1. INTRODUCTION

The family Polynemidae comprises 41 species in 8 genera (Fig. 1). In many parts of the tropics, the marine polynemids, including ***Eleutheronema***, ***Galeoides***, ***Leptomelanosoma***, ***Pentanemus*** and ***Polydactylus***, are important food fishes (some species attaining 2 m in total length), with the largest quantities taken commercially. However, separate catch statistics are not reported for most species and landings are usually summarized as a vernacular name which often corresponds to two or more species. This lack of species-specific catch data is due to the difficulty in identifying many of the species. For the proper management of this resource correct specific identifications are necessary.

Polynemids are easily identified as a family due to their similarity in overall body appearance, and condition of the eye and pectoral-fin rays. They have a conical snout, inferior mouth, adipose eyelid (firm transparent gelatinous tissue) covering the eye, 2 well-separated dorsal fins, 3 to 16 thread-like (individually-separated) lower pectoral-fin rays (pectoral filaments) and the caudal fin deeply forked to lunate. However, these external morphological similarities have led to much confusion in specific identifications. The pectoral filaments of polynemids are the most distinctive feature, specific identifications to date having been based mainly on the number and length of the former. Taxonomic confusion in polynemids may, however, result from identifications based on pectoral filaments only. For example, ***Polydactylus*** species characterized by a large black anterior lateral-line spot have until recently been considered to include 3 species, ***P. microstomus*** (5 pectoral filaments), ***P. mullani*** (7 filaments) and ***P. sextarius*** (6 filaments). The latter, however, an Indo-West Pacific species originally believed to range from South Africa to Papua New Guinea, is now known to comprise 3 species: ***P. malagasyensis*** (distributed off the east coast of Africa and Madagascar), ***P. persicus*** (Persian Gulf), and ***P. sextarius*** (India to Papua New Guinea), all with 6 pectoral filaments.

The purposes of this polynemid catalogue are to provide a means of identifying the various species and to present a synopsis of the literature on the biology and fisheries of these species. The genera ***Eleutheronema*** (3 species), ***Galeoides*** (1 species) and ***Leptomelanosoma*** (1 species), plus the Indo-Pacific ***Polydactylus*** (14 species) and eastern Pacific ***Polydactylus*** (2 species) have been recently revised by the author of this catalogue and colleagues (Motomura and Iwatsuki, 2001a; Motomura, Iwatsuki and Kimura, 2001b; Motomura *et al.*, 2002a; Motomura, 2002; Motomura, Kimura and Iwatsuki, 2002) the results of those studies being incorporated here. Treatments of the genera ***Filimanus*** (6 species) and ***Parapolynemus*** (1 species) were greatly facilitated by the revisions of Feltes (1991, 1993). Taxonomic information given here for ***Polynemus*** (8 species) and western Atlantic ***Polydactylus*** (3 species) was taken from on-going revisions of those genera by the author, and publications on the living marine resources of the western central Pacific and western central Atlantic (FAO Species Identification Guides for Fisheries Purposes). The taxonomic information provided for all of the polynemid species covered here is based on the examination by the author of all known available type specimens and a large number of non-type specimens, representing broad geographical ranges of each species.

1.1 Habitat and Biology

Polynemids are epibenthic fishes found in the tropical and subtropical waters of all oceans. Most species occur in coastal waters and estuaries, although some (e.g. ***Polynemus*** species and ***Polydactylus macrophthalmus***) live entirely in fresh-water rivers. Polynemids generally occur on sandy and muddy bottoms in depths less than 150 m, although juveniles are found in seagrass beds and tidepools.

As major predators of coastal and estuarine ecosystems, most polynemids generally feed on a variety of fishes and crustaceans. A few small species (e.g. ***Filimanus*** species) have numerous gillrakers adapted for plankton feeding. Young stages of most polynemids also feed on plankton, some species later becoming piscivorous with growth. The number of gillrakers tends to decrease with fish size in all of the ***Eleutheronema*** species, those on the anterior parts of both the upper and lower limbs being replaced during fish growth by tooth plates with villiform teeth. Furthermore, each gillraker on both the upper and lower limbs becomes shorter with fish growth, indicative of a change from plankton feeding to piscivorous habits.

