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Grenadiers (Families Bathygadidae and Macrouridae, Gadiformes, Pisces) of New South Wales, Australia

by

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Twenty-six years of extensive trawling off New South Wales (NSW) by the FRV *Kapala*, supplemented by opportunistic sampling by ORV *Franklin*, revealed a grenadier fauna comprising 60 species in 21 genera. Despite a relatively limited coastline (600 nautical miles), the diversity in NSW is comparable to those off Western Australia (63 spp.), New Caledonia (63 spp.), and New Zealand (about 67 spp.). Of the 60 species, none are endemic to NSW, but 12 are the only Australian records. Most of the material used in this study and data on abundance, depth, and distribution were collected on the *Kapala* during fishery resource surveys. Between 1972 and 1997, *Kapala* surveyed shelf and slope depths along the whole NSW coast, although most trawling was on the more extensive and commercially productive grounds off central and southern NSW. The maximum depth trawled was about 1200 m. Grenadiers were present in about 10% of tows on the outer-shelf (about 100–200 m), about half of all tows between 200 and 300 m, and in almost every trawl deeper than 300 m. Smaller-meshed nets caught on average two more species per station than those with larger mesh, and the mean number of species increased with depth. The data also suggested that the NSW grenadier fauna is relatively rich in species at depths beyond those sampled by *Kapala*. Depth-distribution data separated the species into two groups, an upper-slope group in about 200–700 m, and a lower-slope group in 700–1300 m. Many species that were rarely caught by *Kapala* appeared to be at the fringes of their geographic or depth distributions in NSW. The large genus *Caelorinchus* was represent by 15 species, while *Coryphaenoides* had 11 species. All other genera had four or fewer representatives. Keys, figures, and brief accounts are provided for all NSW genera and species, with emphasis in the species accounts placed on their abundance and distribution in NSW.

Fishes of the families Bathygadidae and Macrouridae, often referred to as grenadiers, whiptails, and rattails, are among the most abundant members of the demersal fish fauna at continental slope depths of the world's oceans. The rich grenadier fauna of the southwestern Pacific has only recently come to the attention of the scientific world, mainly through the research and development of deep-water trawl fisheries around Australia and New Zealand. McCann and McKnight (1980) made the first major study of the New Zealand grenadier fauna and recognized 25 species from the area. That number has been increased by the addition of new records and new species described by McMillan and Paulin (1993)[*Caelorinchus*], McMillan (1995) [*Trachyrincus*], Iwamoto and McMillan (1997) [*Trachonurus*], and McMillan (1999) [*Coryphaenoides*]. Current research by McMillan and Iwamoto

suggests that the number will exceed 65. The New Caledonian grenadiers were treated by Iwamoto and Merrett (1997) and Merrett and Iwamoto (2000). They recorded 63 species belonging to 20 genera.

Australia's rich fauna was documented little more than a decade ago by Paxton et al. (1989) as having about 57 species of grenadiers. Unpublished records of Iwamoto suggest that there are more than 100 species in all of Australia's waters. Iwamoto and Williams (1999) found 63 species (17 new species; 20 genera) off the western and northwestern coasts of Australia. On the southeast coast of Australia, extensive deep-water trawling by the fisheries research vessel *Kapala* over a period of 26 years is principally responsible for revealing an extremely diverse grenadier fauna off New South Wales (NSW). The number of species now known from NSW is 60 in 21 genera.

The diversity of the NSW fauna is unusually large given the limited extent of coastline [600 nautical miles (n. mi.)] and is probably attributable to the geographic position of NSW, between the species-rich tropical waters to the north and the productive temperate waters to the south. The grenadier fauna of NSW includes species known from the Coral and Tasman seas as well as from the Indian and Southern oceans. Our knowledge of this diversity results from the extensive sampling by the *Kapala* on the NSW slope over a prolonged period, which provided a unique opportunity for the collection of grenadiers.

The purposes of this paper are threefold: (1) to record the species of grenadiers of New South Wales; (2) to provide a key to the species and brief descriptions as an aid to their identification; and (3) to record aspects of their distribution and abundance off NSW, so far as information is available.

Historical Perspective. Most of the grenadiers collected off NSW are housed in the Australian Museum, Sydney (AMS). The earliest AMS specimens were collected in 1906 by the government vessel *Woy Woy* from "a single cast of a small trawl which was built on the principal of one designed and successfully used by the Prince of Monaco. It was lowered in 800 fathoms at a point thirty-five miles due east of Sydney, on the 152nd Meridian" (McCulloch 1907). Grenadiers collected from this trawl were *Caelorinchus innotabilis* (2 specimens), *C. "fasciatus" [maurofasciatus]* (1), *"Macrourus" [Lucigadus] nigromaculatus* (5), and *"Optonurus" [Lepidorhynchus] denticulatus* (6). *Caelorinchus innotabilis* and *Lucigadus nigromaculatus* were subsequently described by McCulloch as new species. It should be noted that the grenadiers and other teleosts collected with them (see McCulloch 1907) are all upper-slope species, which suggests that the depth of this station was, in fact, much less than the stated 800 fathoms and probably around 300 fathoms (550 m).

Between 1920 and 1968, a further 27 grenadier specimens were registered in the AMS collection; these were *C. australis* (3), *C. mirus* (22), and *L. denticulatus* (2), all upper-slope species. The holotype and four paratypes of *C. mirus* are included in this collection (see McCulloch 1926).

In 1970 the collection and study of NSW deep-water fishes was given great impetus with the commissioning of FRV *Kapala* (Plate 1) by the NSW State Government. The 26 m *Kapala* was built as a research vessel designed principally for trawling. Between 1971 and 1997, *Kapala* conducted numerous research surveys on continental shelf and slope trawling grounds between southern Queensland and eastern Victoria. During this period, about 1260 grenadier specimens (55 spp.) from 217 *Kapala* stations in depths between 130 and 1240 m were registered in the AMS collection.

A further 40 grenadiers from off NSW were deposited in AMS by other collectors between 1970 and 1999; these included specimens of *Coryphaenoides striaturus* and *C. filicauda* from depths of 1590 and 2450 m. Additional NSW grenadiers are held by the Museum of Victoria (NMV) in Melbourne (69 specimens, 16 spp.); included are four species not represented in the AMS collections. The I.S.R Munro Ichthyological Collection at the Commonwealth Scientific and Industrial Research Organization, Marine Research Laboratories, Hobart (CSIRO), also has a small collection of grenadiers caught off NSW between 1975 and 1993 (41 specimens, 11 spp.), but this collection contains no additional species to those in AMS and NMV.

PLATE 1. The 26-meter fishery research vessel *Kapala*.

This paper describes the NSW grenadier fauna as represented in the AMS and NMV collections. As the great majority of NSW grenadiers were collected from *Kapala* stations, much of the discussion relates to observations made during *Kapala's* offshore surveys. Relative abundance, depth, and distribution data were collected by Graham on *Kapala* between 1972 and 1997, and during subsequent trawling on a commercial trawler off the southern NSW port of Bermagui in 1999–2001.

MATERIALS AND METHODS

Study Area. New South Wales is on the east coast of Australia between latitudes 28°10′S and 37°45′S (Fig. 1). New South Wales waters extend to the edge of the Australian Fishing Zone (AFZ; 200 n. mi. from land) and include the area around Lord Howe Island (31°30′S, 159°05′E). Apart from a few isolated seamounts and reefs, most of the seabed beyond the continental slope is deeper than 2000 m; some parts of the Lord Howe Rise within the AFZ are as shallow as 1000 m. The NSW continental shelf is narrow, with the shelf break mostly between 15 and 25 n. mi. offshore at a depth of about 200 m. The continental slope (between the 200 and 2000 m isobaths) can be arbitrarily divided into three depth zones. The upper-slope (200–700 m) is mostly between three and five n. mi. in width, with a gradient between 1:10 and 1:20, while the mid-slope (700–1300 m) and lower slope (>1300 m) are relatively much narrower and steeper.

The *Kapala* collected grenadiers from shelf and slope waters between 27°50′S and 38°15′S over a depth range of 130 to 1240 m. Collections were also made from a few mid-slope and lower-slope stations between 800 and 2500 m off Nowra by CSIRO's oceanographic research vessel *Franklin* (NMV specimens). A small number of grenadiers at AMS were collected by *Franklin* with a beam trawl and epibenthic sled on the Lord Howe Rise.

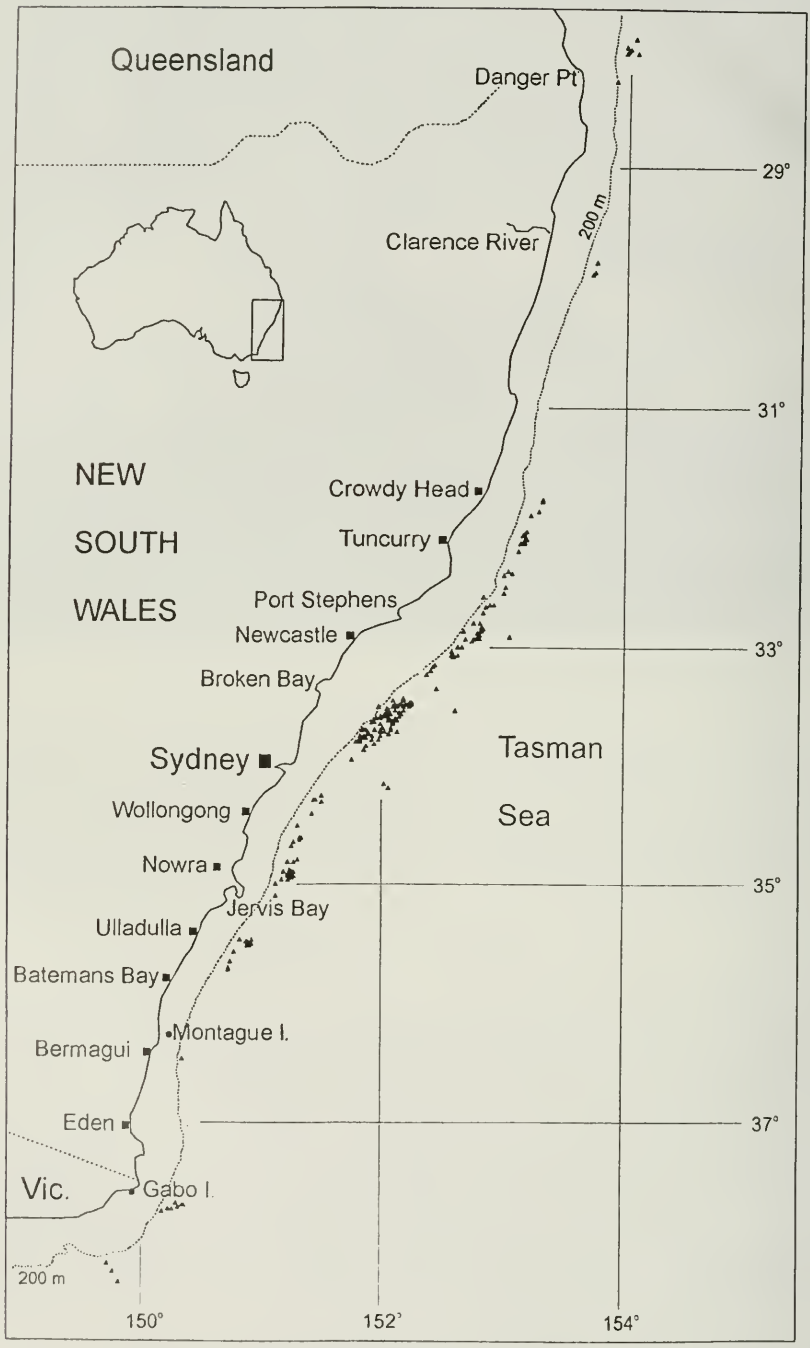

FIGURE 1. Map of New South Wales coast showing FRV *Kapala* stations where grenadiers were collected for AMS.

