1. INTRODUCTION

This catalogue presents fisheries-related and identification information for the 39 presently recognized species of emperors and large-eye breams (emperors are also sometimes collectively referred to as scavengers, pig-face breams, barefaces, and emperor snappers). The details on biology, ecology, catch statistics and fishing techniques come principally from the literature. These data are abundant for some species and scarce for others, mostly because lethrinids vary widely in their importance to fisheries. The taxonomic information in this catalogue is based on an ongoing revision of the family (G.R. Allen has taken the lead in the revision of ***Gnathodentex***, ***Gymnocranius***, ***Monotaxis*** and ***Wattsia***, while K.E. Carpenter has taken the lead in the revision of ***Lethrinus***). There has been much progress in solving the numerous taxonomic problems and further research is aimed at resolving the remaining uncertainties. The interested reader is alerted to a forthcoming revision by the authors.

Taxonomically, lethrinids are considered one of the most problematic of tropical marine fish families. Several major attempts at revision of this group have been made in this century, and these accounts are laced with lamentations regarding the perplexity encountered. For example, Smith (1959) stated: "It must be emphasized, however, that at present, the positive identification of certain species, preserved, without colour notes from fresh specimens, is, especially with juveniles, a formidable, almost impossible task. In scarcely any other group of marine fishes it is so difficult to decide the true definition of some of the species." Walker (1975) summed up his taxonomic experience with lethrinids: "For one can only emerge from such a study, particularly of preserved material, with a feeling of humility and some apprehension." Sato (1978, 1986), who has worked on both subfamilies of lethrinids remarked on the genus Lethrinus: "The intrageneric systematics within this genus, however, has been in great chaos..." and for the Monotaxinae, "I have tried to review this subfamily and to show major moot points."

Due to the problems in identifying preserved specimens of lethrinids, it is no wonder that the earliest taxonomists gave many different names to the same species. The most prolific earlier worker on this group, Valenciennes (in Cuvier & Valenciennes, 1830), recognized 37 species of the genus ***Lethrinus***, 31 of these were new names. Today, we recognize 27 species of ***Lethrinus***, of which only 11 of Valenciennes' names are valid. In fact, Valenciennes assigned nine different new names to the species that we recognize here as ***L. nebulosus***. Pieter Bleeker, the eminent Dutch ichthyologist who spent much of his life studying fishes in Indonesia in the 19th century, named 17 species of lethrinids, three of which we recognize here as valid. Only the earliest worker on lethrinids, Forsskål (1775), was successful in naming a number of species, all of which we recognize as valid. This is mainly because he was the first taxonomist to work on lethrinids and, he worked only on the few lethrinid species from the Red Sea, which are relatively easy to differentiate.

The problems previously encountered in identification of lethrinids are primarily due to the fact that many of the characters traditionally used to differentiate fishes are relatively constant among certain species of lethrinids. When they are live or still fresh, colour can be very helpful for species determination. Body colours and markings also add to the confusion because they can change substantially according to the time of day, the emotional state of the fish, geographic locality, and state of freshness. Despite these problems, previous researchers have contributed to our understanding of the systematics of lethrinids and have revealed a number of characters that help differentiate species. For example, Sato (1978) found that the pattern of dark pigment cells, or melanophores, on the membranes of the pelvic fin, help differentiate some species which were previously difficult to separate. In preparation for this publication, 75 different counts, measurements and observations were taken on each of over 450 specimens of ***Lethrinus***, representing all species, including most of the type specimens found in major museums in the United States, Europe and Australia. Of the 75 characters found to vary among ***Lethrinus***, 25 are presented here in detail. Among these 25 useful characters there are some that have not previously been used to differentiate species of ***Lethrinus***. An additional 310 specimens were examined for key characters in museums and from collections made specifically for lethrinids in the Philippines, Thailand, and the Arabian Gulf. This catalogue is timely therefore as a report on the progress in taxonomic work on lethrinids and to clear up many of the identification problems that have existed.

In keeping with the formal and style of the "FAO Species Catalogue" series, literature citations in the text have been kept to a minimum. The literature that has been consulted is listed in the bibliography. A glossary of technical terms and illustrations are included to reduce the necessity to consult other sources for identification purposes.

Acknowledgments

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We offer special thanks to J.E. Randall who made available his collection of lethrinid colour transparencies; these were a tremendous aid in our work. Jack's enthusiasm for finding solutions to the many taxonomic problems plaguing the Lethrinidae served as inspiration and impetus for our work.

We are grateful to the illustrators, R. Swainston and P. Lastrico who prepared the colour paintings and drawings for this catalogue.

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Special gratitude is due to Cecilia Luz M. Carpenter for her patience, and the countless hours spent in helping to collect and computerize data on lethrinid specimens; a comprehensive review of ***Lethrinus*** for this catalogue would not have been possible without her help; and to Connie Allen who provided considerable assistance with library work, data processing and preparation of the typescript. M. Eustaquio assisted in osteolgical preparations. The C.O. Minsalan family provided laboratory space during field work in the Philippines.

1.1 Plan of the Catalogue

A family description is given, followed by a key to genera which includes the species of monotypic genera. The species accounts are arranged alphabetically by genera and species. Each genus is introduced with its type reference and synonyms. Descriptions of genera with more than one species also list diagnostic features and, comments on general biology, habitat, distribution, and interest to fisheries. The genus descriptions are followed by a key to the species and species accounts in alphabetical order. The information pertaining to each species is arranged by paragraphs, in the order listed below:

(1) **Scientific Name:** The reference for the original description and type locality is given.

(2) **Synonyms :** All invalid names and combinations that have been applied are referenced.

(3) **FAO Name :** The FAO English name is considered the standard to be used for fishery purposes. This should avoid confusion which can be caused due to the existence of multiple names for the same species or the same name for several species. The FAO name is not intended to supplant the use of local names but rather, to serve as a worldwide reference. FAO French and Spanish species names are not yet available.

(4) **Diagnostic Features :** Distinctive characters of the species are given as an aid for identification, accompanied by useful diagrams. These diagnoses should be consulted to confirm species identified using the illustrated key.

(5) **Geographical Distribution:** The general geographic range is given in the text and illustrated on a map. The map shading includes known areas of occurrence and intermediate areas between locality records where a species is expected to be found.

(6) **Habitat and Biology:** Information on habitat, behaviour, food habits and reproduction is given.

(7) **Size:** The approximate maximum total length is given.

(8) **Interest to Fisheries:** General information on the extent, type of fisheries, and utilization are given. Detailed fisheries data is unavailable for all species and therefore, only a qualitative assessment is possible.