The pectoral fins of polynemids are their most distinctive feature, being divided into an upper part with the rays joined by membranes and a lower part with 3 to 16 separate rays (pectoral filaments). The pectoral filaments have been considered to operate as a sense organ, enabling polynemids to search for food in muddy water (Motomura, Sado and Kimura, 2002). In particular, ***Parapolynemus*** and ***Polynemus*** species, generally occurring in fresh-water rivers and estuaries, have extremely long pectoral filaments that exceed their total length. Pectoral filaments are usually spread forward to enable searching for prey while swimming and probably act as a substitute for eyesight. An exception, ***Leptomelanosoma indicum***, also generally occur in muddy water in large river mouths (e.g., Ganges and Chao Phraya rivers) but does not have long pectoral filaments. Instead it has an unique swimbladder with numerous appendages in 2 rows along the entire, approximate midlateral surface. Because these appendages are fully inserted into the lateral walls of the abdominal cavity, the tips being located near the outer layer of epidermal tissue, the swimbladder is considered to have the capacity for sensing water vibrations caused by movements of prey. Underwater observations of ***L. indicum*** indicate that it usually spreads the pectoral filaments, but remains motionless on the bottom, a behaviour pattern unknown in other members of the family. In addition to the apparent ability of ***L. indicum*** to sense subtle water vibrations while themselves remaining motionless, there exists also the possibility that the swimbladder appendages transmit sounds and may enable communication with conspecific individuals. Specializations of both the pectoral filaments and swimbladder in polynemids have probably arisen as an adaptation to their muddy habitats.

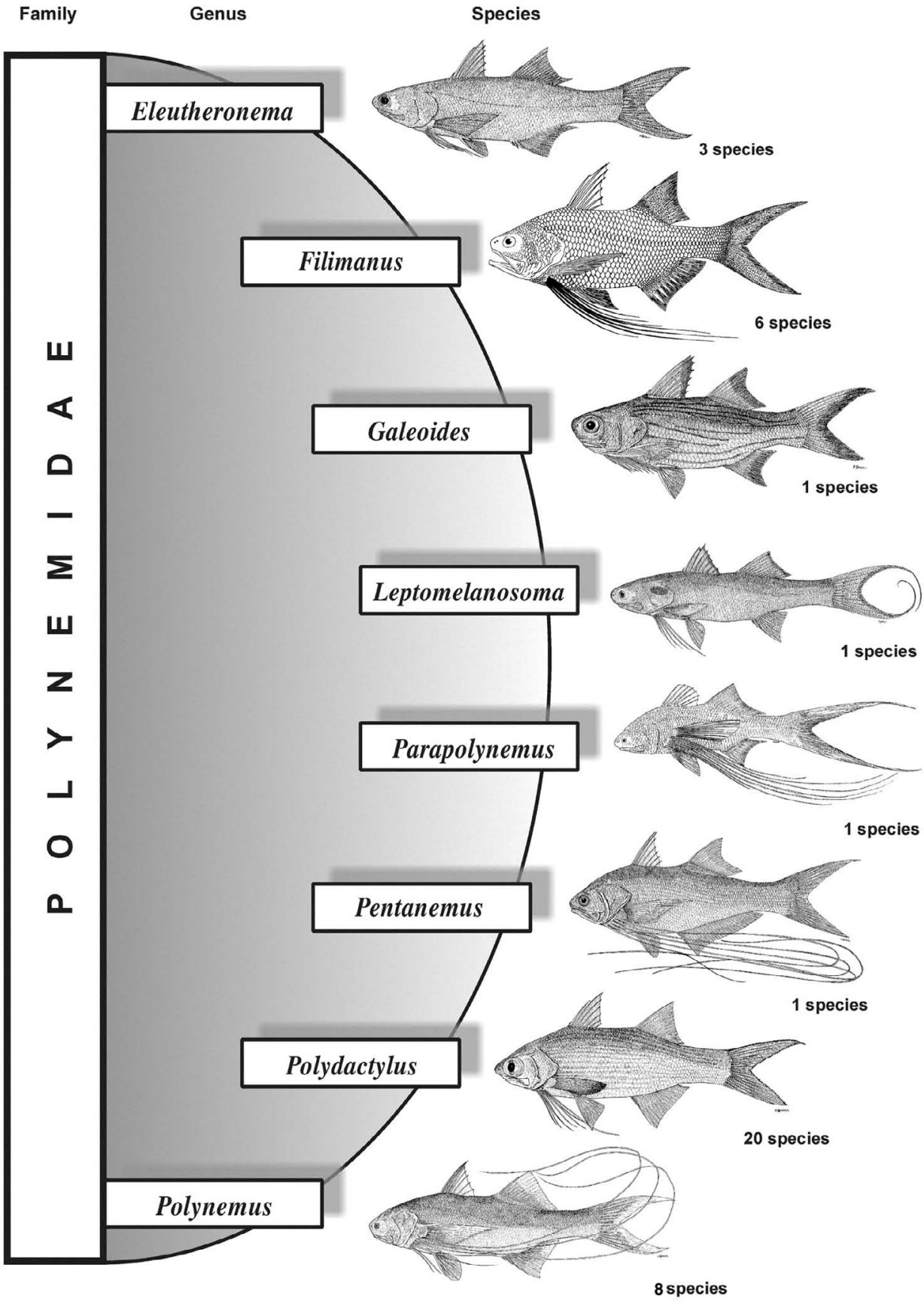

Fig. 1 Classification of the family Polynemidae

Judging from the few species that have been studied, most polynemids exhibit protandry, their sex changing from male to female with fish growth. However, spawning behaviour of polynemids has never been reported. Although the spawning grounds of most polynemids are also unknown, they probably occur in coastal waters and estuaries. In the northern Bay of Bengal, ***Polynemus paradiseus*** may ascend higher up rivers than usual for breeding purposes (David, 1954).