***Kapala* Trawl Gear and Survey Methods**. A range of net sizes and styles was used during the many *Kapala* exploratory and stock-assessment surveys, with the choice dependent on the purpose of each study. Nets for the capture of prawns ranged in size between 20 and 30 m headline length and were constructed throughout with 45 mm mesh netting. Fish trawls had headline lengths between 20 and 56 m, and were made with relatively large-mesh panels in the front of the net (100–200 mm mesh) and usually with codends of 90 mm mesh. During some surveys, fish trawls were fitted with 45 mm mesh codend liners. Towing speed in upper-slope depths was between 2.5 and 3.5 knots; mid-slope trawling was usually 1.8–2.5 knots. The maximum depth trawled by *Kapala* (1240 m) was limited by the amount of trawl warp carried on her main winch (2500 m). A large mid-water trawl was also deployed in oceanic waters off Sydney-Newcastle on a few occasions in 1977–79 for the capture of bathypelagic species.

Normal practice for exploratory and stock-assessment trawling was to tow along a selected depth for one to two hours. The depth range of upper-slope tows was usually within ± 20 m of the target depth, while on the steeper mid-slope the range was often greater, around ± 40 m of the target. Recorded fishing depths were for the period the trawl was fishing the seabed. Catches were sorted into commercial and non-commercial species for assessment; all grenadiers caught off NSW were considered to be part of the non-commercial component of the catch. A list of all fishes (with approximate numbers) was compiled for each station. Any rarely caught specimens were retained for AMS.

Taxonomic Descriptions

In the descriptive section of this work, general features of the family, subfamily, and genera are provided separately under each section and in the key. Detailed characters that distinguish the species are given under the species descriptions, although characters previously given in the keys are generally not repeated except for necessary elaboration. For synonymies and additional figures and descriptions of most of the species and genera treated here, the reader is referred to Last et al. (1983), Gomon et al. (1994), Iwamoto and Merrett (1997), Iwamoto and Williams (1999), Merrett and Iwamoto (2000), and references cited in the last three publications. Methods of taking measurements and counts are described in detail in Iwamoto and Sazonov (1988) and in a condensed version in Iwamoto and Williams (1999).

Abbreviations for fins are 1D = first dorsal, 2D = second dorsal, P = pectoral, V = pelvic. Spinous rays in the first dorsal fin are designated with Roman numerals, segmented rays are given in Arabic numerals (e.g., II,10). The splintlike uppermost ray of the pectoral fin is designated with a small *i* (e.g., i16). Counts of gill rakers (GR) are distinguished as to which gill arch the rakers are counted (e.g., first or outermost arch = GR-I, second arch = GR-II) and whether the outer or inner series is counted. Gill-raker counts are usually made on the right side of the fish, with the gill covers pulled back to expose the rakers, which are often quite small. In some species, the upper connection of the gill cover to the body must to severed in order to pull the cover back far enough to expose the rakers. Scale rows are counted in a diagonal series from the first dorsal origin ("below 1D"), mid-base of 1D, and below 2D origin, to, but not including, the lateral-line scale. The count of lateral-line scales includes those from the anterior origin of the lateral line to a point marking the distance equal to that from the snout tip to the origin of the first dorsal fin (viz., the predorsal length) (Fig. 2). Size given is maximum total length, rounded up to the nearest 5 cm. Institutional abbreviations follow Leviton et al. (1985) and Leviton and Gibbs (1988). Australian states are abbreviated as follows: New South Wales, NSW; Queensland, Qld; South Australia, SA; Tasmania, Tas.; Victoria, Vic.; Western Australia, WA.

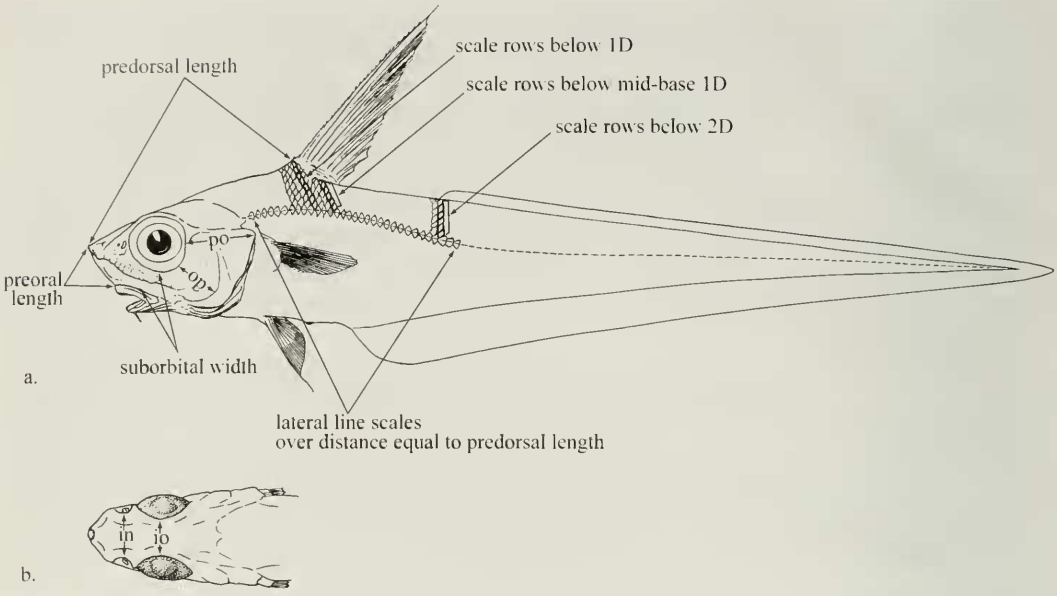

FIGURE 2. Diagrammatic illustration of typical grenadier to show method of counting scale rows and measuring predorsal length, preoral length, and suborbital width; (a) lateral view; (b) dorsal view of head. Abbreviations: *in*, internasal width, *io*, interorbital width, *po*, postorbital length, *op*, opercle to preopercle distance, 1D, first dorsal fin, 2D, second dorsal fin.

RESULTS

***Kapala* Surveys**. Prior to 1970, little was known about the extent and productivity of trawl grounds along the NSW slope. Between 1971 and 1981 exploratory trawling and resource assessment surveys determined the extent of upper-slope trawling grounds and the nature of demersal prawn and fish stocks on those grounds (Gorman and Graham 1975; Graham and Gorman 1985; Andrew et al. 1997). Off northern NSW only two relatively small areas of trawlable seabed were found, one off the Clarence River and the other off the NSW-Queensland border. Apart from a single tow in 740 m off Danger Point, all trawls north of latitude 31°30′S were shallower than 600 m. Because catch rates of commercial fishes were relatively low during early surveys, there was no trawling by *Kapala* in any slope depths off northern NSW after 1978. At present, commercial trawlers occasionally fish for royal red prawns (*Haliporoides sibogae*) and deepwater slipper lobsters (*Ibacus* spp.) in 200–500 m on the Clarence River ground.

In contrast, relatively large areas of trawlable ground with commercial fish stocks were found on the upper-slope off central and southern NSW. A significant trawl fishery for both deep-water fishes and prawns developed during the late 1970s (Tilzey 1994), and today about 40 trawlers continue to fish these grounds. Consequently the majority of *Kapala* upper-slope trawling was done south of Port Stephens, particularly on grounds off Sydney, Ulladulla, and Eden-Gabo Island. This included the final study by *Kapala* before her decommissioning in 1996–97, which was a repeat stock-assessment survey of the upper-slope south of Newcastle (Graham et al. 1997, 2001).

Mid-slope trawl grounds (700–1200 m) were charted in detail by *Kapala* between 1983 and 1989 (Graham 1990). Trawlable seabed on the mid-slope was more restricted in area than on the upper-slope, and very little trawl ground was found in depths below 1000 m. Most fishable ground was located between latitudes 31°40′S and 36°00′S, and consequently, almost all mid-slope stations were in this area. A small number of tows were also made southeast of Gabo Island (37°40′S). No large

stocks of commercial fish were found, but commercial trawlers occasionally target orange roughy (*Hoplostethus atlanticus* Collett, 1889), oreo dories (family Oreosomatidae), and edible dogsharks (family Squalidae) in mid-slope depths off NSW.

Outer shelf grounds (100–200 m) were surveyed off northern NSW in 1978, and between Port Stephens and Gabo Island in 1993–94 (Graham et al. 1995, 1996).

***Kapala* Grenadier Data.** Table 1 shows the distribution by depth and latitude of *Kapala* survey trawls on the NSW outer shelf and slope between 1976 and 1997. For each of these trawls a list of fishes was compiled, and from these data, abundance and distributional information for NSW grenadiers were derived (see species descriptions for details). Figure 1 shows the locations of all *Kapala* stations from which grenadiers were collected for AMS; station numbers, location and depths for these are listed in Appendix 1.

The depth and geographic ranges derived from *Kapala* catches were influenced by the distribution of stations, which, as discussed above, reflected the lack of mid-slope trawling off northern NSW. As Table 1 shows, most trawling was done on the commercially productive grounds off central and southern NSW, the maximum depth trawled was about 1200 m, and no depths greater than 740 m were sampled north of Crowdy Head (31°45′S). The style of trawl used during the various surveys may have also influenced the data. About 75% of upper-slope trawls and 56% of mid-slope trawls were done with large-meshed fish nets, which reduced the likely capture of small specimens. The capture rate by *Kapala* may therefore understate the true abundance of some species of small adult size.

During the period that detailed catch data were recorded (1976–97), grenadiers were caught in 1072 *Kapala* trawls over a depth range of 130–1240 m. Grenadiers were present in about 10% of outer-shelf tows, about half of all tows between 200 and 300 m, and in almost every trawl deeper than 300 m. The number of species caught at each station was related to the trawl gear and depth fished (Fig. 3). Nets with 45 mm codend mesh caught, on average, two more species per station than those with 90 mm mesh, and the mean number of species per trawl increased almost linearly with depth (see Appendix 2 for data). The data also suggest that the grenadier fauna off NSW is relatively rich in spe-

TABLE 1. Distribution by latitude and depth of FRV *Kapala* demersal stations over 100 m trawled between 1976 and 1997. New South Wales distribution and abundance were derived from catches at these stations.

	Depth (m)											
Latitude (°S)	100–199	200–299	300–399	400–499	500–599	600–699	700–799	800–899	900–999	1000–1099	1100–1200	Total
27	0	1	1	0	1	0	0	0	0	0	0	3
28	22	3	3	5	2	0	1	0	0	0	0	36
29	14	7	9	13	4	0	0	0	0	0	0	47
30	11	7	1	0	0	0	0	0	0	0	0	19
31	6	2	1	0	0	0	0	1	1	1	0	12
32	94	8	10	13	9	1	4	10	14	31	0	194
33	104	45	68	96	34	14	15	22	30	23	6	457
34	102	10	13	44	10	7	7	8	18	12	4	235
35	79	53	64	54	33	10	4	9	24	15	3	348
36	71	9	9	6	0	0	0	0	0	0	0	95
37	75	42	68	45	22	6	1	3	3	2	0	267
38	1	4	10	10	6	3	1	0	1	1	0	37
Total	579	191	257	286	121	41	33	53	91	85	13	1750

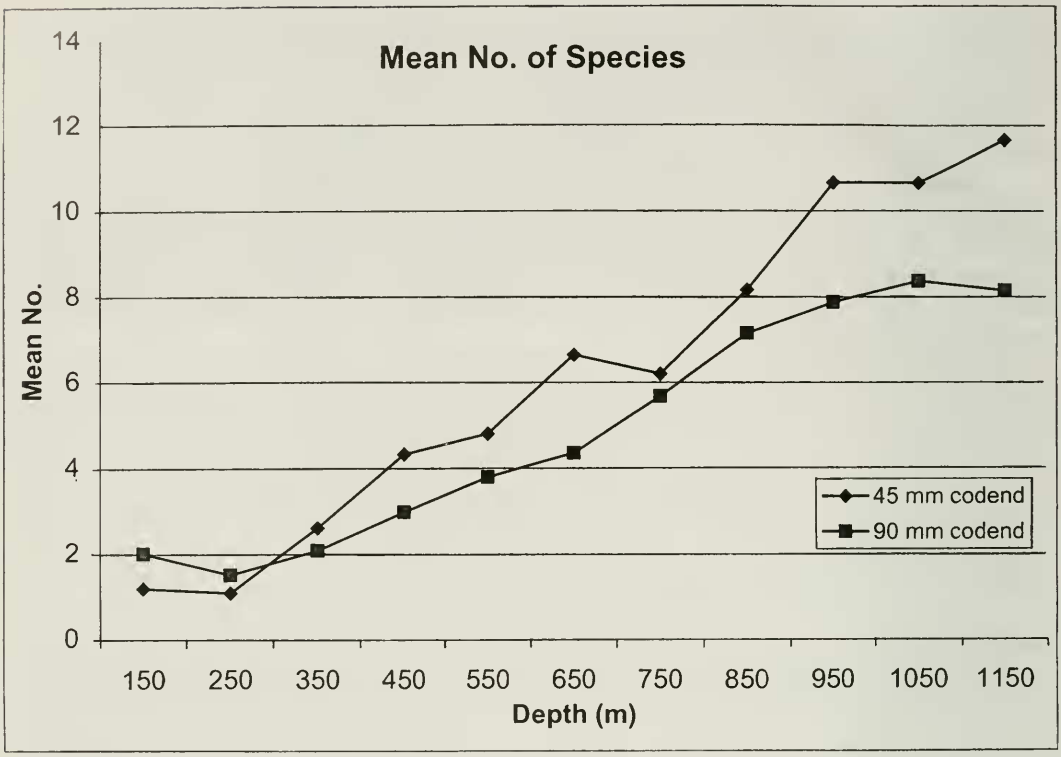

FIGURE 3. Graph showing influence of depth and mesh size to mean number of grenadier species captured off New South Wales by *Kapala*.

cies at depths beyond those sampled by *Kapala*. Apart from a small number of ORV *Franklin* stations, the lower slope and extensive abyssal seabed off NSW is largely unsampled.