(9) **Local Names:** These are given where published names are available. Often, a single local name is applied to several species.

(10) **Literature:** Recent references which contain illustrations that could be useful for identification are given. It is stated if an incorrect name is given in the reference.

(11) **Remarks:** Useful information which is not appropriately covered in the previous paragraphs is included here. Frequently used incorrect scientific names are mentioned here.

1.2 General Remarks on Lethrinids

Systematics : The Lethrinidae are tropical marine perciforms found entirely in the Indo-Pacific, except one species that occurs only in the eastern Atlantic. They belong to the suborder Percoidei, a diverse group containing many families whose relationships are poorly understood. Within this suborder, lethrinids are included under the superfamily Sparoidea which also contains the families Sparidae (porgies), Centracanthidae and Nemipteridae (threadfin bream). Among percoids, sparoicis appear most closely related to the Lutjanoidea (includes the snappers or Lutjanidae and, fusiliers or Caesionidae) and the Haemuloidea (includes the grunts or Haemulidae and Inermiidae). There has been much confusion concerning the familial allocation of the genera and species amongst these groups.

Akazaki (1962) and Johnson (1981) defined the limits of sparoid fishes. They present convincing evidence to support the integrity of what are currently considered the constituent genera of the Sparidae, Centracanthidae, Nemipteridae and Lethrinidae. The genera included in the Lethrinidae are ***Gnathodentex, Gymnocranius***, ***Lethrinus***, ***Monotaxis*** and, ***Wattsia.*** These genera are divided into two subfamilies by some taxonomists (Fig. 1), although the integrity of this classification is still in need of critical evaluation. A phylogenetic analysis of this group is currently in progress. A problem encountered in this analysis is the determination of outgroup relations and polarity of character states within the Lethrinidae. The supraspecific classification presented here is therefore considered provisional.

Table 1 lists the major characters that vary among the genera of the Lethrinidae. Many of these characters are easily observable and there is no problem in distinguishing between genera. The number of dorsal and anal fin rays, the presence or absence of scales on the cheek, and the presence of certain bony structures on the maxilla are constant within genera and serve as convenient aids in identification. Three of the five genera of lethrinids are monotypic (***Gnathodentex***, ***Monotaxis***, and ***Wattsia***) and the integrity of these taxa appears incontroversible. The almost effortless task of differentiating among genera of lethrinids does not properly prepare one for the many difficuities that can be encountered in separating species within the multispecies genera ***Gymnocranius*** and ***Lethrinus***. No attempts have been made to separate subgenera within ***Gymnocranius***. In ***Lethrinus*** however, some taxonomists have divided this genus into different genera or subgenera. These attempts have centered around differences in dentition and lateral teeth types; ***Lethrinella*** has been meant to include species with long snouts and conical lateral teeth while ***Lethrinus*** includes species with short snouts and rounded or molariform lateral teeth. There are many intermediates in these basic forms however, and it is difficult to assign some species to one or the other taxa; subdivisions within the genus ***Lethrinus*** are generally ignored in recent work. We prefer to defer any recognition of supraspecific division within what we recognize as ***Lethrinus*** or ***Gymnocranius*** until a thorough evaluation of phylogenetic relationships within these genera is complete.

Habitat and Biology: Lethrinids are bottom-feeding, carnivorous, coastal fishes, ranging primarily on or near reefs. They generally possess large, strong jaws and food preference is correlated with the type of lateral jaw teeth and to a certain extent, the length and angle of the snout found in a particular species. For example, the humpnose big-eye bream, ***Monotaxis grandoculis***, has large, well-developed molars, and a short, blunt snout. It consumes molluscs, sea urchins and other hard-shell invertebrates. At the other extreme, the longface emperor, ***Lethrinus olivaceus***, has conical lateral teeth, and an elongate, gradually sloping snout. It feeds mainly on fishes