Information on the larval development of polynemids is minimal. Eggs are spherical and pelagic (de Sylva *in* Moser *et al*., 1984). Data for ***Eleutheronema tetradactylum***, ***Polydactylus sexfilis***, and ***Polynemus paradiseus*** suggest that polynemids are 0.8 to 2.0 mm long at hatching, have a large yolk sac, unpigmented eyes, an unformed mouth and pigment that may intensify during yolk absorption (Jones and Menon, 1953; Kowtal, 1972; May, Akiyama and Santerre, 1979). Leis and Trnski *in* Leis and Carson-Ewart (2000) described larval developmental stages of ***Eleutheronema tetradactylum*** and ***Polydactylus multiradiatus*** from Australian waters (Figs 2 and 3), and summarized larval morphology of Indo-Pacific polynemids: moderate to deep bodied, compressed; gut coiled and triangular, reaching between 44 and 62% of body length; gas bladder conspicuous, located near apex of gut mass; head initially round, slightly elongated by 7 mm; mouth initially oblique, reaching to level of midpupil, becoming horizontal and inferior, and extending beyond level of posterior margin of eye by about 6 mm; many small villiform teeth on upper and lower jaws at 2.5 mm; adipose eyelid not present until at least 15 mm, but present by settlement stage; a very small spine appearing at anterior tip of maxilla, disappearing shortly thereafter (see Figs 2c and 3b); dorsal- and anal-fin anlagen appearing in preflexion larvae from 3.0 to 4.1 mm, soft rays developing during flexion; feeble spines of first dorsal and anal fins starting to form in early post-flexion larvae; pectoral-fin elements beginning to differentiate in late flexion to early post-flexion larvae; pectoral-fin rays fully ossified by 6.5 mm, at which time ossification of pectoral filaments initiated; all pectoral-fin elements ossified shortly after 7 mm; pectoral-fin base initially level with top of gut, but beginning to move ventrally shortly after flexion, eventually located near ventral margin of body by about 12 mm, except in ***Parapolynemus*** and ***Polynemus*** species; scales beginning to form laterally on trunk and tail from about

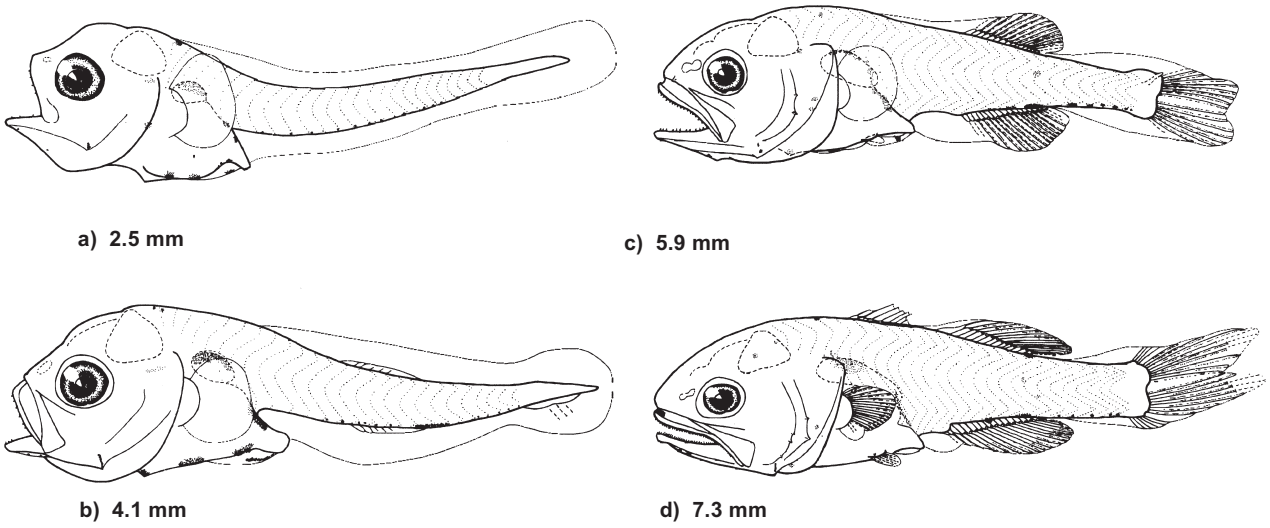

Fig. 2 Larval development of *Eleutheronema tetradactylum* (from Leis and Trnski, 2000)