Figures 4 and 5 summarize the depth and geographical ranges for each of the 55 species caught by *Kapala*. In Figure 4, the 53 demersal species are ordered according to their minimum depth of capture; those recorded on more than five occasions are divided into "upper-slope" and "mid-slope" groups, and rarely caught species are listed beneath. The same species, ordered by their latitudinal ranges, are shown in Figure 5; the bathypelagic species *Cynomacrurus piriei* and *Odontomacrurus murrayi* are included in this figure. The depth range of the upper slope is arbitrarily defined as 200–700 m and the mid slope as 700–1300 m. Figure 4 shows that while some species fit neatly within these depth categories, many show some overlap, and for those taken in the deepest trawls (>1100 m), no maximum depth range can be defined. There is an overall pattern of gradually increasing depth ranges, but within this a number of depth groupings can be discerned.

Ten species are characteristic of the upper slope. Although the depth ranges of six of these extended to about 800 m or more, each was most abundant in depths less than 700 m. The two species with the shallowest depth ranges, *Caelorinchus mirus* and *C. australis*, were also caught in outer-shelf depths; either or both species were present in about 10% of the 579 outer-shelf trawls. *Lepidorhynchus denticulatus* was the most abundant upper-slope species and also exhibited the greatest depth range (230–1080 m) of any NSW grenadier. Trends in geographic range are also evident for several upper-slope species (Fig. 4). The ranges of three species (*Lucigadus microlepis*, *Ventrifossa nigrodorsalis*, and *Hymenocephalus longibarbis*) with known tropical distributions extended to central or southern NSW; the latter two were caught by *Kapala* as far south as Jervis Bay and Ulladulla,

FIGURE 4. Depth distributions for NSW species collected by *Kapala* (thin line represents range or range extension by 1 or 2 observations only).

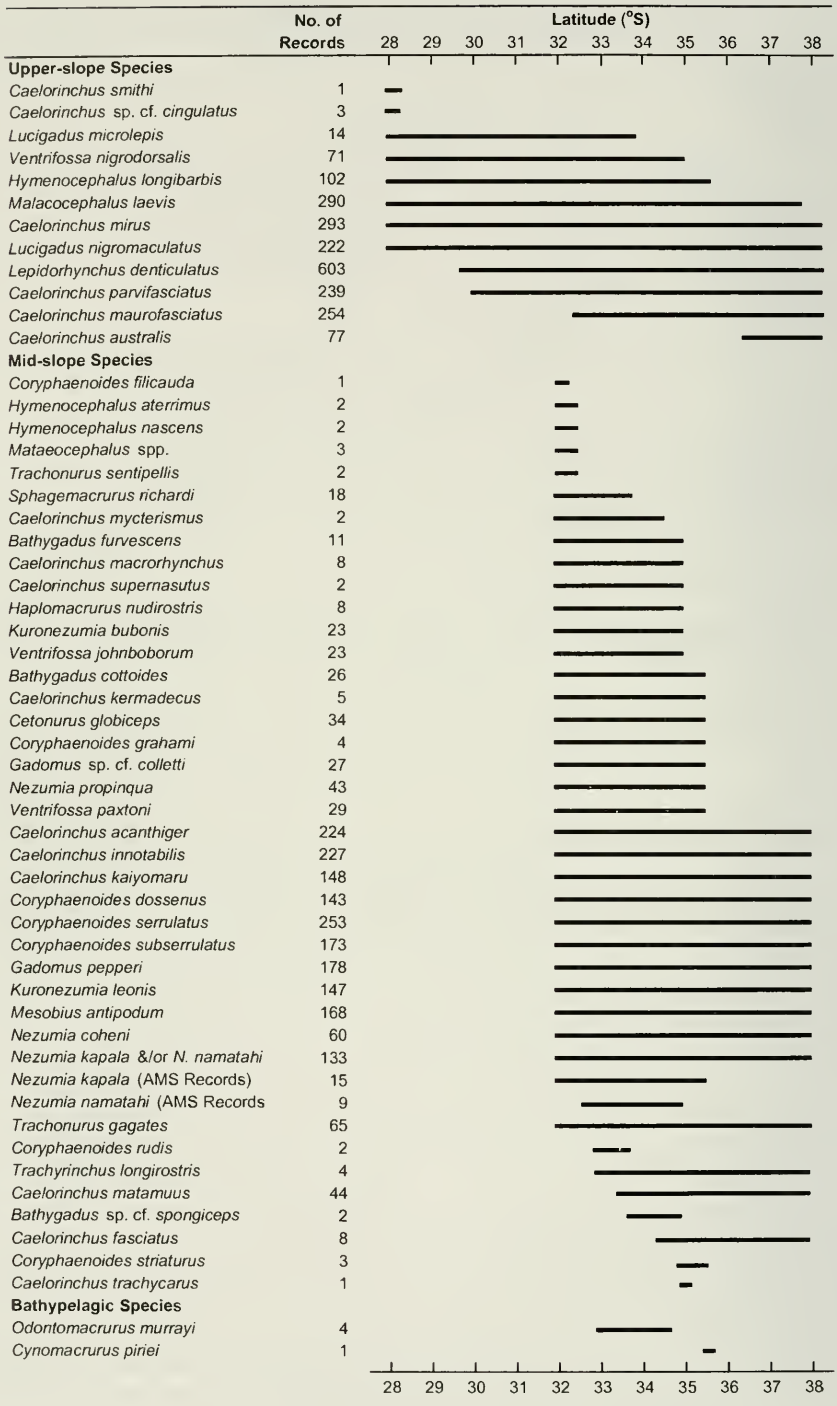

FIGURE 5. Geographical distributions for NSW species collected by *Kapala*.

although recently both were collected (by Graham) further south off Bermagui (36°20′S). Four southern species showed limits to their northern distributions within NSW: *C. parvifasciatus* and *Lepidorhynchus denticulatus* did not extend north of the Clarence River, *C. maurofasciatus* was only caught south of Port Stephens, whereas *C. australis* was restricted to waters south of Batemans Bay.

The depth range of *C. innotabilis* (450–1075 m) spanned both the upper and middle slopes, but the species was most abundant between 600 and 900 m. *Caelorinchus innotabilis* can be included in a group that mainly inhabits the shallower mid-slope depths. This group also includes *Caelorinchus macrorhynchus*, *C. fasciatus*, *C. matamuus*, *Gadomus* sp. cf. *colletti*, *Kuronezumia bubonis*, *Nezumia propinqua,* and *Ventrifossa johnboborum*. They were mostly caught shallower than about 1000 m and mainly between 700 and 900 m, and although all showed relatively extensive geographic ranges, none was abundant in any part of their NSW range. Four of these species are also found in tropical waters; of these, *C. macrorhynchus*, *K. bubonis,* and *V. johnboborum* were caught by *Kapala* south to Jervis Bay, and *N. propinqua* to about Batemans Bay. A juvenile *C. macrorhynchus* was recently collected (by Graham) further south near Montague Island. Two southern species, *C. fasciatus* and *C. matamuus*, were taken as far north as Broken Bay.

Eighteen species (with eight or more captures) were found only in depths greater than 700 m. *Haplomacrourus nudirostris*, *Sphagemacrurus richardi,* and *Ventrifossa paxtoni* are species previously reported from more tropical waters than NSW (Iwamoto and Merrett 1997) and were caught by *Kapala* mostly north of Sydney and only between 800 and 1100 m. The full depth ranges of the remaining species were probably greater than those shown by *Kapala* catches. Six species, *Coryphaenoides dossenus*, *C. serrulatus*, *C. subserrulatus*, *Kuronezumia leonis*, *Mesobius antipodum,* and *Nezumia namatahi*, were caught across the full mid-slope depth range (about 700–1200 m) and on all grounds between Crowdy Head and Gabo Island. Another five species also caught between Crowdy Head and Gabo Island but with greater minimum depths (800–900 m) were *Caelorinchus acanthiger*, *C. kaiyomaru*, *Gadomus pepperi*, *Nezumia coheni*, and *Trachonurus gagates*; *N. kapala* is also likely to be in this group (based on AMS collection; see species description). These 12 species have generally southern distributions, being found around the south coast of Australia and many also off New Zealand. The last three mid-slope species on the list, *Bathygadus cottoides*, *B. furvescens,* and *Cetonurus globiceps,* were mostly caught deeper than 1000 m and are possibly more abundant at depths greater than trawled by *Kapala*.

Species rarely caught by *Kapala* may be put in one or other of the groups discussed above, but there are too few observations to be definitive. Most of these species appear to have been caught at the fringe of either their geographic or depth range. Eight species, *Caelorinchus cingulatus*, *C. kermadecus*, *C. smithi*, *Hymenocephalus aterrimus*, *H. nascens*, *Mataeocephalus* sp., *M. acipenserinus,* and *Trachonurus sentipellis*, are more commonly found in tropical waters (Iwamoto and Merrett 1997). *Kapala* captures of these species were from the most northern stations, although the small size of *Hymenocephalus* spp. and *Mataeocephalus* spp. may have also contributed to their relatively low number of captures. In contrast, *Cynomacrurus piriei,* which was caught once by *Kapala* off the NSW south coast, is primarily a Southern Ocean species (Iwamoto 1990). McMillan and Paulin (1993) reported that *Caelorinchus mycterismus* and *C. supernasutus* are relatively common around northern New Zealand and are also recorded from the Wanganella Bank to the northwest of the North Island. The *Kapala* captures are the only confirmed specimens from the western Tasman Sea. The few specimens of *Bathygadus* sp. cf. *spongiceps*, *Caelorinchus trachycarus*, *Coryphaenoides filicauda*, *C. grahami*, *C. rudis*, *C. striaturus*, and *Trachyrincus longirostris* were caught only in trawls deeper than 1000 m and are possibly more abundant at depths greater than those sampled by *Kapala*.

TAXONOMY

We use grenadier as a collective term for four distinct groups of gadiform fishes, each of which has at one time or another been considered as a separate family. In fact, the bathygadids have been placed in a separate suborder (Gadoidea) from the others (Macrouroidea) (Howes 1989). The problems of relationships have yet to be adequately resolved, so for this paper we have chosen to take a conservative approach as used by Iwamoto and Merrett (1997). It should be noted that the long-tailed hakes (*Macrouronus* spp., Merlucciidae) are also called grenadiers. The southern Australian species, *M. novaezealandia*, is known as blue grenadier (Last et al. 1983; Gomon et al. 1994). All grenadiers have a long, tapered tail with long dorsal and anal fins that meet posteriorly without a noticeable caudal fin, and the anal fin lacks an elevated lobe. The trachyrincines are reported to have a caudal fin, but it is so rudimentary that examination under magnification is usually necessary to observe its presence. One often finds specimens with what appears to be a sizable caudal fin, but that structure is a result of loss of the tail tip and an overgrowth of the anal and dorsal fin rays. Grenadiers can be distinguished from other deep-sea fishes that have a long tapered tail by a combination of the lack of a distinct caudal fin, one or two dorsal fins, a single, long, low anal fin lacking lobes or dips in its profile, pelvic fins present (in all but *Macrouroides inflaticeps*), well separated, and consisting of five to as many as 18 rays, and no teeth on roof of mouth or on tongue.

