *Merluccius*

Gill opening - The opening of the flap over the gills is smaller and restricted to below the level of the pectoral fin in muraenolepidids (Fig. 8).

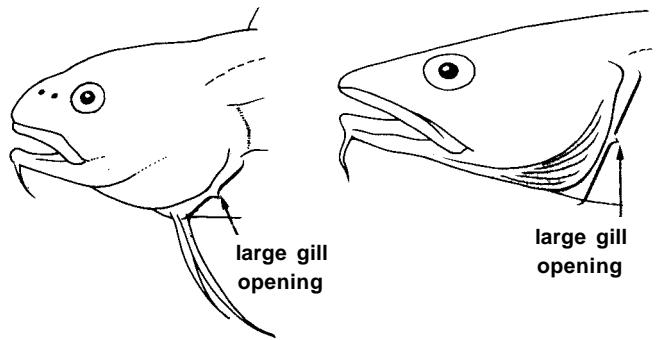


Fig. 8

Gill slits - The openings between gill arches. First gill slit restricted in some macrourids.

Hypural bones - The terminal bones at the posterior end of the vertebral column (Fig. 9). The number of bones, varying from one to several is important in classifying gadiform families.

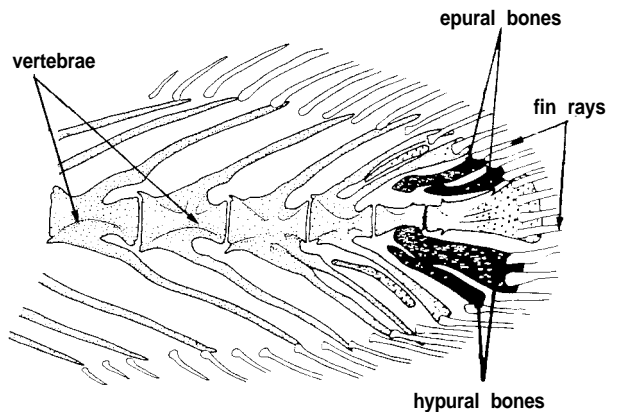


Fig. 9 Caudal skeleton (*Euclichthys*)

(from Patterson & Rosen, in Cohen, 1989)

Infraorbital (or suborbital) ridge - A longitudinal crest or ridge variously formed along the mid-lateral axis of the infraorbital region. Sharp and armed with strong, scute-like scales in many grenadiers (Fig. 10). Various continuous with ridges on snout and preopercle, separating dorsal and ventral areas of head.

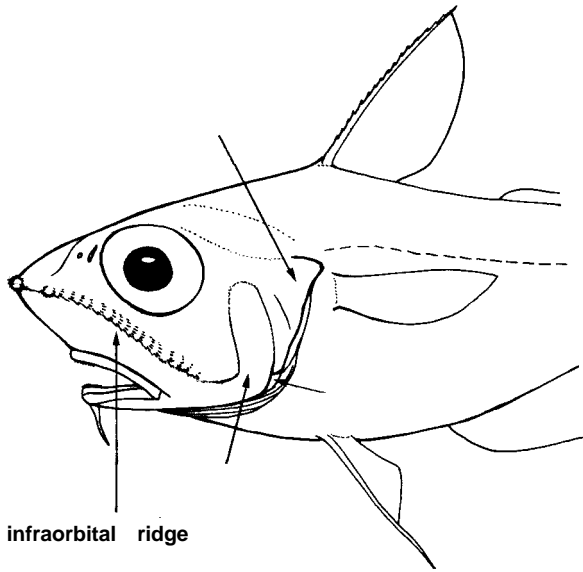


Fig. 10 Macrouridae

Interopercle - One of the bones of the gill cover, useful in classifying macrourids (Figs. 10 and 14)

Lateral line - A sensory system that runs in a line along the body (Fig. 3) and is present also on the head. The position of the line on the body and the degree to which it is continuous or interrupted is a useful taxonomic character. On the head, it may be in a canal, which is marked by small pores, or it may be represented by series of tiny papillae which are sometimes sunk in pits and called pit organs (Fig. 11).