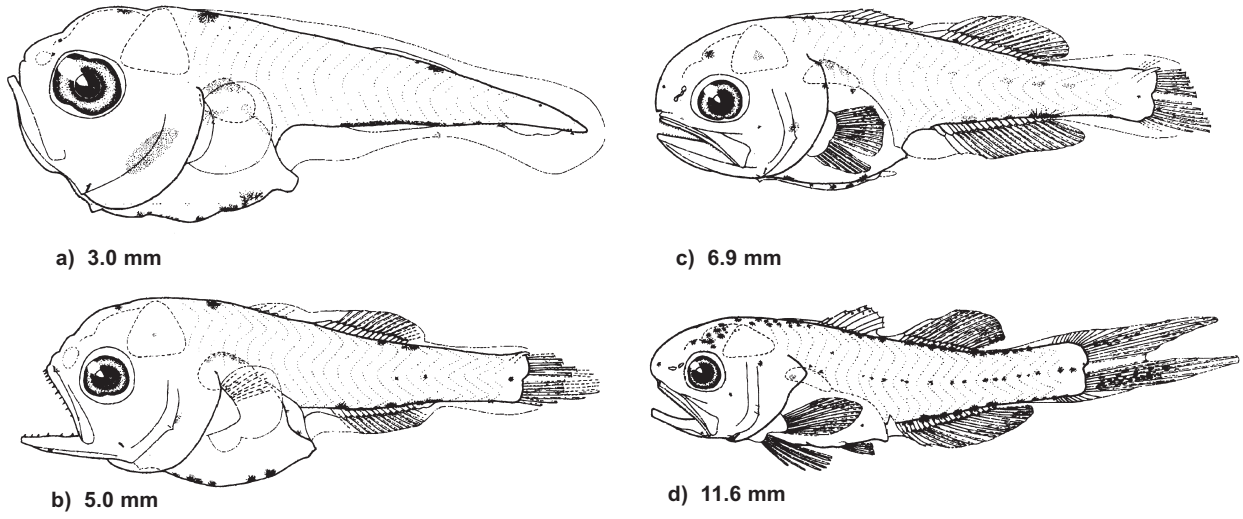

Fig. 3 Larval development of *Polydactylus multiradiatus* (from Leis and Trnski, 2000)

12 mm; all scales present by 15 mm. There is no distinct transformation to the adult form, development is direct and gradual. A small spine on the anterior tip of the maxilla is the only apparent specialization for larval life.

1.2 Fisheries

Polynemids are of considerable importance in commercial fisheries in tropical and subtropical seas worldwide (Tables 1 to 3), and in the sport fishery off Australia and the west coast of Africa. A few species (e.g. ***Eleutheronema tetradactylum*** and ***Polydactylus sexfilis***) are used in aquaculture (Table 4). Fresh-water polynemids (e.g. ***Polynemus aquilonaris*** and ***P. multifilis***) are sometimes used as aquarium fishes.

Polynemids contribute to the global fish catch, with about 93 000 t reported to FAO for 2001 (Table 1). FAO compiled statistics (Fishstat Plus 2000), may however greatly underestimate the total catch, because most polynemids are caught by local fisheries in tropical regions, where collection and reporting of detailed statistics at the species level encounter difficulties and several countries still report their catches by large groups of species. In these circumstances, the catch data presented by individual species items are likely to be underestimated and an unknown proportion of the catches for a species or group of species might have been reported by the national office under miscellaneous fishes. In particular, the catch statistics of ***Eleutheronema tetradactylum*** have been reported only from Kuwait, Pakistan and Taiwan Province of China (Table 1), although the species is widely distributed from the Persian Gulf to Australia and Papua New Guinea, and is one of the most important fisheries species for countries throughout those regions. The largest commercial catch of polynemids has been reported from the Western Central Pacific (Table 2, FAO Fishing Area 71). Most catch statistics reported from fresh-water rivers in India (Table 2, FAO Fishing Area 4) probably involved ***Polynemus paradiseus***, although catches were recorded as Polynemidae spp. From 1970 to 2001, there has been a general increase in landings of polynemids (Table 3).

Table 1
FAO Reported world catch of polynemids in metric tonnes by area in 2001

Species	Main Areas				
	Inland waters	Atlantic Ocean	Indian Ocean	Pacific Ocean	Grand Total
Eleutheronema tetradactylum			55	1 715[1/]	1 770
Galeoides decadactylus		17 101			17 101
Pentanemus quinquarius		3 947			3 947
Polydactylus quadrifilis		12 447			12 447
Polynemidae spp.	66	2 258	15 894	39 434	57 652
Grand Total	**66**	**35 753**	**15 949**	**41 149**	**92 917**

[1/] Catches of a Polynemidae species reported by Taiwan Province of China probably belong to *Eleutheronema rhadinum* (Motomura *et al*., 2002a) instead of *E. tetradactylum*.