KEY TO THE FAMILIES AND SUBFAMILIES OF GRENADIERS FROM NEW SOUTH WALES

1a. A single long-based, low dorsal fin; head enormous, bulbous and spongy; eyes tiny, more than 10 in head length (Fig. 6) . . . . . [Macrouridae, subfam. Macrouroidinae—not yet found off NSW but can be expected]

1b. Two dorsal fins; head variously shaped, not especially huge and bulbous; eyes less than 10 in head length 2

2a. First and second dorsal fins separated by a distinct gap (Fig. 7a); gill rakers all short, tubercular or tablike (Fig. 8a); opening of first gill slit restricted by membrane across upper and lower arms of gill arch (Fig. 9) . . . . . Macrouridae, subfam. Macrourinae (Fig. 10)

2b. First and second dorsal fins closely approximated, without a distinct gap (Fig. 7b); gill rakers slender, lathlike (Fig. 8b); opening of first gill slit unrestricted by membrane. 3

3a. Mouth subterminal to inferior, a long, stout, sharp snout; scales covered with spinules; series of sharply spined scutes present along bases of dorsal and anal fins (Fig. 11) . . . . . Macrouridae, subfam. Trachyrincinae

3b. Mouth essentially terminal, snout rounded not protruding (Fig. 12); scales all smooth; no scutes on body . Bathygadidae

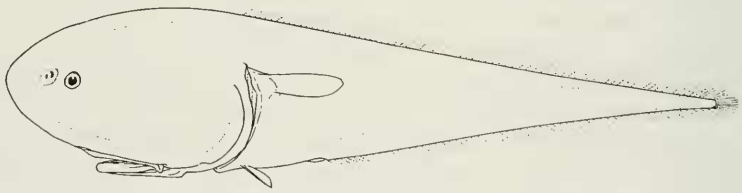

FIGURE 6. Diagrammatic illustration of a Macrouroidinae (*Squalogadus modificatus*).

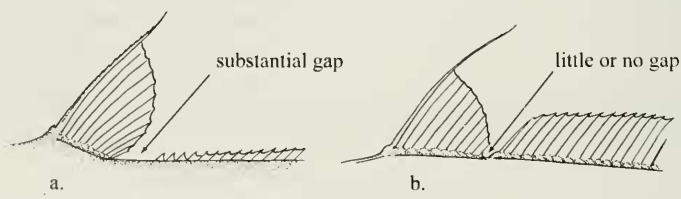

FIGURE 7.(a) First and second dorsal fins separated by a distinct gap; (b) first and second dorsal fins closely approximated.

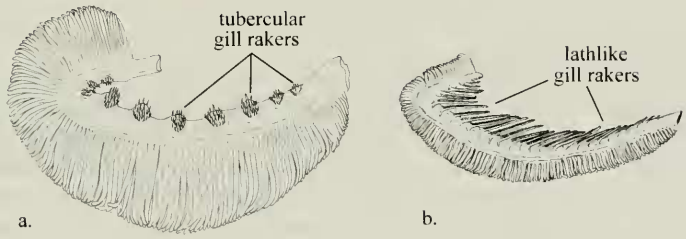

FIGURE 8. (a) Gill rakers on outer arch short and tubercular; (b) gill rakers long and slender.

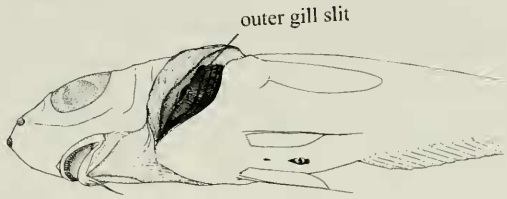

FIGURE 9. Opening of first (outermost) gill slit restricted by membranes across upper and lower arms of gill arch.

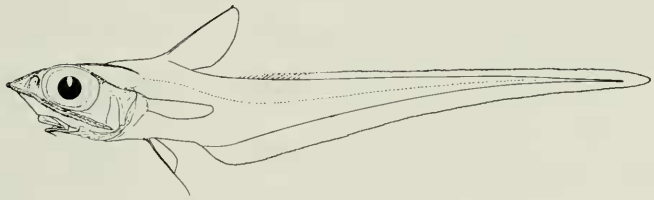

FIGURE 10. Diagrammatic illustration of a Macrourinae (*Caelorinchus* sp.).

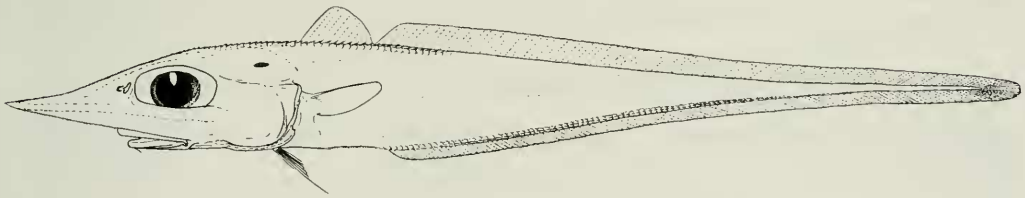

FIGURE 11. Diagrammatic illustration of a Trachyrincinae (*Trachyrincus sp.*).

FIGURE 12. Diagrammatic illustration of a Bathygadidae (*Bathygadus* sp.).

Family Bathygadidae

Distinguishing Features. — Two dorsal fins, the second beginning immediately behind first without a pronounced gap. Outer gill rakers on first arch long, lathlike, 20 or more total. Branchiostegal rays 7. No membrane restricting first gill slit. Pelvic fin rays 8–10; first dorsal fin with smooth, flexible spinous ray. No spinules on scales. Large terminal mouth and no protruding snout.

Remarks. — Only two genera are recognized, *Bathygadus* and *Gadomus*, with about 35 nominal species; the taxonomy of the group is still not fully resolved. Members of the family are found in tropical to temperate waters, and the family is widely distributed in the Atlantic, Indian, and Pacific oceans, but notably absent (as are many macrourid genera) in the eastern North Pacific. Bathygadids are abundant throughout the Indian Ocean and the western South Pacific, but their occurrence and abundance in the central and eastern South Pacific is uncertain because of the lack of sampling in those regions (aside from the Nazca and Sala y Gomez ridges in the southeastern Pacific; see Sazonov and Iwamoto 1992). Contrary to Howes and Crimmen's (1990:201) statement, the family is not found in the Southern Ocean as it is usually defined (see for example, Gon and Heemstra 1990), as the Kermadec Islands and Lord Howe Rise, from which they cite occurrences of the family, have never been considered part of the Southern Ocean.

References. — Gilbert and Hubbs (1920); Howes and Crimmen (1990); Iwamoto (1990).

Key to Genera and Species of Bathygadids from New South Wales

1a. Chin barbel well developed; ground color of body cream to light brown; first dorsal, pectoral, and pelvic fins with stout, greatly produced rays (Fig. 13) . . . . . (*Gadomus*) 2
1b. Chin barbel absent; ground color of body dark, usually blackish; rays of first dorsal, pectoral, and pelvic fins weak, anterior ray of fins if produced, distally hair thin (Fig. 14) . . . . . (*Bathygadus*) 3

2a. Outer gill rakers 24–25 total, longest about length of longest gill filaments; chin barbel about 3 times orbit diameter; mouth pale; all fins black; pyloric caeca short, more than 100 . . . . . *Gadomus* sp. cf. *colletti*
2b. Outer gill rakers 28–31 total, longest about twice length of gill filaments; chin barbel about 1–2 times orbit diameter; mouth black; fins dark but not intensely black; pyloric caeca long, about 75 . . . . . *Gadomus pepperi*

3a. Head broad, interorbital width 30–40% (Fig. 15a); orbit diameter 16–22%; paired fins dusky to black; flesh soft, head bones weak 4
3b. Head narrow, compressed, interorbital width 26–30% (Fig. 15b); orbit diameter 21–23%; paired fins black; flesh firm, head bones rather strong . . . . . *B. furvescens*

4a. Pyloric caeca 8–12; P i10–i15 (usually i12–i14); length longest gill rakers 14–20% HL; suborbital width 16–19% HL; small adult size, <30 cm . . . . . *B. cottoides*
4b. Pyloric caeca 15–28, usually 20–28; P i14–i18; length longest gill rakers 7–16% HL; suborbital width 12–16% HL; large adult size, >46 cm . . . . . *B.* sp. cf. *spongiceps*

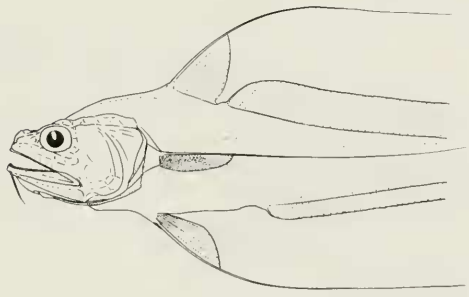

Figure 13. Diagrammatic illustration of a *Gadomus* sp.

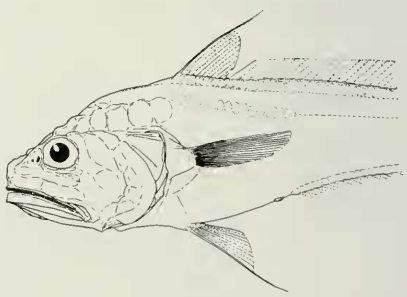

Figure 14. Diagrammatic illustration of a *Bathygadus* sp.

Genus *Bathygadus*

DISTINGUISHING FEATURES. — Distinguished from *Gadomus* by absence of chin barbel, more fragile head bones and head covering, generally darker color (usually mostly blackish), absence of extremely long, well-developed rays in dorsal and pectoral fins.

REMARKS. — Three species known from NSW, each widely distributed in parts of the Indian and Pacific oceans; two species found in other parts of Australia.

REFERENCES. — Gilbert and Hubbs (1920); Howes and Crimmen (1990).

Bathygadus cottoides Günther, 1878

Fig. 16

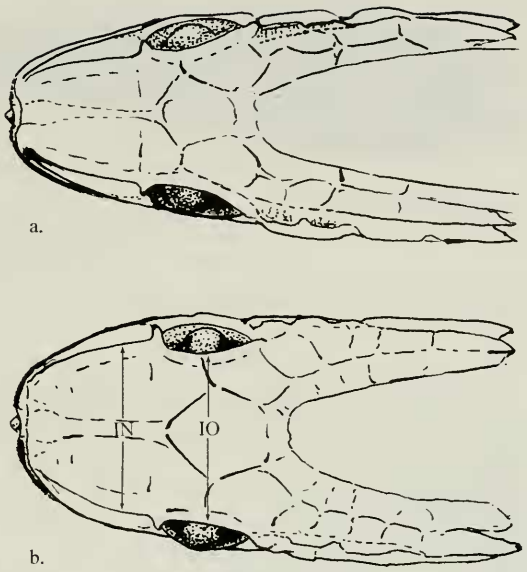

FIGURE 15. Comparison of internasal width (IN) and interorbital space (IO) in (a) *Bathygadus furvescens* and (b) *Bathygadus* sp. cf. *spongiceps*.

DISTINGUISHING FEATURES. — D II,8–10, P i10–i14, rarely i15, V 9 (rarely 8 or 10); outer GR-I (4–6)+(19–21), total 25–28, GR-II (outer) 17–20 total; pyloric caeca 8–12. Measurements in percent HL: snout length 30–36; internasal width 31–35; interorbital width 31–40; orbit diameter 16–21; suborbital width 16–19; distance orbit to angle of preopercle about 49–59 (sometimes less); upper jaw length 49–59; height ascending premaxillary process 13–16; vent to anal fin origin 9–29; length pectoral fin 41–86; length pelvic fin 49–66; length outer gill raker 14–20. Outer pelvic ray in some specimens moderately prolonged, but most others lack produced rays; pectoral fin rays not extending beyond anus. Teeth bands relatively narrow, 7 or 8 teeth wide at broadest part of premaxillary band, 4 or 5 wide in broadest part of dentary band. Fin rays dark dusky to black. Flesh and head bones rather soft and weak.