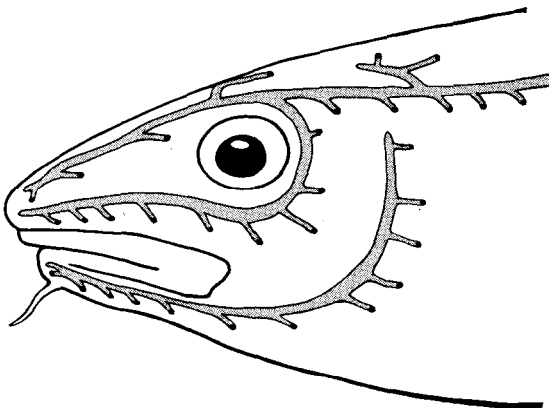


Fig. 11 Lateral line system on head, with pores
(adapted from Svetovidov, 1948)

Light organs - Of two kinds when present in gadiforms. One is an extensive area of silvery skin carrying a pattern of darkly pigmented striations (Fig. 12a) and occurs in the merlucciid *Steindachneria*, the macrourids

Hymenocephalus, *Lepidorhynchus*, and perhaps other genera as well. A second kind is indicated by a dark, scale-less area variously located on the ventral surface and occurs in a number of genera of morids and macrourids (Fig. 12b).

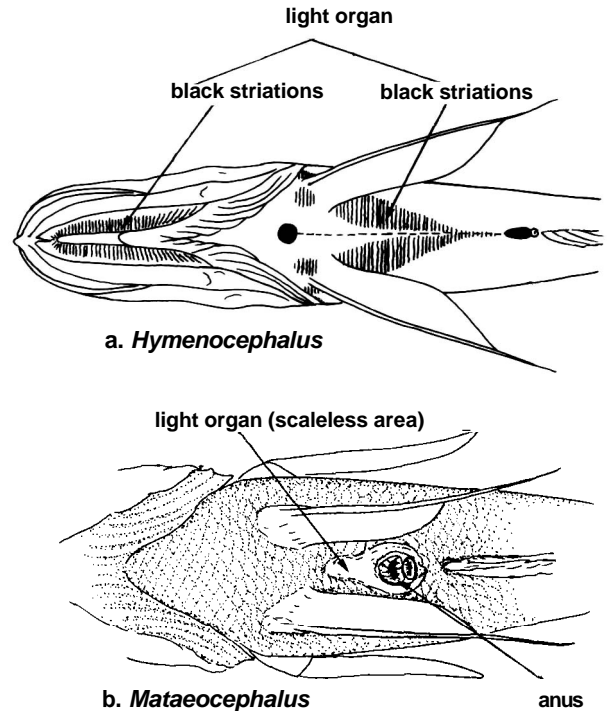
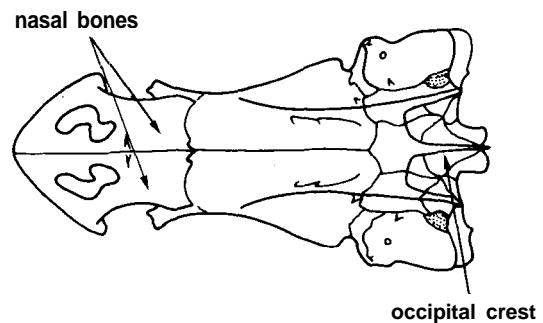


Fig. 12 Ventral view

Mandible - The lower jaw, which includes several bones, of which only the dentary bears teeth.

Nasals - Various enlarged and anteriorly elongated in many macrourids. The median and lateral processes are united in some *Coelorinchus* forming a solid horizontal front to the snout (Fig. 13). A stout, spiny, button scale at top and lateral angles of snout in many macrourids.



Coelorhynchus kishinouyei

Fig. 13 Dorsal view of skull
(after Okamura, 1970b)

Nostrils - Paired openings from olfactory organ (Fig. 3). Sometimes with tentacles; variously located in some species and a useful taxonomic character.

Occipital crest - Compressed median crest at top rear of skull (Figs 13,14). Variously free from, or tightly connected with spine at top of first vertebrae.