1.3 Classification of the Family Polynemidae

The family Polynemidae have long been considered to be related to the Mugilidae and Sphyraenidae, but there is no convincing evidence to support that relationship (Johnson, 1993). In fact, Johnson (1993) stated that evidence at that time supported a sister-group hypothesis for Polynemidae and Sciaenidae, suggesting that they might be included in a superfamily (Polynemoidea). However, otolith evidence does not support such a placement (Grove and Lavenberg, 1997) and the taxonomic status and relationships of the Polynemidae remain poorly known.

Table 2
FAO Reported world catch of polynemids in metric tonnes by FAO Fishing Areas in 2001

Species	FAO Fishing Areas							
	4	34	47	51	57	61	71	87
Eleutheronema tetradactylum				55		1 715[1/]		
Galeoides decadactylus		17 101						
Pentanemus quinquarius		3 947						
Polydactylus quadrifilis		12 447						
Polynemidae spp.	66	424	1 834	2 827	13 067		39 424	10
Grand Total	**66**	**33 919**	**1 834**	**2 882**	**13 067**	**1 715**	**39 424**	**10**

[1/] Catches of a Polynemidae species reported by Taiwan Province of China probably belong to *Eleutheronema rhadinum* (Motomura *et al*., 2002a) instead of *E. tetradactylum*.

Table 3
FAO Reported world catch of polynemids in metric tonnes for the year 1970 to 2001

Species	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Eleutheronema tetradactylum[1/]	1 440	2 759	3 423	5 639	4 559	4 284	5 200	5 353	7 558	6 652	5 850	7 849	8 286	6 341	6 414	7 584
Galeoides decadactylus	3 624	4 218	5 205	3 355	3 974	3 556	5 938	8 304	8 515	10 451	10 551	9 031	12 366	11 630	11 933	13 312
Pentanemus quinquarius	329	196	100	100	100	106	910	1 545	2 214	290	342	432	483	438	994	973
Polydactylus quadrifilis										450	450	377	281	451	421	749
Polynemidae spp.	34 155	42 030	35 356	49 384	58 613	52 017	43 131	47 003	53 960	47 897	37 129	38 605	44 145	43 111	43 104	42 440
Total	**39 548**	**49 203**	**44 084**	**58 478**	**67 246**	**59 963**	**55 179**	**62 205**	**72 247**	**65 740**	**54 322**	**56 294**	**65 561**	**61 971**	**62 866**	**65 058**

Species	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Eleutheronema tetradactylum[1/]	7 871	12 472	16 362	13 291	12 125	8 008	11 055	11 063	5 256	4 281	3 673	4 614	4 217	2 414	6 980	1 770
Galeoides decadactylus	14 322	13 838	14 475	10 093	11 394	12 542	9 893	7 228	8 500	12 903	17 768	18 385	12 890	10 764	13 948	17 101
Pentanemus quinquarius	2 063	2 070	1 515	872	870	2 620	4 882	4 634	4 218	3 734	3 005	3 356	4 430	4 162	3 612	3 947
Polydactylus quadrifilis	118	151	9 453	3	147	4 905	8 120	2 401	3 670	3 598	7 359	10 705	10 023	10 770	12 237	12 447
Polynemidae spp.	42 762	49 464	50 953	67 278	41 990	47 995	54 636	47 024	50 907	54 624	51 837	50 769	53 842	53 098	53 707	57 652
Total	**67 136**	**77 995**	**92 758**	**91 537**	**66 526**	**76 070**	**88 586**	**72 350**	**72 551**	**79 140**	**83 642**	**87 829**	**85 402**	**81 208**	**90 484**	**92 917**

[1/] Catches of a Polynemidae species reported by Taiwan Province of China probably belong to *Eleutheronema rhadinum* (Motomura *et al.*, 2002a) instead of *E. tetradactylum*

Table 4
FAO Reported aquacultural catch of polynemids in metric tonnes for the years 1972 to 2001

Species	Country	Area	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Eleutheronema tetradactylum	Thailand	71	15	16	16		409	155	4			
Eleutheronema tetradactylum	Singapore	71									3	
Eleutheronema tetradactylum[1/]	Taiwan (Province of China)	61					1	2	16	38	16	5

[1/] Aquaculture production of a Polynemidae species reported by Taiwan Province of China probably belongs to *Eleutheronoma rhadinum* instead of *E. tetradactylum*.

1.4 Illustrated Glossary of Technical Terms and Measurements

Anal-fin base length - The straight-line distance from the anal-fin origin to the posterior basal end of the anal-fin base (Fig. 4).