SIZE. — Maximum size about 30 cm.

DISTRIBUTION. — Australia (NSW, Vic., Tas., SA, WA), New Zealand and southern Africa, in depths of about 1000 m to more than 1500 m.

NSW CAPTURES. — Taken by *Kapala* between Crowdy Head and Batemans Bay in depths greater than 950 m. One specimen (AMS I.29318-001) captured in 1325 m by ORV *Franklin* near Lord Howe Island. *Kapala* captured 56 specimens in 26 tows (or 14% of *Kapala* tows deeper than 900 m). Because of its small adult size (most specimens less than 20 cm), *B. cottoides* is probably more abundant than its trawl capture rate suggests.

REMARKS. — This species can be confused with small individuals of *B. furvescens*, but the lower counts of pectoral fin rays and pyloric caeca, the wider head, and the smaller orbit of *B. cottoides* are characters that differentiate the two species.

REFERENCE SPECIMENS. — AMS I.24978-005 (3 spec.); K84-20-04. AMS I.25095-004 (1 spec.); K84-20-05. AMS I.26000-010 (1 spec.); K86-01-08. AMS I.27638-003 (1 spec.); K88-11-01. AMS I.27717-001 (1 spec.); K88-04-08. AMS I.29310-001 (1 spec.); ORV *Franklin* 28°44.08′S, 161°54.59′E; 1325 m; 4 May 1989. AMS I.29745-007 (1 spec.); K89-18-02. AMS I.29801-002 (1 spec.); K89-08-02. AMS I.39052-002 (3 juveniles); K89-18-04.

REFERENCES. — Iwamoto and Merrett (1997)(in part); Merrett and Iwamoto (2000).

FIGURE 16. *Bathygadus cottoides* Günther, 1878. AMS I.24978-005. From *Kapala* stn K84-20-04, off Broken Bay, NSW, in 1070-1125 m.

***Bathygadus furvescens* Alcock, 1894**
Fig. 17

DISTINGUISHING FEATURES. — Holotype data in square brackets [ ]. D II,8–9 [10], P i15–i19 [i16], V 8–9 [8]; GR-I (outer/inner) (5–6)+(18–20)[6+18]/(3–4)+(15–16)[3+16], totals 23–26/18–19, GR-II 2+(14–15)[2+15]/(2–3)+(14–16)[2+15], totals 16–17/17–18; pyloric caeca 20–22[20]. Measurements (in percent HL): snout length [26] 28–30; internasal width 24; interorbital width [26] 29–30; orbit diameter [21] 21–23; suborbital width 14–15; postorbital length [51] 51–52; distance orbit to preopercle [48] 48–50; length upper jaw [57] 56–59; length pectoral fin [61] 71–81; length pelvic fin 67–83; length longest gill raker 14–15. Fins well developed; pectoral and pelvic fins long, extending to or beyond origin of anal fin; pelvic fin with distally filamentous elongated outer ray. Flesh and head bones relatively stout and more like that of *Gadomus*. Teeth tiny, in broad villiform band in both jaws, premaxillary band about 10 to 12 teeth at widest point, dentary band about 7 or 8 teeth at widest. Paired fins black, median fins black to dark dusky.

SIZE. — To approximately 55 cm.

DISTRIBUTION. — Known only from the holotype taken off the Maldives in 1315 m and the current specimens from NSW and Tasman Sea, but can be expected in other parts of the Indian Ocean and western Pacific. In addition to *Kapala* material, AMS specimen (I.29338-002) was captured in 1050 m on the Lord Howe Rise to the east of the Australian Fishing Zone.

NSW CAPTURES. — *Kapala* caught 14 specimens of *B. furvescens* at 11 stations between Crowdy Head and Jervis Bay, in depths between 1000 and 1240 m. It was present in only 11% of all *Kapala* tows deeper than 1000 m, but is possibly more abundant at greater depths.

REMARKS. — These NSW specimen agree rather closely with the holotype, for which count and measurement data in the Distinguishing Features section were provided by Yuri I. Sazonov (ZMMGU) and Yuri N. Shcherbachev (IOAN). The snout length, interorbital width, and pectoral fin length in the holotype were slightly shorter than in the NSW specimens examined, and the count of first dorsal fin rays was high. Alcock (1894:14) gave the pyloric caeca count as 20 (Sazonov and Shcherbachev counted only 18). These data fall well within the expected range of variation. The pectoral fin length in the holotype may have been longer in the fresh specimen than when examined by Sazonov and Shcherbachev. Alcock (*ibid.*) stated that the fin "... tips reach beyond the origin of the anal" and "the length ... is not quite equal to that of the postrostral portion of the head."

Gilbert and Hubbs (1920:388–390) recorded *B. furvescens* from Indonesia and the Philippines. Howes and Crimmen (1990:195) erroneously referred these to *B. cottoides* (see Iwamoto and Merrett 1997:479 for comments on Howes and Crimmen's treatment of *B. furvescens*). Our examination of three of the five specimens (CAS-SU 25442, CAS-SU 25443, CAS-SU 25444) suggested that Gilbert and Hubbs may have had a species different from *B. furvescens*. The three specimens were small and in poor shape when examined, however, and certain of our measurements may not have been entirely accurate. Notably, all three had 15 pyloric caeca, although Gilbert and Hubbs recorded 20 in one of

five specimens (they did not state which one). Additional material from the general region of the Philippines and Indonesia must be examined to properly determine which species actually occur there.

REFERENCE SPECIMENS. — AMS I.24355-016 (1 spec.); K83-18-02. AMS I.25273-003 (1 spec.); K84-11-09. AMS I.26001-016 (2 spec.); K86-01-09. AMS I.28070-002 (1 spec.); K88-11-02. AMS I.28372-002 (1 spec.); K88-08-05. AMS I.28712-002 (1 spec.); K88-10-02. AMS I.29338-002 (1 spec.); ORV *Franklin* stn FR0580-25, 28°05.76′S, 163°06.04′E; 1051 m; 5 May 1989. AMS I.29812-002 (1 spec.); K89-15-02. AMS I.30738-003 (1 spec.); K89-12-02.

REFERENCE. — Alcock (1894).

***Bathygadus* sp. cf. *spongiceps* Gilbert and Hubbs, 1920**
Fig. 18

DISTINGUISHING FEATURES. — D II,8–10, P i14–i18, V 9 (rarely 8 or 10); GR-I (outer) (5–6)+19–20, total 25–26, GR-II (outer) 17–19; pyloric caeca 15–28, usually 20–28. Measurements (in percent HL): snout length 30–33; internasal width 31–34; interorbital width 32–39; orbit diameter 16–22; suborbital width (bony) 12–16; postorbital length 52–55; distance orbit to preopercle 48–53; length upper jaw 54–59; length pectoral fin 47–62; length pelvic fin 46–71; length outer gill raker 7–16. Outer pelvic ray in some specimens moderately prolonged, but most lack produced rays; pectoral fin not extending beyond anus. Teeth bands relatively narrow to moderately broad, 7–12 teeth wide at broadest part of premaxillary band, 4–8 wide in broadest part of dentary band. Fin rays dusky to dark, but generally not black. Flesh and head bones rather soft and weak.

SIZE. — To approximately 50 cm.

DISTRIBUTION. — From most of the southwestern Pacific, New Zealand, Australia (NSW, WA), Indonesia, and the Philippines. Depth range about 900–1500 m.

NSW CAPTURES. — A single specimen taken at each of the two deepest *Kapala* tows (1130–1240 m), off Sydney and Jervis Bay; possibly more abundant at greater depths.

REMARKS. — Iwamoto and Williams (1999) found color differences in their material of *B. spongiceps* from Western Australia, with some specimens considerably blacker than others, but they found no other characters that would suggest specific differences. Merrett and Iwamoto (2000) examined specimens from the New Caledonian region that appeared to be identical to *B. spongiceps* except for slight differences in the dentition of the lower jaw and counts of pyloric caeca. They called their specimens *B.* sp. cf. *spongiceps*. We consider our NSW specimens as identical to the New Caledonian species and have therefore followed Merrett and Iwamoto's designation. More specimens of *B. spongiceps* from the type locality must be examined and compared with specimens from other areas.

REFERENCE SPECIMENS. — AMS I.26001-005 (1 spec.); K86-01-09. AMS I.30394-03 (1 spec.); K89-16-02.

REFERENCES. — Iwamoto and Merrett (1997)[in part; most specimens *B. cottoides*]; Iwamoto and Williams (1999); Merrett and Iwamoto (2000).

Genus *Gadomus*

DISTINGUISHING FEATURES. — *Gadomus* and *Bathygadus* specimens are readily separated by the former having a firmer body, stronger head bones and fin rays, and paler overall color of body. Almost all species of *Gadomus* have a long chin barbel, although two species have small or rudimentary ones, and most have greatly elongated rays in one or more fins. Teeth are generally finer and in broader bands in *Gadomus*.

REMARKS. — The taxonomy of the genus in the western Pacific and Indian Ocean is yet to be adequately resolved. Howes and Crimmen (1990) distinguished two groups based on gill raker counts.

FIGURE 17. *Bathygadus furvescens* Alcock, 1894. AMS I.25273-003. From *Kapala* stn K84-11-09, east of Nowra, NSW, in 1161–1207 m.

FIGURE 18. *Bathygadus* sp. cf. *spongiceps* Gilbert and Hubbs, 1920. AMS I.26001-005. From *Kapala* stn K86-01-09, off Broken Bay, NSW, in 1116–1207 m.

One of the New South Wales species falls in the group with low counts, the other (*G. pepperi*) in the high-count group. Iwamoto and Williams (1999) provide a full account of both species.

***Gadomus* sp. cf. *colletti* Jordan and Gilbert, 1904**
Fig. 19

DISTINGUISHING FEATURES. — D II,10; P i16–i21; V 8; outer gill rakers short, about length of gill filaments, (4–5)+(19–21), 24–25 total; pyloric caeca small, very numerous, more than 100. Barbel thick, long, about 3 times diameter of orbit; gums and lower branchiostegal membrane pale; all fins black; elongated dorsal ray less than twice head length, an extremely long upper pectoral ray, outer pelvic ray about equal to or less than head length.

SIZE. — To 30 cm.

DISTRIBUTION. — So far known only from Australia (NSW, WA), in 500–1150 m.

NSW CAPTURES. — Caught in a relatively narrow depth range of 690–975 m between Crowdy Head and Batemans Bay, with most taken north of Sydney. Of the 65 specimens from 27 *Kapala* stations (15% of tows in 700–1000 m), 30 specimens were from two tows off Port Stephens; all other stations yielded fewer than five specimens per tow.

REMARKS. — Distinguished from *G. pepperi* by its lower gill raker count, shorter rakers on the first gill arch, generally shorter elongated fin rays, and its pale mouth and tongue. Iwamoto and Williams (1999) discuss their reluctance to identify this species as *G. colletti*, which is described as having a blackish buccal cavity, in contrast to the distinctly pale buccal cavity in the Australian specimens.

REFERENCE SPECIMENS. — AMS I.29813-006 (1 spec.); K89-06-05. AMS I.24979-011 (1 spec.); K84-16-04. AMS I.19862-006 (1 spec.); K76-23-01. AMS I.24659-001 (1 spec.); K84-06-04. Others listed in Iwamoto and Williams (1999).

REFERENCE. — Iwamoto and Williams (1999).

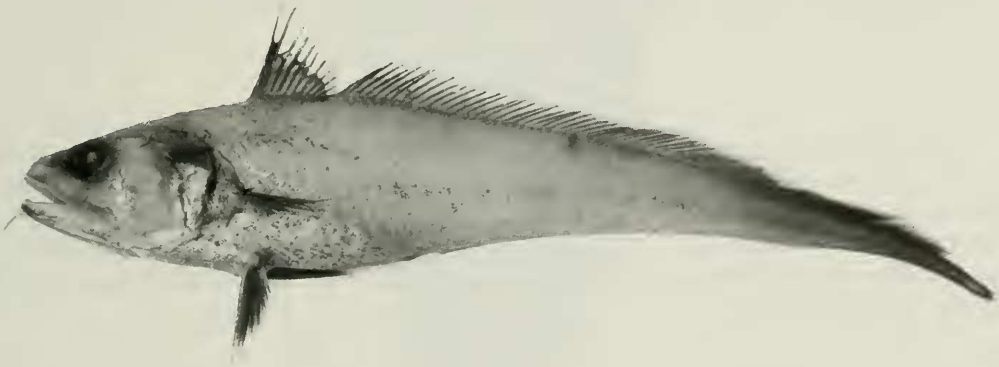

FIGURE 19. *Gadomus* sp. cf. *colletti* Jordan and Gilbert, 1904. AMS I.24659-001. From *Kapala* stn K84-06-04, off Broken Bay, NSW, in 914–933 m.