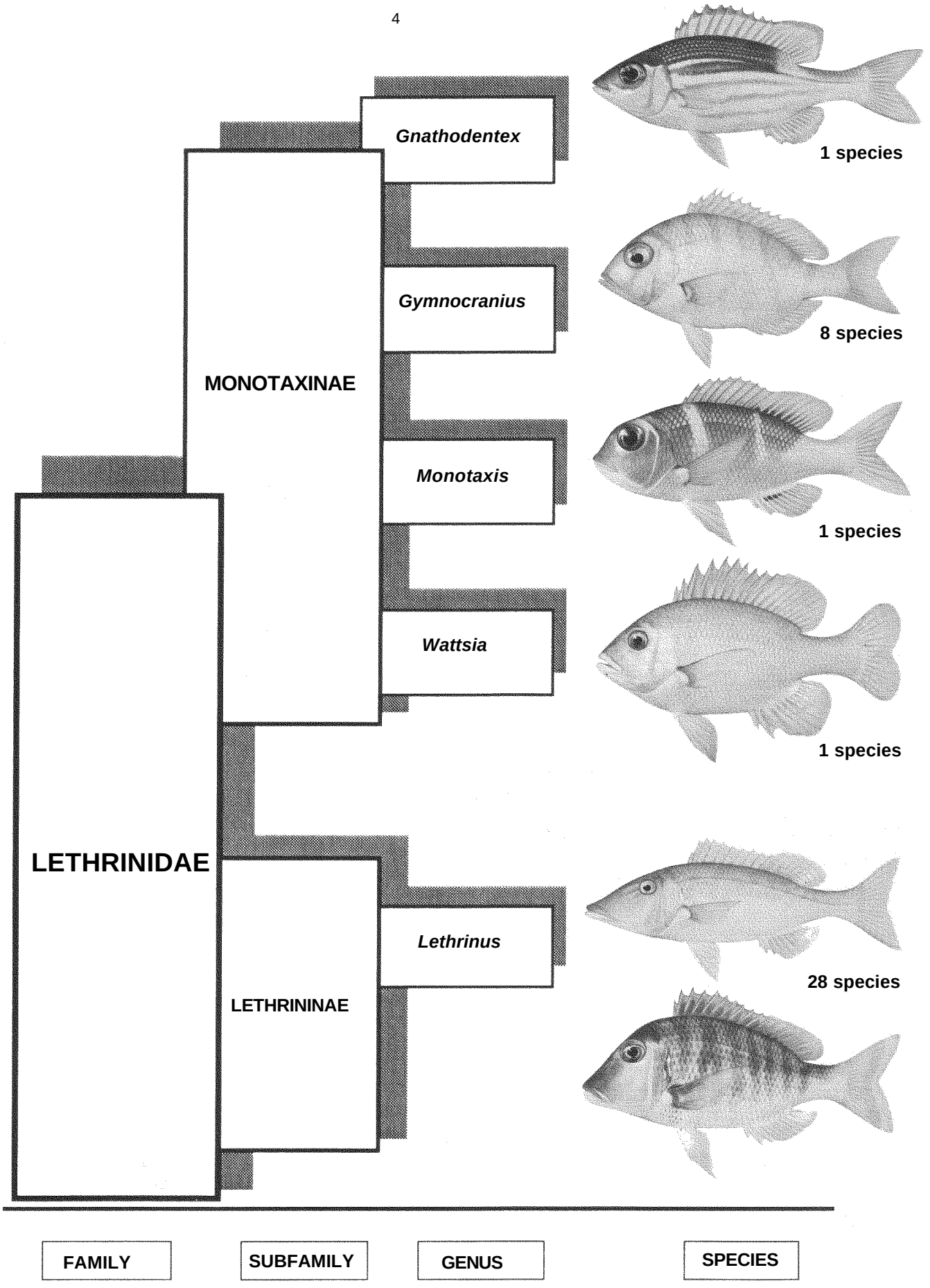

Fig. 1 **A provisional classification of the subfamilies and genera of the Family Lethrinidae**

Table 1

Characters found to vary among genera of the Lethrinidae

	Gnathodentex	***Gymnocranius***	***Wattsia***	***Monotaxis***	***Lethrinus***
Dorsal rays	10	10	10	10	9
Anal rays	8-9	9-10	10	9	8
Pectoral rays	15	14	14	14	13
Lateral-lìne scales	68-74	46-49	41-47	44-47	42-49
Scales above lateral line	5	5-6	5	4-5	5-6
Cheek scales	+	+	+	+	-
Pectoral axil scales	-	-	-	+	- +
Maxilla surface	denticulated	smooth	denticulated	denticulated	smooth, knob ridge
Lateral teeth	conical	conical, molars	conical	molars	conical, molars
Ascending premax. process to alveolar ramus ratio	> 1	> 1	> 1		> 1
Subocular shelf	+	+	+	+	-
Epiotic-pterotic suture	narrow	narrow	narrow	narrow	broad
Vertical sphenotic flange	eroded	eroded	eroded	eroded	entire

and crustaceans. Between these extremes, species exhibit many intermediate lateral teeth types, from molar through rounded to conical, and snout shape also varies widely. Diet concommittantly varies between the extremes from primarily hard-shell invertebrates, to soft-shell invertebrates, to fishes, with combinations of these food items found in many species. There is also a great deal of selectivity for particular food items. For example, the predominant food eaten by some species is sea urchins. Food items most commonly reported for lethrinids are polychaetes, crabs, shrimps, gastropods, bivalves, squid, octopus, sea urchins, sand dollars, starfish, brittle stars, and fish. Feeding in most species is done at night, although many species forage coincidentally or purposefully during the day. Diurnal feeding migrations are reported for some species. For example, ***Lethrinus borbonicus*** typically ranges over sandy bottom during the day and at night they feed actively over the reef. Another species, ***L. miniatus*** , reportedly rests on the reef during the day and actively forages over sand bottoms at night.

Lethrinids are mostly reef fishes but their preferred habitat is sandy or rubble substrate. The reefs which they frequent can be shallow, coralline reefs or deep, rocky reefs. One species frequents the outer edges of the continental shelf and is caught to depths of 180 m. Lethrinids can be solitary or schooling and do not appear to be territorial. They often form large aggregations while spawning.

Sequential protogynous hermaphroditism is apparently the usual mode of sexuality in lethrinids, that is, when sexually mature they are initially females and later in life they change sex. This explains certain characteristics of lethrinid populations: males tend to be larger on the average than females and there is usually a sex ratio slightly in favor of females. There is considerable overlap in size distributions between males and females suggesting that sexual transformation occurs over a wide size range. The testes of males that have been examined histologically (Young & Martin, 1982) show typical secondary male (having transformed from an ovary) characteristics and no evidence has been found to support occurrence of primary males (testes form without going through an ovary stage).

There are few reports on the spawning behavior of lethrinids. This is not surprising since it is thought that most lethrinids spawn after dark. Much of what is reported about the spawning behavior of emperors comes from observations by fishermen (Johannes, 1981). Spawning is apparently preceded by local migrations at dusk to

particular areas near a reef, either in a lagoon or on the outer edge of a reef. Spawning occurs in large aggregations while swimming in circles near the surface or, at the bottom of reef slopes. This activity is at a peak, around the time of the new moon.

Spawing seasonality varies widely among different species of lethrinids, and for some species, it varies between localities. Spawning is generally prolonged throughout the year with peaks occurring in different seasons. For example, Toor (1964) reports spawning in the redspot emperor to occur mostly from December to February and again from June to August in India. Loubens (1980a) reports a high percent of sexually mature indìviduals of the redspot emperor between September and December in New Caledonia. In the Red Sea, Kedidi (1984) reports peaks in sexually mature females for this species in January and again in April-May. Fecundity for the redspot emperor was estimated at 12 000 to 77 000 eggs spawned per female per year (Toor, 1964).

Courtship behaviour has been reported for the grey large-eye bream in a public oceanarium during May and June shortly after dusk (Suzuki & Hioki, 1978). During courtship, males assume a colour pattern different from its normal pattern, with several wavy silver stripes on the sides. Females remain motionless in aggregations near the bottom and males initiate spawning by nudging the abdomen of the female with their snouts. The pair then ascend slowly toward the surface together and release their gametes simultaneously at a depth of about one or two meters; release is followed by a quick return to the bottom.

The only sexual dimorphism reported for lethrinids is the average larger size of males and the courtship colouration described for the grey large-eye bream. It is possible however, that future studies may reveal different courtship colours for other lethrinids. This is one possible mechanism for the various colour patterns observed in some emperors.

Fertilized eggs reported for lethrinids are pelagic with an oil globule, spherical, colourless and between 0.68 to 0.83 mm in diameter (Fig. 2). Normally, hatching occurs 21 to 40 hrs after fertilization. Newly hatched larvae are 1.3 - 1.7 mm with an unopened mouth, unpigmented eyes, a large yolk sac and variable body pigmentation. Notable characteristics of the larvae are extensively developed head spination and cheek scales (Fig. 3).