Body depth - The vertical distance from first dorsal-fin origin to ventral surface (Fig. 4).

Body width - The width (thickness) between pectoral-fin bases.

Caudal fin - The tail fin (Fig. 4).

Caudal peduncle - The part of the tail joins the caudal fin to the body.

Caudal-peduncle depth - The least depth of the peduncle (Fig. 4).

Caudal-peduncle length - The straight-line distance from the rear end of the anal-fin base to a vertical at the caudal-fin base (Fig. 4).

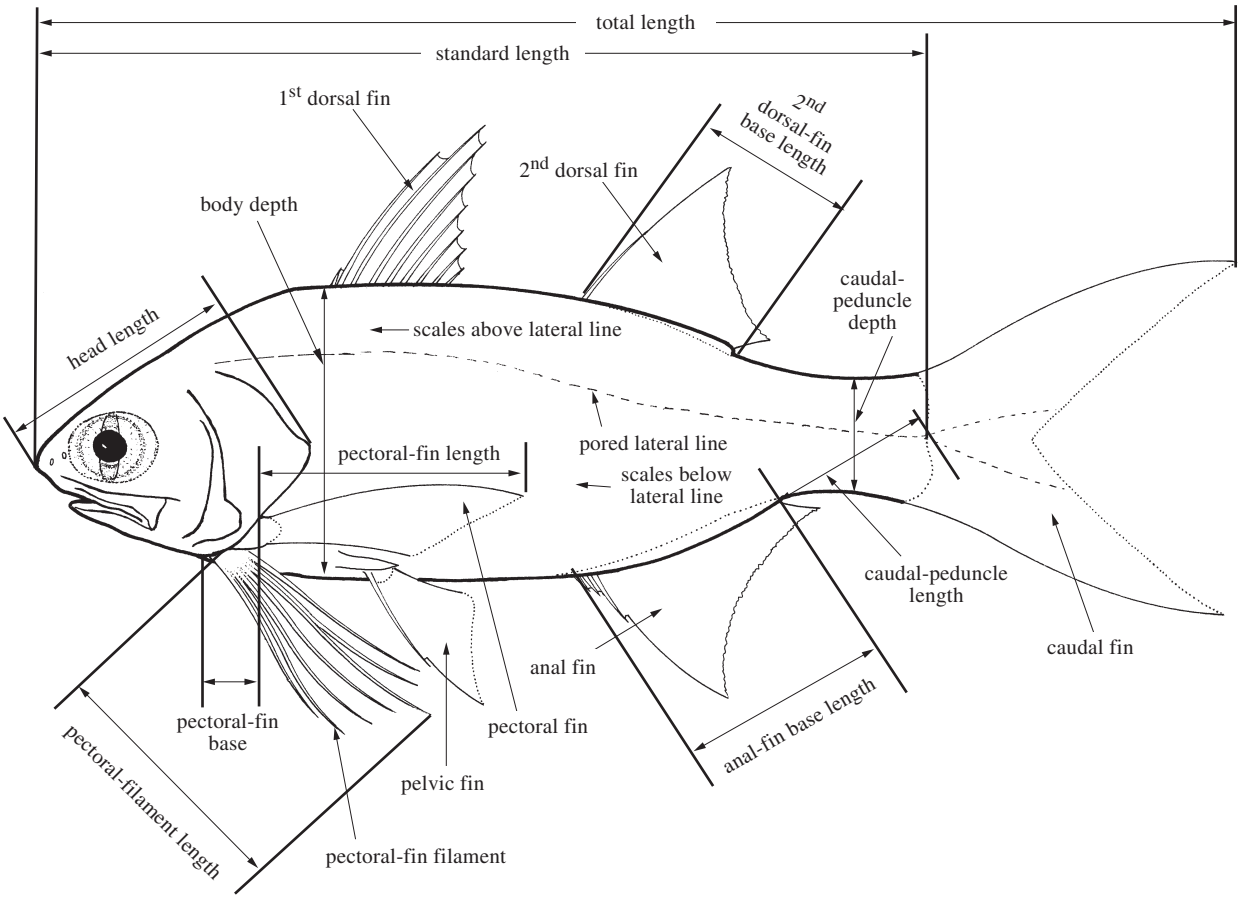

Fig. 4 External morphology and measurements

Cranium - Bony part of the head, enclosing the brain. It is composed of many different bones (Fig. 5).