Gadomus pepperi **Iwamoto and Williams, 1999**
Fig. 20

DISTINGUISHING FEATURES. — 1D II,9; P i14–i18 (rarely i20); V 8; outer gill rakers long, twice length of gill filaments, (5–6)+(22–25), total 28–31; pyloric caeca about 75 long, slender. Barbel slender, length about one to two times orbit diameter; interorbital width 18–23% of HL; mouth all black; gular membrane pale, branchiostegal membrane blackish, lips dark; fins dark but not intensely black, tail tip dusky; first dorsal, pectoral, and pelvic fins with a prolonged ray generally exceeding twice head length.

SIZE. — To 40 cm.

DISTRIBUTION. — Australia (Qld, NSW, west to WA), in 800–1500 m.

NSW CAPTURES. — Relatively common between Crowdy Head and Gabo Island in 825–1200 m. Recorded from 178 *Kapala* stations (including 94% of all tows deeper than 900 m); usually more than 10 specimens per tow.

REMARKS. — Distinguished from *G.* sp. cf. *colletti* by its higher gill raker counts, fewer pyloric caeca, shorter barbel, dark mouth, pale gular membrane, longer fin rays, and less intensely black fins.

REFERENCE SPECIMENS. — AMS I.24059-002 and I.24059-020 (7 spec.); K83-09-02. Others listed in Iwamoto and Williams (1999).

REFERENCE. — Iwamoto and Williams (1999).

Family Macrouridae

DISTINGUISHING FEATURES. — The most noticeable feature that separates this family from the bathygadids is the protruding snout (the nasal bones have an anteriorly directed medial process that is lacking in the bathygadids). Exceptions to this are *Haplomacrourus nudirostris* and *Kuronezumia spp.*, which may lack a protruding snout in adults, but unlike bathygadids they have small mouths. In addition, almost all macrourids have spinules on the scales. The exceptions are some species of *Hymenocephalus*, which may have lost the spinules secondarily.

REMARKS. — This large family contains about 300 species, many of which have yet to be described. Three subfamilies are generally recognized, although each may warrant full family status. Subfamily Macrourinae contains most of the 300 plus species in about 30 genera; Trachyrincinae has about seven species in two genera; and Macrouroidinae has only two species in two genera.

REFERENCES. — Okamura (1970, 1989); Marshall (1973).

SUBFAMILY MACROURINAE

DISTINGUISHING FEATURES. — First dorsal fin high, the segmented rays preceded by one rudimentary or spikelike spinous ray closely adpressed to a long spinous ray; first dorsal fin separated from second dorsal by a distinct gap; anal fin rays much better developed (usually longer and stouter) than those of second dorsal fin in almost all species. Branchiostegal rays 6–7 (rarely 8). Gill rakers short, usually tubercular; the outer gill arch closely attached to gill cover by membrane, greatly reducing size of outermost gill slit.

FIGURE 20. *Gadomus pepperi* Iwamoto and Williams, 1999. AMS I.24059-002. From *Kapala* stn K83-09-02, east of Broken Bay, NSW, in 933–969 m.

Key to Genera and Some Species of Macrourinae from New South Wales

(Adapted from Iwamoto and Williams 1999. Species in square brackets are not yet recorded from NSW but can be expected.)

1a. Second spinous ray of first dorsal fin smooth (Fig. 21a). 2
1b. Second spinous ray of first dorsal fin serrated along leading edge (weakly or much reduced in some) (Fig. 21b) 9

2a. Snout stoutly supported and pointed; a continuous suborbital ridge of coarsely spined scales extending from snout tip to preopercle angle, terminating in a sharp point . . . . . *Caelorinchus* (Fig. 22)
2b. Snout strongly to weakly supported, rounded to pointed; suborbital ridge, if present, not continuous from snout tip to angle of preopercle and not terminating in a sharp point 3

3a. Broad areas of fine, parallel black lines (ventral striae) overlying silvery ground on ventral surfaces of chest, shoulder girdle, along each side of isthmus, and belly (Fig. 23, 24) 4
3b. No ventral striae 5

4a. Ventral striae extend alongside anterior half or more of anal fin base; 6 branchiostegal rays; no lenslike light organ on chest; attains more than 50 cm TL . . . . . *Lepidorhynchus denticulatus* (Fig. 23)
4b. Ventral striae rarely extend posterior to anus; 7 branchiostegal rays; a small lens of light organ on chest; adults small, usually less than 23 cm TL. . . . . *Hymenocephalus* (Fig. 24)

5a. Lower jaw with large, widely spaced, fanglike teeth in one row 6
5b. Lower jaw with rather small teeth in more than one row 8

6a. Head pores small; grooved lateral line complete to end of tail; chin barbel present; 7 branchiostegal rays . . . . . *Malacocephalus laevis* (Fig. 25)
6b. Large open pores on head; grooved lateral line interrupted posterior to first dorsal fin; no chin barbel; 6 branchiostegal rays 7

7a. Anus removed from anal fin, usually about midway between pelvic fin and anal fin, preceded by a small black fossa of light organ between pelvic fins; grooved lateral line single, short, terminating at vertical behind first dorsal fin; abdomen short, distance isthmus to anus less than half head length . . . . . *Odontomacrurus murrayi* (Fig. 26)

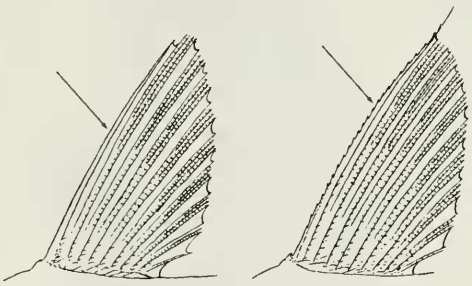

Figure 21. Leading edge of second spinous ray of first dorsal fin smooth (a) and serrated (b).

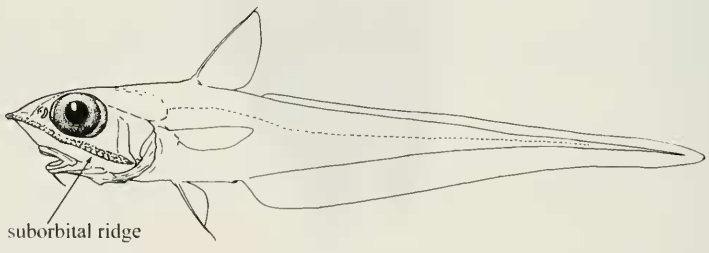

Figure 22. Suborbital ridge in *Caelorinchus* extending from snout tip to preopercle angle, terminating in a sharp point.

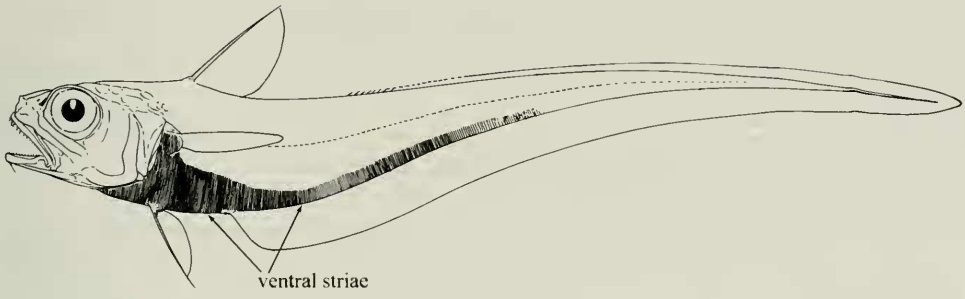

FIGURE 23. Ventral striae in *Lepidorhynchus denticulatus*.

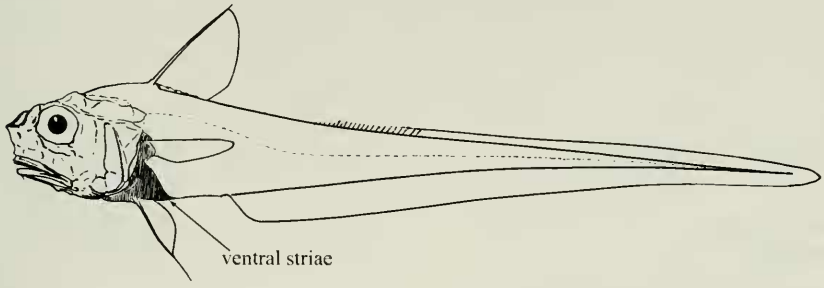

FIGURE 24. Ventral striae in *Hymenocephalus* sp.

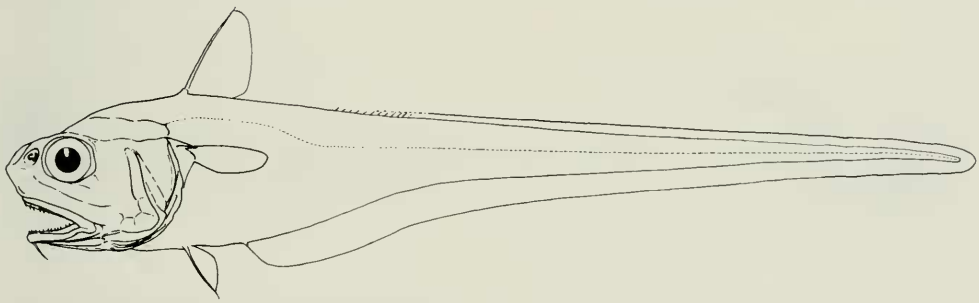

FIGURE 25. Diagrammatic illustration of a *Malacocephalus* sp.

FIGURE 26. Diagrammatic illustration of an *Odontomacrurus murrayi* showing position of anus and short lateral line.

7b. Anus immediately before anal fin, no fossa of light organ; grooved lateral line prominent, in two parts, an anterior dorsolateral section and a posterior midlateral section; abdomen long, distance isthmus to anus more than three-fourths of head length . . . . . *Cynomacrurus piriei* (Fig. 27)

8a. Pelvic rays 6–7 . . . . . *Trachonurus* (Fig. 28)
8b. Pelvic rays 9–12 . . . . . [*Ventrifossa sazonovi*]

9a. Head massive, globose, soft; scales along base of second dorsal fin enlarged 10
9b. Head not especially massive or globose; no enlarged scales along base of second dorsal fin 11

10a. Base of pelvic fin posterior to vertical through origins of first dorsal and pectoral fins; interorbital width 31–34% HL . . . . . [*Cetonurichthys subinflatus*]
10b. Base of pelvic fin about at or anterior to vertical through origin of first dorsal and pectoral fins; interorbital width 36–48% HL (Fig. 29). . . . . *Cetonurus globiceps*

11a. Scales of head elongated, with spinules longitudinally aligned to give striated pattern to head surfaces; chin barbel absent. . . . . *Mesobius* (Fig. 30)
11b. Head scales not elongated, no striated pattern to head surfaces; chin barbel present 12

12a. Snout rounded, not protruding beyond mouth in adults, naked; scales on head and front of body without spinules or ridges; maxilla reaches only to vertical through front of orbit in adults (more posteriorly in juveniles); second spinous ray of first dorsal fin notably large and laterally compressed, heavily serrated. . *Haplomacrourus nudirostris* (Fig. 31)
12b. Snout angular, protruding beyond mouth, completely naked to variously covered with scales; almost all scales covered with spinules or low ridges; maxilla usually extends well posterior to front of orbit (except in some species of *Sphagemacrurus* and *Lucigadus*); spinous second ray of first dorsal fin not greatly compressed laterally, sparsely to densely serrated or smooth along leading edge. 13

13a. Branchiostegal rays 6 14
13b. Branchiostegal rays 7 15

14a. Anus at or close to anal fin origin; no light organ . . . . . *Coryphaenoides*
14b. Anus removed from anal fin; small light organ present (Fig. 32) . . . . . *Mataeocephalus* sp.