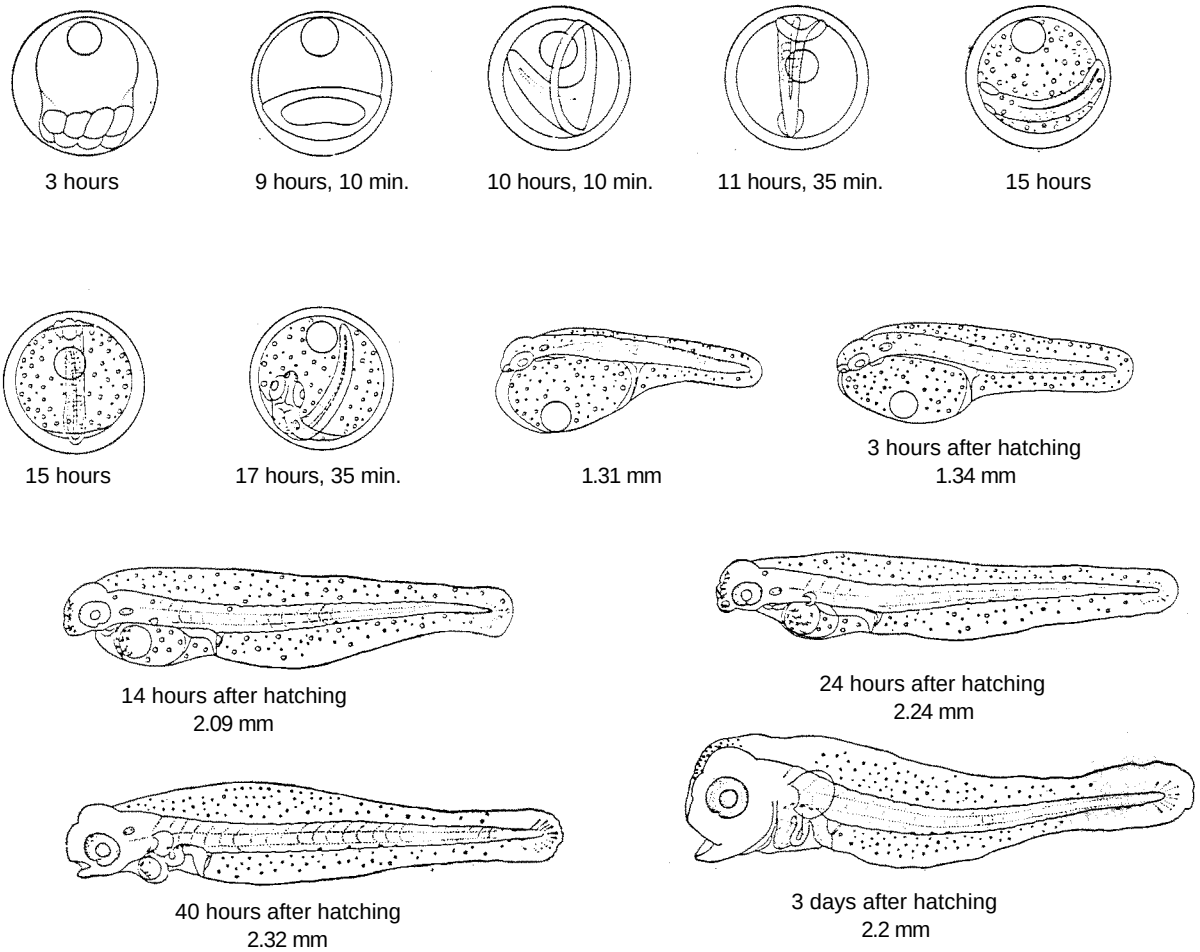

Fig. 2 Developmental series of ***Gymnocranius griseus*** (from Renzhai & Suifen, 1980)

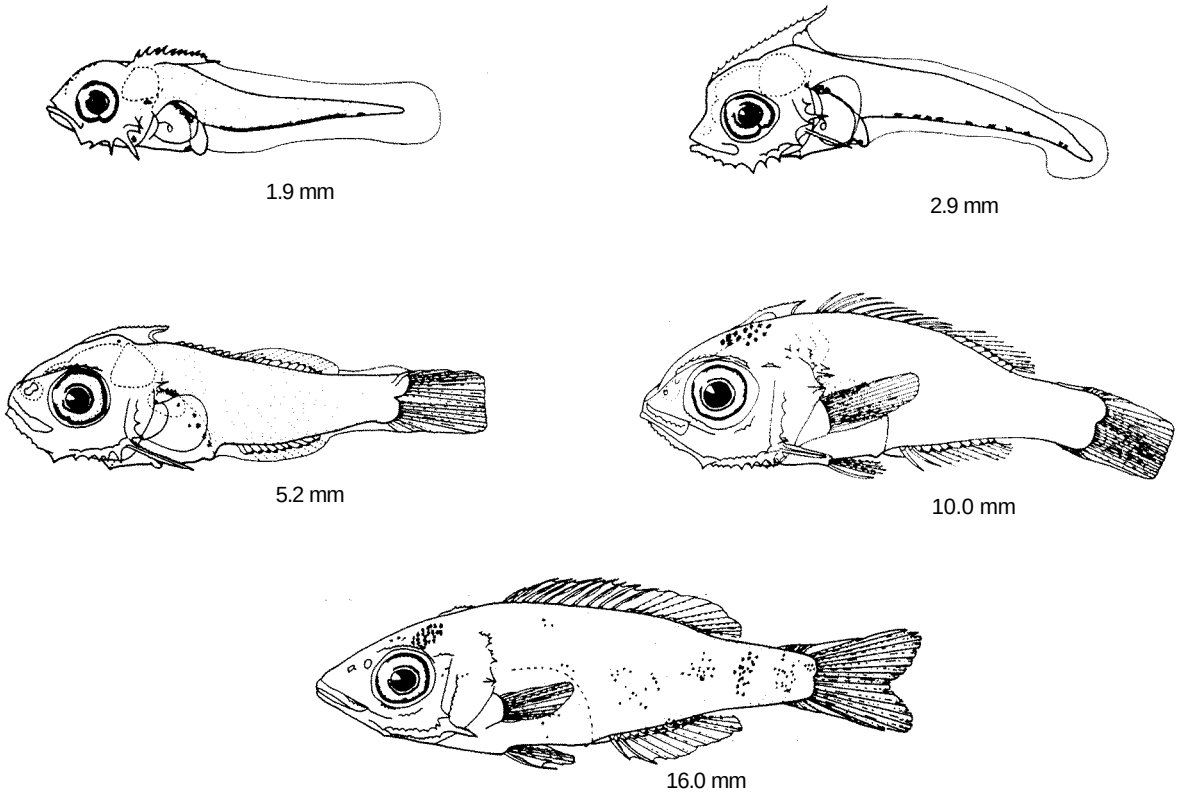

Fig. 3 ***Lethrinus*** larvae (probably more than one species) from Leis & Rennis, 1983.