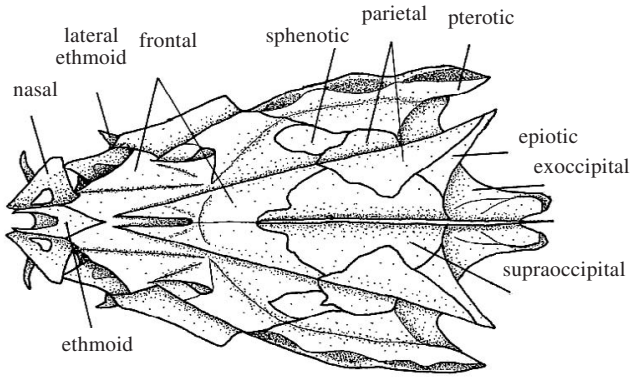

Fig. 5 Dorsal view of cranium of *Leptomelanosoma indicum* (from Motomura and Iwatsuki, 2001a)

Dorsal fin - A median fin along the back. Polynemids have 2 dorsal fins; the first is supported by spinous rays while the second has 1 spinous ray anteriorly and soft rays posteriorly (Fig. 4).

Ectopterygoids - The paired bones on each side of the roof of the mouth immediately posterior to the palatines (Fig. 6).

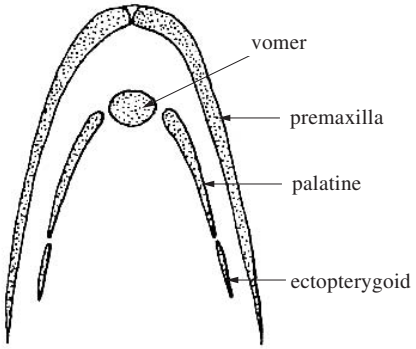

Fig. 6 Ventral view of dentition of premaxilla and roof of oral cavity

Eye diameter - The horizontal distance between the fleshy margins of the eye (Fig. 7).

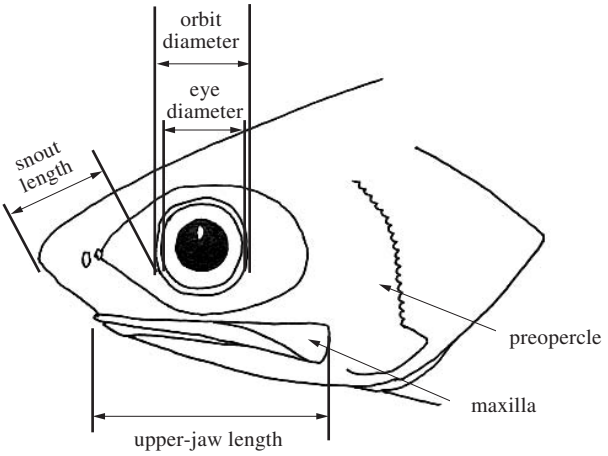

Fig. 7 Parts of head

Gillrakers - The long bony protuberances along the anterior (inner) edge of the gill arches (Fig. 8). Gillraker counts are often given as 2 numbers (X + Y), where X is the number of rakers on the upper limb of the first arch, and Y is the number of rakers on the lower limb, with the raker at the angle (junction of upper and lower limbs) included in the lower-limb count.

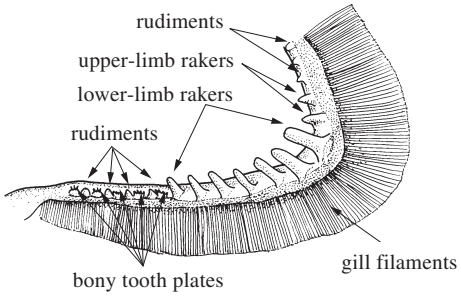

Fig. 8 Gillrakers
(after Heemstra and Randall, 1993)

Head length - The distance from the most distant end of the opercle to the anterior tip of the snout (Fig. 4).

Interorbital length - The least distance between the orbits.

Maxilla - The posterior, toothless bone of the upper jaw; partly covered by the upper lip when the mouth is closed (Fig. 7).

Orbit diameter - The horizontal distance between the bony margins of the eye (Fig. 7).

Palatines - The paired bones on each side of the roof of the mouth immediately posterior to the vomer (Fig. 6).

Pectoral fin - The fin on each side of the body immediately behind the gill opening (Fig. 4). Pectoral-fin ray counts only include rays interconnected by a membrane; the lower free rays are given separately.

Pectoral-fin base - The distance from the uppermost point of the pectoral-fin base to the lowermost point of the pectoral-filament base (Fig. 4).

Pectoral-fin length - The distance from the posterior tip of the pectoral-fin ray to the uppermost point of the pectoral-fin base (Fig. 4).

Pectoral filaments - The free rays below the pectoral-fin rays (Fig. 4). Pectoral-filament counts are made from the anteriormost (ventralmost) element.

Pectoral-filament length - The distance from the posterior tip of the pectoral filament to the base of the filament (Fig. 4).

Pelvic fin - Paired fins ventrally on the body behind the pectoral fins (Fig. 4).

Pored lateral-line scales - The series of pored scales that run from the upper end of the gill cavity to the caudal fin (Fig. 4).