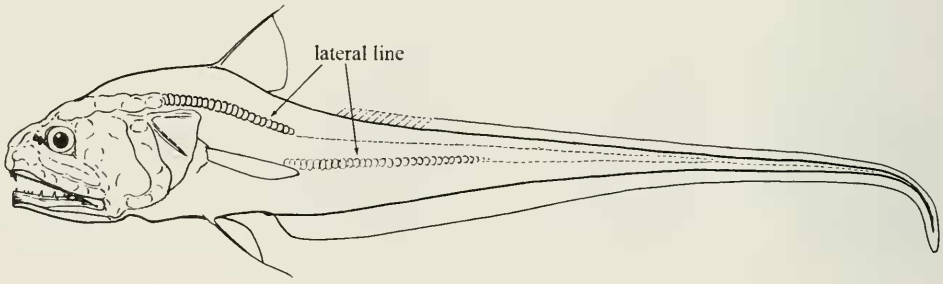

FIGURE 27. Diagrammatic illustration of a *Cynomacrurus piriei* showing position of anus and lateral line in two parts.

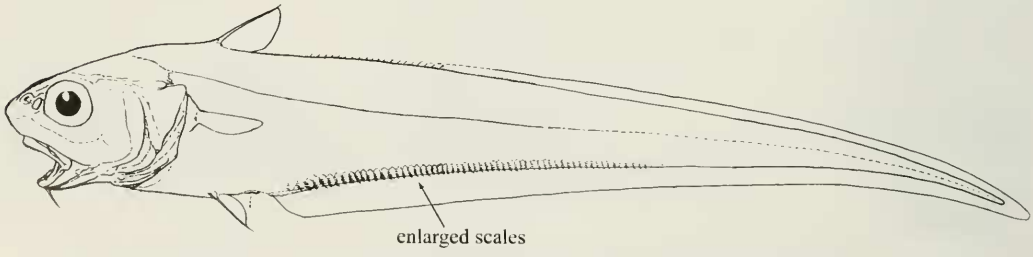

FIGURE 28. Diagrammatic illustration of a *Trachonurus* showing enlarged scales along base of anal fin.

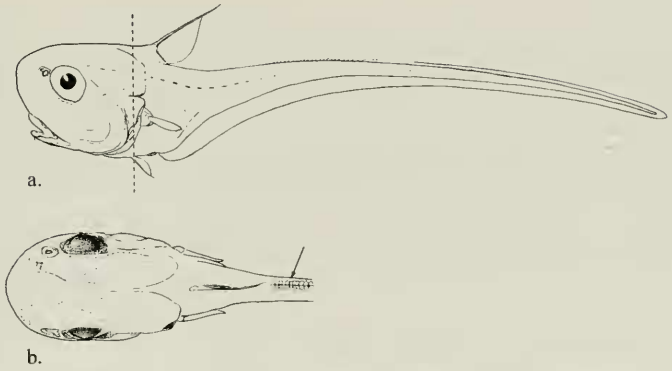

FIGURE 29. Diagrammatic illustration of a *Cetonurus* sp. (a) Lateral view showing relative positions of pelvic, pectoral, and first dorsal fins. (b) Dorsal view of head; arrow points to enlarged scales along anterior part of second dorsal fin.

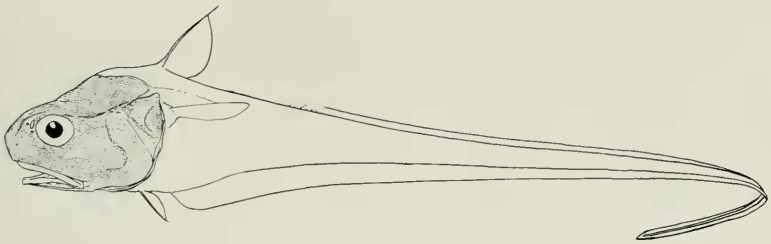

FIGURE 30. Diagrammatic illustration of a *Mesobius* sp. showing striated pattern of spinulation on head.

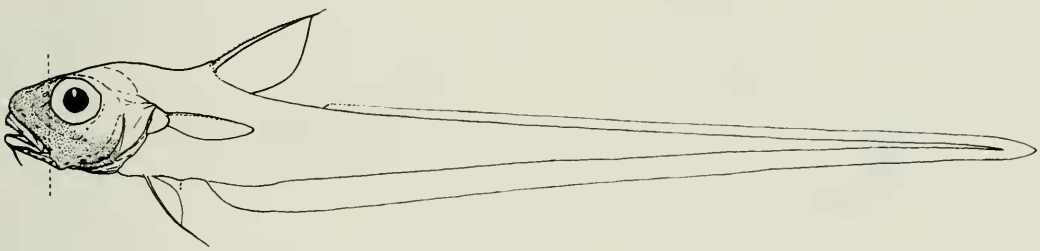

FIGURE 31. Diagrammatic illustration of a *Haplomacrourus nudirostris* showing extensive naked areas on head (stippled) and forward position of mouth.

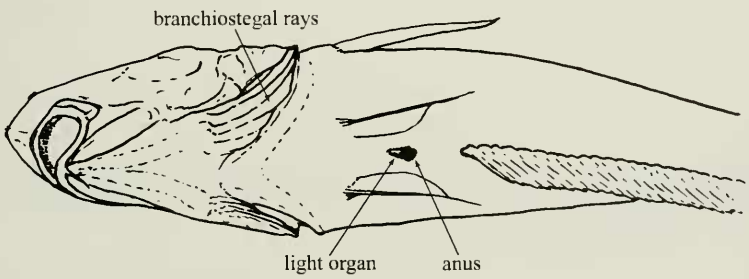

FIGURE 32. Diagrammatic ventrolateral view of *Mataeocephalus* sp. with six branchiostegal rays: anus far removed from anal fin origin and small light organ before anus.

15a. Snout mostly naked dorsally and ventrally without terminal and lateral tubercular scales 16
15b. Snout variously naked, but usually no extensive naked area dorsally; tubercular scales present at terminal and lateral tips of snout 18

16a. Olfactory organ huge, length of posterior nostril about one-half diameter of orbit . . . [*Macrosmia phalacra*] (Fig. 33)
16b. Olfactory organ normal, posterior nostril much less than half diameter of orbit 17

17a. Origin of anal fin below first dorsal fin; anus usually closer to pelvic fin than to anal fin. . . . . [*Kumba*] (Fig. 34)
17b. Origin of anal fin well posterior to vertical through hind margin of first dorsal fin; anus immediately before anal fin . . . . . *Asthenomacrurus victoris* (Fig. 35)

18a. A double row of stout, modified scales under orbit forming a stout shelf and usually a sharp, rough ridge (Fig. 36) . 19
18b. Scales under orbit all small, forming smooth, rounded surface 21

19a. Anus closer to pelvic fin insertions than to anal fin origin (Fig. 37a) . . . . . *Nezumia*
19b. Anus closer to anal fin than to pelvic fin (Fig. 37b). 20

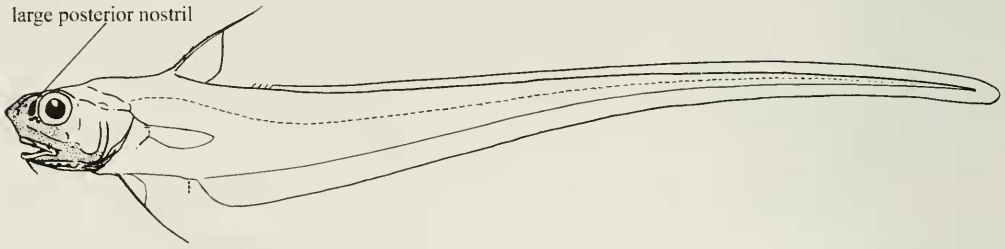

FIGURE 33. Diagrammatic illustration of a *Macrosmia phalacra* showing extensive naked areas (stippled) on head and large posterior nostril.

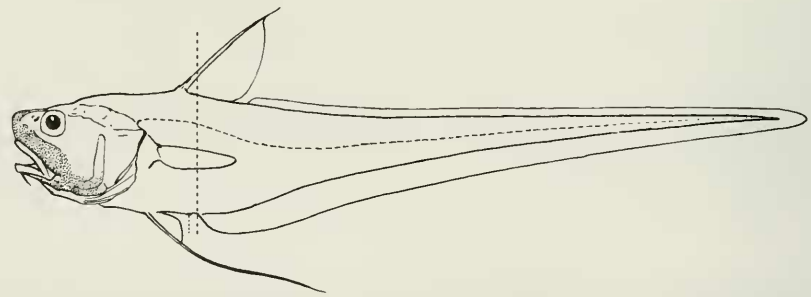

FIGURE 34. Diagrammatic illustration of a *Kumba* sp. showing extensive naked areas (stippled) on head and position of anal fin origin relative to first dorsal fin.

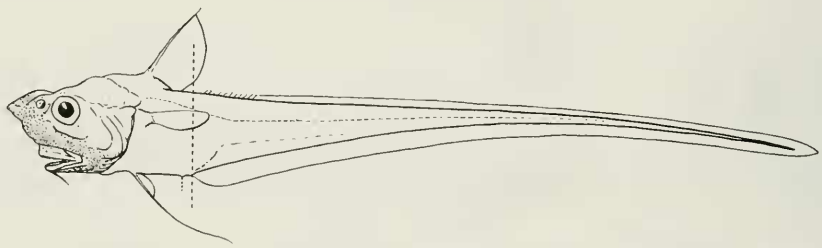

FIGURE 35. Diagrammatic illustration of *Asthenomacrurus victoris* showing extensive naked areas (stippled) on head and position of anal fin origin relative to first dorsal fin.

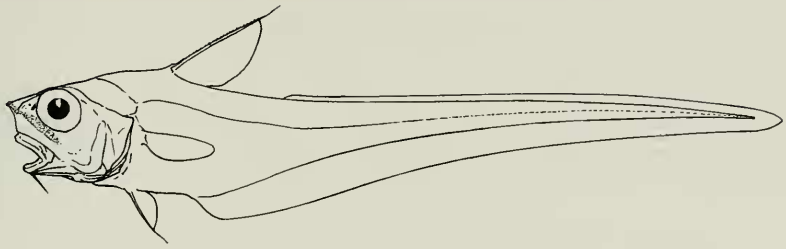

FIGURE 36. Diagrammatic illustration of a *Nezumia* sp.

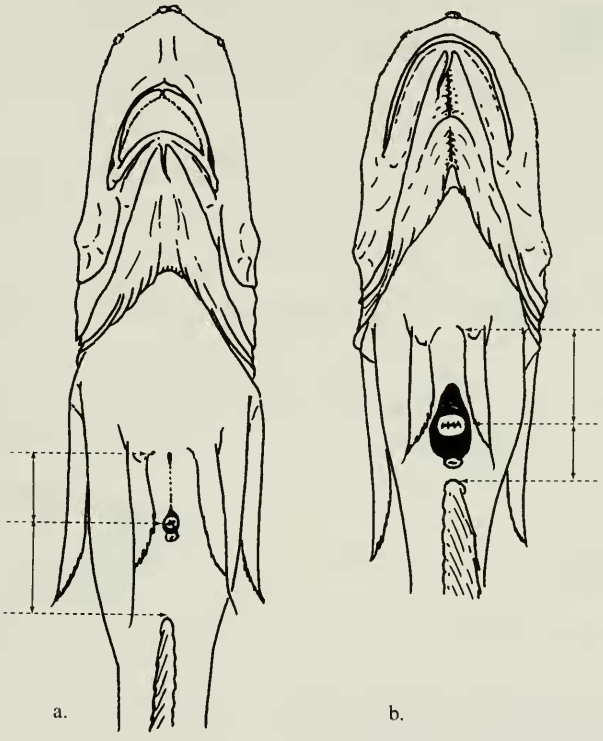

FIGURE 37. Diagrammatic ventral views of (a) *Nezumia* and (b) *Sphagemacrurus* showing positions of anus and relative sizes of periproct region.