Lethrinids are relatively long-lived fishes. The average maximum observed age reported for nine species of lethrinids is 17 years; the range of maximum observed age is seven to 27 years. Average age of growth cessation is 11 years; the range, four to 17 years. Both scales and otoliths have been used to age lethrinids and annual mark formation on these structures are generally distinct.

Population dynamics of lethrinids have been studied widely and the von Bertalanffy growth parameters asymptotic length ($L_{infinity}$) and the coefficient of growth (K) are known for populations of over 15 species. The asymptotic length ranges from about 19 cm total length for the smallest species studied to over 100 cm total length for the largest. Growth coefficient estimates range from around 0.1 to 0.9. Estimates of rate of natural mortality range from 0.5 to 1.9.

Fisheries: Emperors and large-eye breams are an important component of commercial, recreational and artisanal fisheries of the worid, although the degree of importance varies. At certain localities and times, a species may be the major focus of a fishery, or the most prized catch. Some lethrinids however, never gain notable importance to fisheries, usually because of their small size or because they are relatively uncommon, but all species are invariably caught and consumed in particular countries. There has been a more-or-less steady increase in the reported total world catch of lethrinids (mostly commerciai fisheries) from 28 242 to 57 887 metric tons over the period 1980 to 1987 (Table 2). This reported catch is from the western central Pacific (including Hong Kong), the eastern Indian Ocean, and the western Indian Ocean; the latter area contributing the greatest percent catch (Table 3). The catch of lethrinids is relatively small compared to the total world catch of fishes (in 1987, this was 92 693 400 metric tons), but for certain countries, lethrinids are of primary importance to fisheries (Table 4). In 1987, lethrinids were the most important fish group in terms of contribution of weight to the fisheries in Mauritius (31% of total catch by weight) and Qatar (25% of total catch by weight); and they are among the top four most important also in Bahrain, Fiji, Saudi Arabia, the United Arab Emirates and the Yemen Arab Republic.

The reported world catch of lethrinids is greatly underestimated in the above account, either because of difficuities in tabulating statistics from different countries, or simply because the catch of lethrinids goes unreported as part of an artisanal or sport fisheries. For example, in the Philippines which is not reported to contribute to the world catch in the above statistics, lethrinids are very common in markets but reported as "Porgies"; a name generally referred to sparids but in the Philippines these refer mostly to lethrinids. The

Table 2

Reported world catch of emperors and large-eye bream in metric tons (FAO, 1989)

	1980	1981	1982	1983	1984	1985	1986	1987
Emperors	26 987	33 620	34 613	43 300	44 364	42 978	51 159	56 710
Large-eye breams	1 255	1 194	1 091	936	882	808	829	1 177
TOTAL LETHRINIDS	28 242	34 814	35 704	44 236	45 246	43 786	51 988	57 887

Table 3

Reported catch of emperors and large-eye breams by fishing area for the year 1987

	Catch (mt)	% Total
Western Central Pacific (incl. Hong Kong)	17 444	30%
Eastern Indian Ocean	2 044	4%
Western Indian Ocean	38 399	66%

average annual catch of lethrinids in the Philippines is estimated at around 11000 metric tons which would increase the above estimates by 19%! Another country not included in the world catch of lethrinids is Kuwait, which averages 50 to 100 metric tons of lethrinids per year (total catch of fin fish in Kuwait usually between 5 000 to 7 500) and lethrinids are considered one of the most valuable market fishes. Other countries which report lethrinids as common or valuable in their fisheries but are not reported as part of the world catch include Australia, India, Japan, the Maldives, Papua New Guinea, Sri Lanka, Taiwan, Thailand, and various countries of Micronesia, Melanesia and Polynesia.

In most areas where lethrinids are fished, stocks are near the level of maximum exploitation. In some areas, however (e.g. the trap fishery in the Tuamotus), lethrinids appear to be overfished. Certain stock assessment activities in this decade also indicate a large potential exploitable stock of lethrinids (e.g. northern Australia) or possibility of further exploitation (e.g. Mauritius Banks).

Lethrinids are potentially utilizable in aquaculture. Certain species grow well in cage culture and at least one species, ***L. nebulosus*** was shown to be tolerant of low salinities. Research also indicates that lethrinid larval culture is feasible.

Emperors are an important component of recreational fisheries in some countries. In Australia, they are one of the most popular sport fishes because they are powerful adversaries. It is not uncommon for keen anglers to travel hundreds of kilometers for the challenge of landing certain emperors.

Lethrinids are caught by a variety of fishing methods. The most important are handlines, droplines, traps, trawls, shore seines, gill nets and vertical longlines.

Generally, the soft white flesh of lethrinids is considered of excellent culinary quality. In some areas however, the flesh of smaller individuals of certain species is said to have an unpleasant chemical taste and smell. This taste is sometimes described as 'coppery' or similar to iodine and is thought to be the result of diet on particular invertebrates. In addition, some species in the South and Central Pacific are reported as ciguatoxic at certain times and localities.

Lethrinids are generally marketed fresh.

Table 4

Reported catch in metric tons and percent of total catch of emperors and large-eye breams by country for 1987; if in the top four, rank of importance among all species reported

	Catch (mt)	Percent Catch	Rank
Western Central Pacific and Eastern Indian Ocean			
Fiji	2 870	8%	(4)
Hong Kong	954	< 1%	
Indonesia	14 000	< 1%	
Kiribati	1 620	4%	
Malaysia	44	< 1%	
Western Indian Ocean			
Bahrain	930	12%	(4)
Kenya	666	< 1%	
Mauritius	5 552	31%	(1)
Oman	1 006	< 1%	
Qatar	672	25%	(1)
Saudi Arabia	7 700	17%	(2)
Seychelles	308	8%	
Tanzania	9 500	3%	
United Arab Emirates	7 951	9%	(2)
Yemen Arab Republic	3 000	14%	(2)