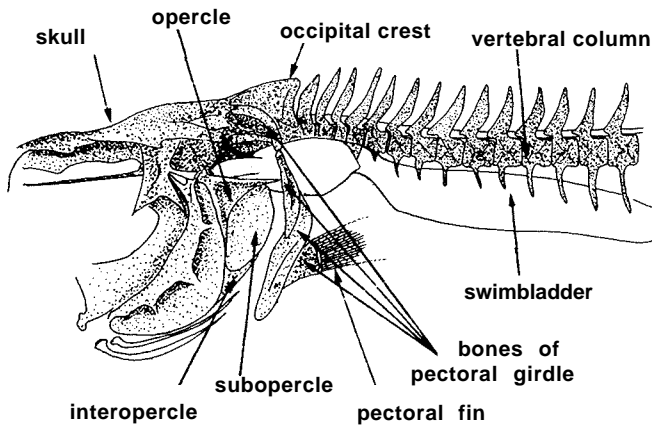


Fig. 14 Anterior part of skeleton (Family Moridae)
(after Paullin, in Cohen, 1989)

Olfactory bulbs - The part of the brain concerned with the sense of smell. In most fishes a swelling at the forebrain but in many gadiforms located farther anterior and connected to the main body of the brain by a slender olfactory tract.

Palatines - A pair of bones in the roof of the mouth located behind and lateral to the vomer. Sometimes bearing teeth.

Parapophyses - Paired bony projections from the ventral region of the vertebral centrum (Fig. 15).

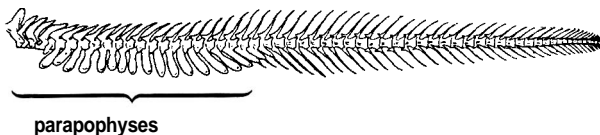


Fig. 15 Vertebral column, lateral view (*Eleginus*)
(from Svetovidov, 1948)

Pectoral girdle - A series of bones that support the pectoral fin and are attached dorsally to the rear of the skull (Fig. 14).

Premaxilla (= Premaxillary) - The elongate bone that forms the tooth-bearing part of the upper jaw in gadiform fishes. At the anterior end a dorsally directed prong called the premaxillary pedicel (Fig. 16).

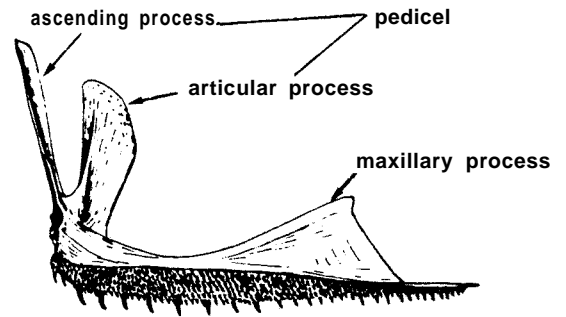


Fig. 16 Right premaxilla (medial view)
(*Ventrifossa*)

Procurent rays - The shorter rays that extend along the caudal peduncle (Fig. 17).

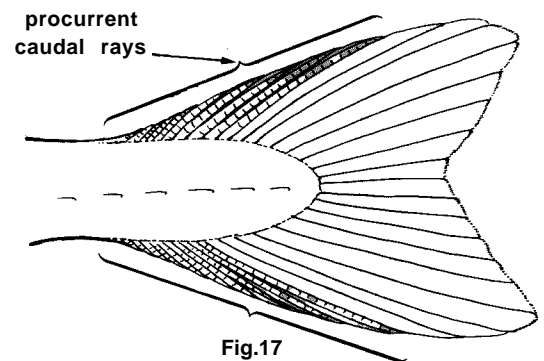


Fig.17

Scale rows - Counted in two ways, along the lateral line and as number of oblique rows between lateral line and the base of the first or second dorsal fin.

Scale spinules - Tiny spines present to varying degree on the scales of many macrourids.

Subopercle - One of the bones of the gill cover (Fig. 14); the posteroventral angle is variously pointed in macrourids of the genus *Coelorinchus* and used as an identification aid.

Swimbladder - A gas filled sac in the dorsal part of the body cavity (Fig. 14). In gadiforms thick walled and important in classifying many forms. It may have anterior extensions that are attached to the rear of the skull as in morids, or ones that are free as in *Gadus* and perhaps other genera as well. In the swimbladder wall are found the rete mirabile, a system of capillary beds, and the gas gland, a structure that secretes and absorbs gas; both have characteristic patterns in many species. A paired sheet of muscles overlying the anteroventral end is present in males of some macrourids. These are believed to have sound-producing (drumming) capabilities.

Vomer - A median bone at the forward part of the roof of the mouth, with teeth present or absent in gadiforms.