Premaxilla - The paired, tooth-bearing bones of the upper jaw (Fig. 6).

Preopercle - The rounded or angular bone on the front part of the opercle; the posterior edge is exposed (Fig. 7).

Ray - The rigid or flexible struts that support the fins. Soft rays are segmented and flexible. Spinous rays are unsegmented, simple (unbranched) and pungent (stiff and sharp pointed). The number of spines are designated by roman numerals (I, II, III, IV . . .) and the number of soft rays are designated by Arabic numerals (1, 2, 3, 4 . . .). The last ray of the second dorsal and anal fins of polynemids is split to its base and looks like 2 rays, but it is counted as a single ray because it is supported by a single pterygiophore.

Scales above and below lateral line - A transverse series of scale rows; scales below lateral line are counted from the origin of the anal fin in an oblique row to the lateral-line scale, but not including the lateral-line row; scales above lateral line are counted from the origin of the first dorsal fin in an oblique row to the lateral-line scale, but not including the lateral-line row (Fig. 4).

Second dorsal-fin base length - The straight-line distance from the second dorsal-fin origin to the posterior basal end of the second dorsal-fin base (Fig. 4).

Snout length - The distance from the anterior margin of orbit to the anterior tip of the snout (Fig. 7).

Standard length - The straight-line distance from the tip of the snout to a vertical line passing through the base of the caudal fin (taken to be the point of flexure of the caudal fin) (Fig. 4).

Supraneural bones - Unpaired bones above the neural spines of anterior vertebrae between the skull and the origin of the dorsal fin (Fig. 9).

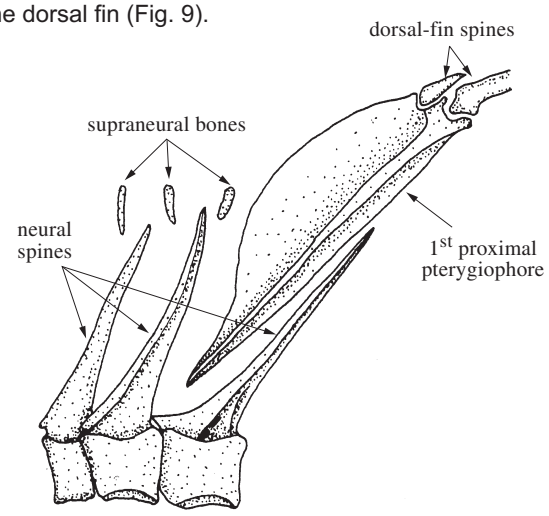

Fig. 9 Supraneural bones, anterior neural spines and first proximal pterygiophore

Swimbladder - A gas filled sac in the dorsal part of the body cavity.

Synonym - An alternate name given to a particular species, genus, family etc. The oldest (senior) synonym that is given to a species is usually considered the valid (correct) scientific name for that species.

Total length - The straight-line distance from the tip of the snout to a vertical line passing through the posterior tip of the caudal-fin ray (Fig. 4).

Upper-jaw length - The distance from the anterior tip of the premaxilla to the posterior margin of the maxilla (Fig. 7).

Vertebrae - Axial skeleton bone; divided into 2 sections, precaudal (abdominal) and caudal vertebrae.

Vomer - A median bone which lies on the roof of the mouth (Fig. 6).

1.5 Plan of the Catalogue

A diagnosis of the family Polynemidae is given, followed by aids to identification of polynemids (keys to genera and species), and the information by genus and species (arranged alphabetically by genus and species). Since most species occur only in a single major region, the key to species of the largest genus, ***Polydactylus***, is divided into regional keys to shorten them and make them easier to use. Each genus account includes the type species and generic synonyms. For genera with more than 1 species, the diagnosis and general comments on the habitat, biology, distribution and interest to fisheries of the included species are listed. The information pertaining to species is divided into the following sections:

(1) **Scientific Name:** The reference to the original description, type locality, and type information of the species is given. Type information includes the museum catalogue number of the type specimen (abbreviations for museums defined in 'Acknowledgements').

(2) **Synonyms:** Primary synonyms and alternate combinations of generic and specific names are listed.

(3) **FAO Name:** The FAO English name is considered the standard to be used for fishery purposes. This should avoid confusion caused by 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 names are given for each species.

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

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

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

(7) **Size:** The maximum known size for each species.

(8) **Interest to Fisheries:** General information on the extent, type of fisheries and utilization is given. Detailed catch statistics (landings) are not available for all individual species.

(9) **Local Names:** Published local names are given. A local name is often applied to several species.

(10) **Literature:** Recent references that contain important taxonomic information are given.

(11) **Remarks:** Taxonomic details and information that is not appropriate in the previous paragraphs are included here.

NEXT PAGE