1.3 Illustrated Glossary of Technical Terms and Measurements

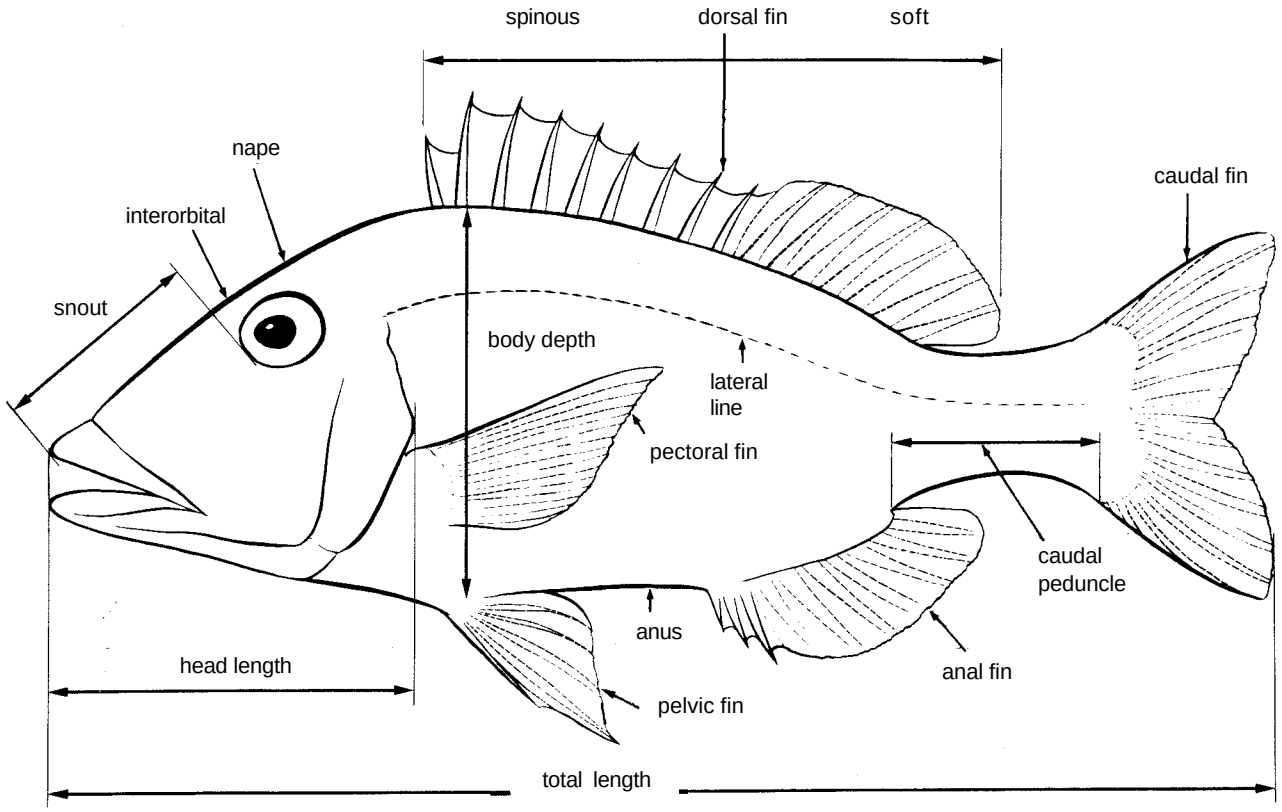

Fig.4 External morphology and measurements

Angle of snout relative to upper jaw - This angle is measured by placing a clear protractor on the snout of the fish with the lower plane bisecting the premaxilla, parallel to the lower line of the premaxilla, with the point of the fine resting on the tip of the snout; the upper plane is taken from the tip of the snout and running along a fine over the anterior profile of the snout (Fig. 5).

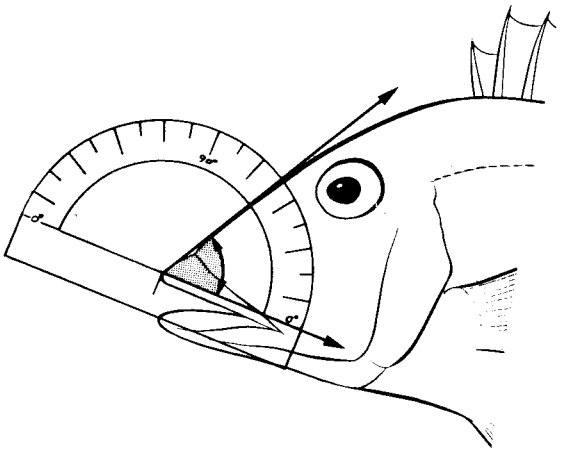

Fig. 5 Angle of snout relating to upper jaw

Anal fin base - The anal fin base is measured from the front base of the anterior-most anal spine to the posterior base of the fast anal ray (Fig. 6).

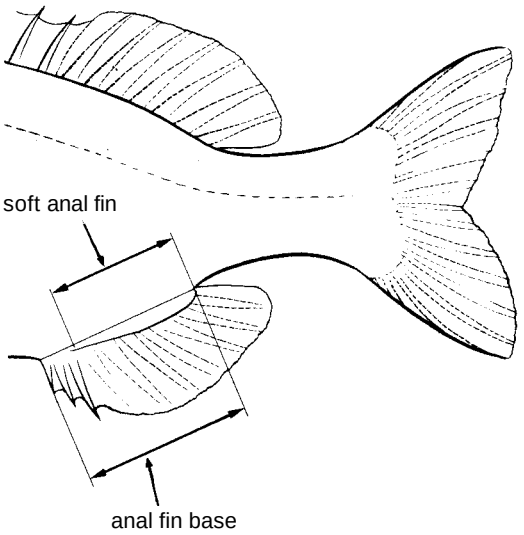

Fig. 6 Length of soft anal fin base and of entire anal fin base

Axil - The angular region between the pectoral fin and the body (Fig. 7).

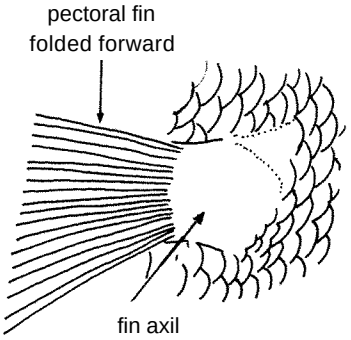

Fig. 7 Pectoral fin axil

Canine - A prominent elongate, sharp tooth. In lethrinids, canines are usually restricted to the front part of the jaws (Fig.8).

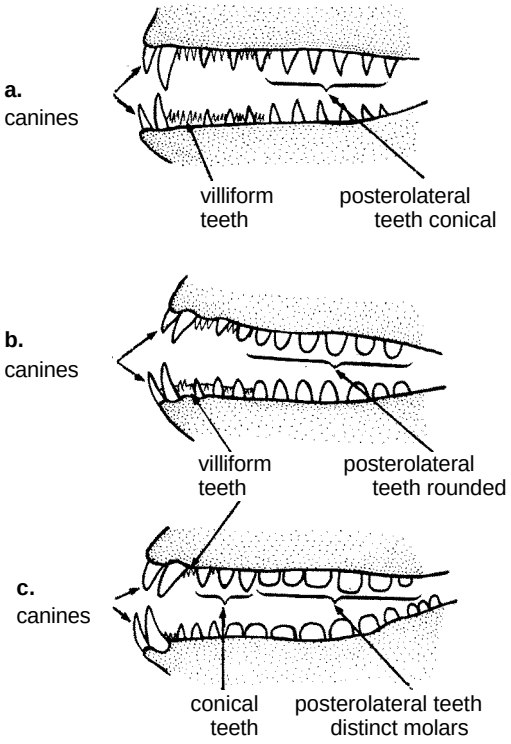

Fig. 8 Types of teeth

Carnivore - A flesh-eating animal.

Caudal peduncle - The narrow end of the body between the posterior basal ends of the dorsal and anal fins and the base of the caudal fin (Fig. 4).

Cheek, Cheek height, Cheek scales - The area between the lower part of the eye and the lower limb of the preopercle. The measurement of cheek height is taken from the lower-most point on the orbit to the furthest point on the angle of the preopercle (Fig. 9). Species of the genus ***Lethrinus*** have naked cheeks, while other lethrinids possess 4 to 6 vertical rows of scales (Fig. 10).

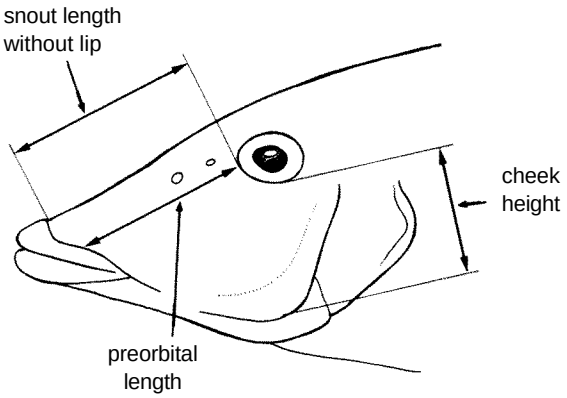

Fig. 9 Measurement of cheek and snout (without lip)

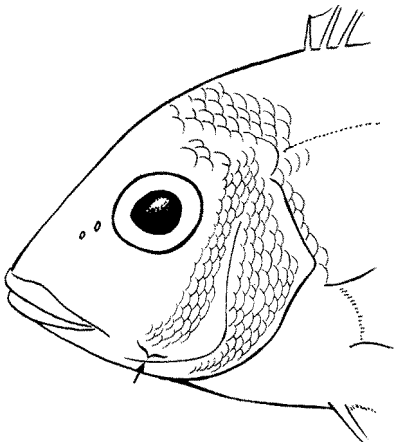

Fig. 10 Rows of scales on cheek

Compressed - Flattened from side to side; refers to relative body width.

Conical - Cone-shaped; refers to teeth (Fig. 8a,c).

Denticulate - Having the appearence of teeth or teeth-like structures (Fig. 13a).

Dorsal - Toward the back or upper part of the body.

Dorsal fin - A median fin along the back. In lethrinids, the fin is supported by spinous rays anteriorly and soft rays posteriorly (Fig. 4).

Edentate - Without teeth.

Interorbital - The region of the head above and between the eyes. In lethrinids, this region can be either concave, nearly flat, or convex(Fig. 11).

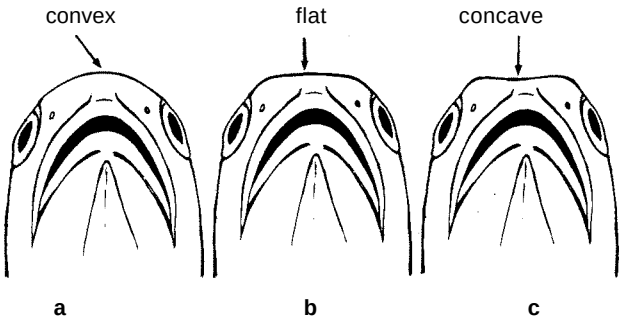

Fig.11 Anterior view of head showing shape of interorbital region

Lateral line - A series of pored or tubed scales forming a raised line along the side of the body (Fig. 4). The lateral-line scales are counted from the most anterior pored scale near the upper end of the operculum to the base of the caudal fin which is detected by the crease which results from folding the fin forward. There are often one or more tubed scales that continue onto the caudal fin, posterior to the base of the caudal fin; these scales are not included in the count of lateral-line scales.

Lateral teeth - Teeth in the sides of the jaws, observed by opening the mouth and parting the lips (Fig. 8).

Maxilla - The bone of the upper jaw lying above the premaxilla (Fig. 12). The outside surface of the maxilla in lethrinids can be either relatively smooth, or have either a denticulated ridge (Fig 13a), a simple ridge (Fig. 13b) or a distinctive knob (Fig. 13c). The presence of these structures can be determined in lethrinids by pulling the upper jaw forward so that it protrudes and running the side of a probe over the surface of the maxilla, in a backward direction, and top to bottom to feel the contours of the surface.

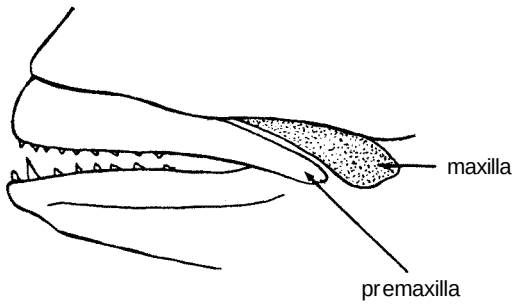

Fig. 12 Bones in upper jaw: maxilla and premaxilla
(Maxilla usually covered when mouth is closed, shown here with overlying bone removed)

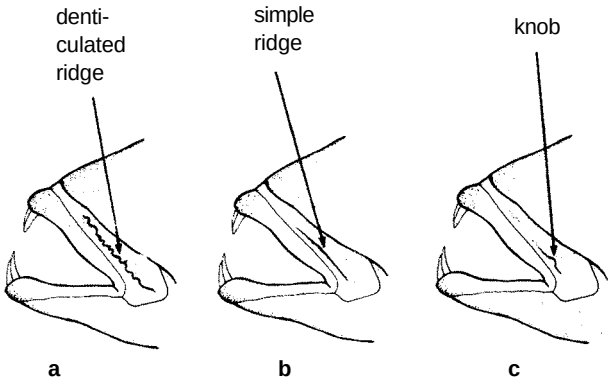

Fig.13 Outer surface of maxilla
(lateral teeth not shown)

Molars, Molariform - Low, broad and rounded teeth; shaped like molars (Fig. 8c).

Naked - Without scales.

Nape - The region of the head where the skull joins the body (Fig. 4).

Opercle - The large bone forming the upper posterior part of the gill cover (Fig. 14).

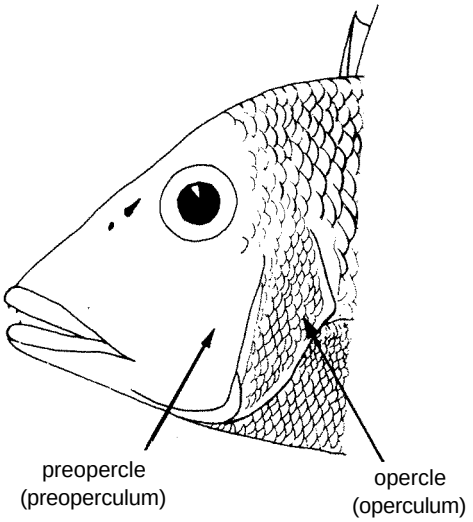

Fig. 14 Lateral view of head

Orbit - The bony border surrounding the eye. Measurements or distances which involve the orbit do not include the fleshy rim of the orbit. It is sometimes necessary to slightly squeeze the rim of the orbit to exclude this fleshy portion.

Palate - The roof of the upper jaw which includes the palatine and vomer bones. These bones bear teeth in many fishes but they are edentate in lethrinids.

Parietal scales - An isolated patch of scales above and behind the eye on the nape, the lame as the supra-temporal patch of scales (Fig. 15).

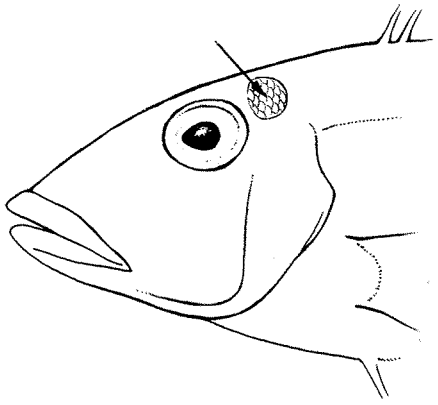

Fig.15 Location of parietal or supratemporal patch of scales

Peduncular scales - Scales found on the caudal peduncle (Fig. 16). The scales in the lover series around the caudal peduncle are counted by starting with, and including, the lateral line scale near the base of the caudal fin, counting alt rows below this scale that terminate on the caudal fin, around the ventral most portion of the caudal, while rotating the fish, and counting the scales on the other side of the caudal peduncle, up to and including the lateral fine scale on the opposite side where the count began.

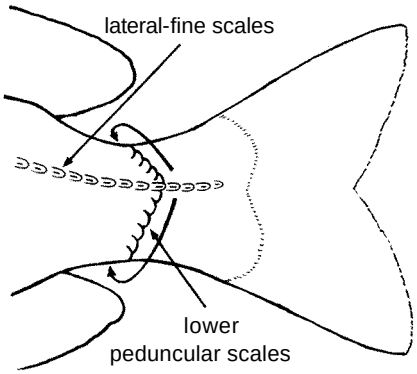

Fig. 16 Scale counts on caudal peduncle

Posterior - The rear or hind portion.

Premaxilla - The anterior bone of the upper jaw (Fig. 12).

Preopercle - Bone on the cheek in front of the opercle and forming the front part of the gill cover (Fig. 14).

Preorbital width - Distance between anterior edge of preorbital bone (can be felt at about midpoint of upper jaw, behind lip) to anterior edge of orbit (Fig. 9).

Rays - The rigid structures that support the fin; soft rays are segmented, and flexible; spinous rays are stiff, unsegmented, and support the anterior portion of the anal and dorsal fins in lethrinids (Fig. 4).

Scales above and below lateral fine - A transverse series of scale rows; scales below lateral-fine are counted from the origin of the anal fin, not including the median scale row, along a forward diagonal to the lateral fine, but not including the lateral line scale; scales above the lateral line are counted from the middle rays of the spinous portion of the dorsal fin (near the base of the fifth or sixth dorsal spine), including the row of small scales at the base of the dorsal fin (this is usually listed as 112 a scale), on a diagonal backward to the lateral line, and not including the lateral line row (Fig. 17).

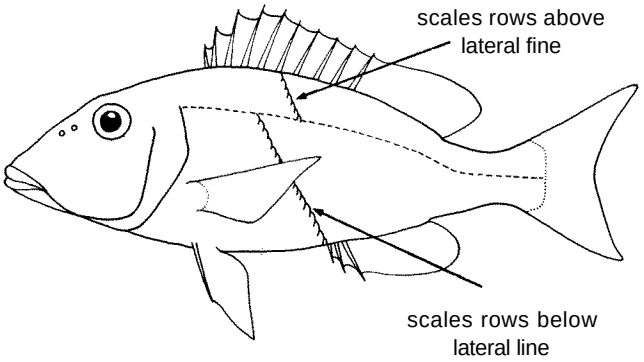

Fig. 17 Scale counts above and below lateral line

Snout - The area between the tip of the upper lip and the anterior margin of the eye (Fig 4). In lethrinids the snout is often measured without lip (Fig. 9).

Supratemporal patch of scales - Same as the parietal patch of scales (Fig. 15). When counting these scales, all scales in the patch are enumerated, including the small scales often at the lover periphery of the patch.

Transverse series - These are scale rows counted in an oblique series above and below (but not including) the lateral line (Fig 17). See "Scales above and below the lateral fine".

Tubercle - A small bump. Some lethrinids have a small tubercle on the crown of a molariform tooth (Fig. 18).

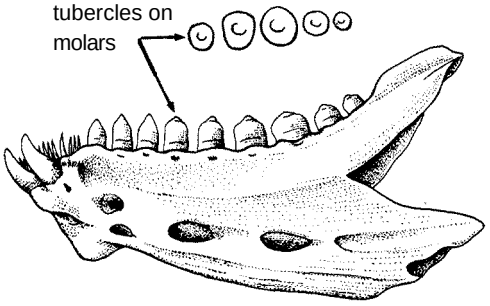

Fig.18 Lover jaw (left dentary borse)

Villiform teeth - Numerous small stender teeth, usually in a band (Fig. 8).

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