20a. Snout short, high, scarcely protruding beyond steeply oblique mouth; pelvic fin anteriorly placed, about under preopercle; anal fin origin about under first dorsal fin origin . . . . . *Sphagemacrurus* (Fig. 38)
20b. Snout long, protruding well beyond slightly oblique mouth; pelvic fin origin below or behind opercle, anal fin origin below or behind vertical through posterior margin of first dorsal fin . . . . . *Mataeocephalus* (Fig. 39)

21a. Outer gill rakers of second arch 13–18; no scales on gular and branchiostegal membranes . . . . *Ventrifossa* (Fig. 40)
21b. Outer gill rakers of second arch 12 or fewer; small scales sometimes present on gular or branchiostegal membranes 22

22a. Prominent fin markings (black blotches or streaks) in most species; spinules on body scales aligned in more or less parallel rows; adult size less than 30 cm TL in most species. . . . . *Lucigadus* (Fig. 41)
22b. Fins lacking prominent markings; spinules on body scales in irregularly quincunx to somewhat divergent rows; adult size greater than 30 cm TL . . . . . *Kuronezumia* (Fig. 42)

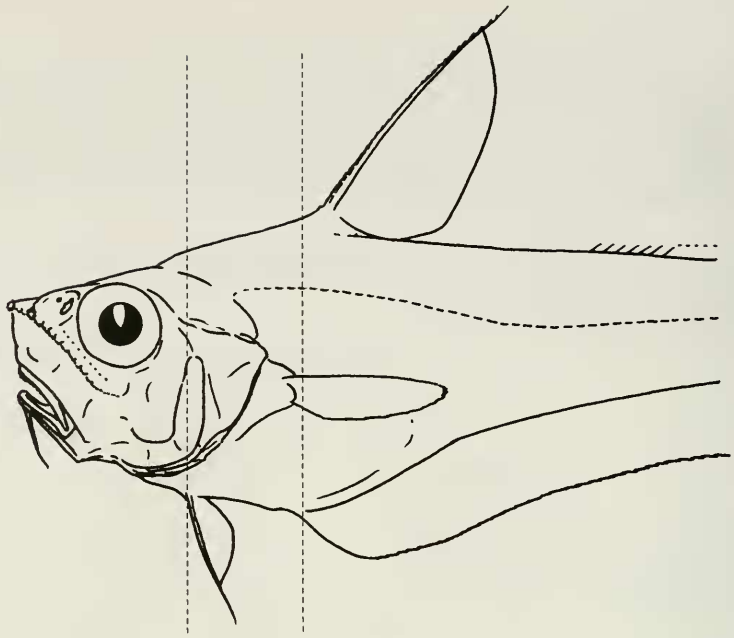

FIGURE 38. Diagrammatic illustration of a *Sphagemacrurus* sp. showing oblique mouth and relative positions of pelvic fin and anal fin origin.

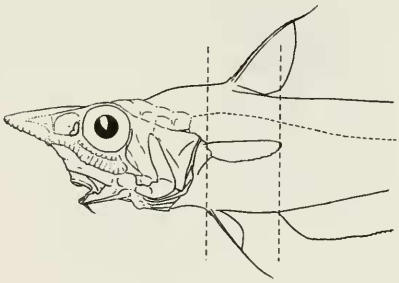

FIGURE 39. Diagrammatic illustration of a *Mataeocephalus* sp. showing thick, coarse scales along suborbital and relative positions of pelvic fin and anal fin origin.

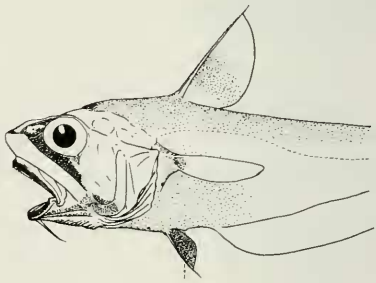

FIGURE 40. Diagrammatic illustration of a *Ventrifossa* sp.

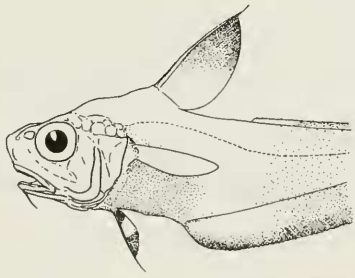

FIGURE 41. Diagrammatic illustration of *Lucigadus microlepis.*

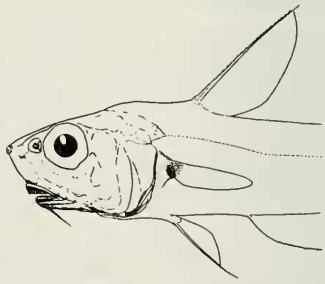

FIGURE 42. Diagrammatic illustration of *Kuronezumia leonis.*

Genus *Asthenomacrurus*

DISTINGUISHING FEATURES. — Anus immediately in front of anal fin. Pelvic fin slightly in advance of vertical through pectoral fin base. Head bones weak, no coarse scaly ridges on head; snout almost entirely naked. Long spinous ray of first dorsal fin with few weak serrations along leading edge. Seven branchiostegal rays. Light organ poorly developed or apparently absent. Species small, probably less than 25 cm.

REMARKS. — The genus is enigmatic and may eventually be considered the same as *Pseudonezumia* Okamura, 1970. Only two species of small adult size, *A. victoris,* here reported, and *A. fragilis* (Garman, 1899) from the eastern central Pacific. Specimens identified as *Paracetonurus* sp. by Iwamoto (1986) are probably of this genus.

REFERENCE. — Sazonov and Shcherbachev (1982b).

Asthenomacrurus victoris Sazonov and Shcherbachev, 1982

Fig. 35

DISTINGUISHING FEATURES. — As for genus, with V7 or 8; outer GR-I 13–14.

SIZE. — Probably less than 25 cm.

DISTRIBUTION. — Indian Ocean, off Japan, and Australia (NSW, WA), in about 1650–3500 m.

NSW CAPTURES. — Two specimens were taken in 1650–1900 m off Nowra by the *ORV Franklin.*

REMARKS. — The species was originally described from three specimens, one of which was from about 200 n. mi. west of Freemantle (WA). The two NMV specimens are the shallowest captures and the first record of the species from the Pacific coast of Australia.

REFERENCE SPECIMENS. — NMV A7000 (220 mm TL) and NMV A7001 (154 mm TL; 67 km ene of Nowra (34°41.97′S, 152°22.44′E); 1896–1642 m; ORV *Franklin* stn CSIRO FR9/88, Slope 59, 22 Oct. 1988.

REFERENCE. — Sazonov and Shcherbachev (1982b).

Genus *Caelorinchus*

DISTINGUISHING FEATURES. — Branchiostegal rays 6. A stout ridge formed of modified scales extending from tip of snout to angle of preopercle, terminating posteriorly in a sharp point; other head ridges stout in most species. Spinous ray of first dorsal fin smooth along leading edge. Pelvic fin rays almost invariably 7. A ventral light organ with a black fossa either on belly or on chest in most species. No gill rakers on outer side of first arch; rakers on inner side of arch tubercular, 10 or fewer total (except in *C. matamuus,* with as many as 12). Chin barbel present.

REMARKS. — This is the most speciose genus of grenadiers with more than 100 known and more awaiting description. The genus is best represented in tropical and subtropical waters, but is also numerous in certain temperate waters such as off New Zealand, where 21 species have been recorded. We have found 16 species of *Caelorinchus* off New South Wales. Most of these are widespread in the southern part of the continent, with other species more representative of the subtropical-tropical Queensland fauna.

REFERENCES. — Gilbert and Hubbs (1920); Iwamoto (1990); McMillan and Paulin (1993); Iwamoto and Williams (1999).

KEY TO THE SPECIES OF *CAELORINCHUS* OF NEW SOUTH WALES

1a. Underside of snout naked 2
1b. Underside of snout fully scaled 8

2a. A prominent black fossa of light organ on midline of chest or belly (Fig. 43) 3
2b. No fossa on chest or belly 7

3a. Rays of second dorsal fin long, about equal to opposite rays of anal fin; black fossa of light organ on chest . . . . . *C.* sp. cf. *cingulatus* (Fig. 44)
3b. Rays of second dorsal fin short, much shorter than opposite rays of anal fin; black fossa of light organ on belly 4

4a. A small but prominent black spot at base of pectoral fin; pelvic fin with large black blotch in middle of fin; light organ large, extending anteriorly to or beyond transverse line connecting origins of pelvic fins (Fig. 45) . . . . . *C. mirus*
4b. No spot at base of pectoral fin; pelvic fins lacking large black blotch; light organ extends forward no further than to line connecting insertions of pelvic fins 5

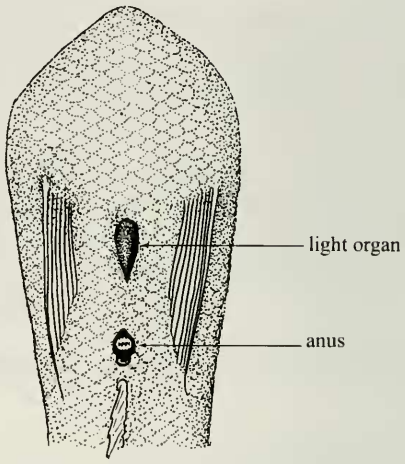

FIGURE 43. Ventral view of trunk of a *Caelorinchus* showing large anterior dermal window of light organ between pelvic fins.

5a. Dorsally behind leading edge of snout with usually clear naked area on each side of midline (Fig. 46); saddles usually absent on trunk, but faintly present on tail; pale interspaces between saddles spotlike in dorsal view (Fig. 47) . . . . . *C. parvifasciatus*
5b. Dorsally behind leading edge of snout densely covered with scales, lacking clear naked areas; saddles prominent on trunk and tail, interspaces not spotlike in dorsal view 6

6a. First dorsal and anal fins black or very dark to base, without prominent pale areas (Fig. 48); body scales relatively deciduous; pyloric caeca 12–23 (Fig. 49) . . . . . *C. fasciatus*
6b. Base of first dorsal fin distinctly pale, anal fin with a prominent black stripe posteriorly (Fig. 50); body scales relatively adherent; pyloric caeca 18–34 (usually 22–32) . . . . . *C. maurofasciatus*

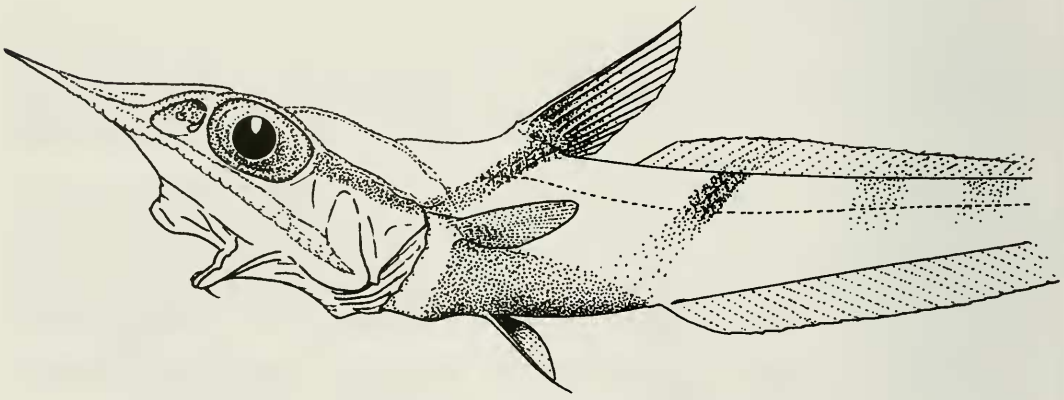

FIGURE 44. Diagrammatic illustration of *Caelorinchus* sp. cf. *cingulatus* showing pigmentation pattern and high second dorsal fin.

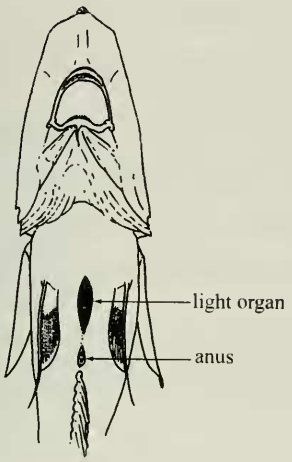

FIGURE 45. Ventral view of a *Caelorinchus mirus* showing large anterior dermal window of light organ and prominent black spot on pelvic fins.

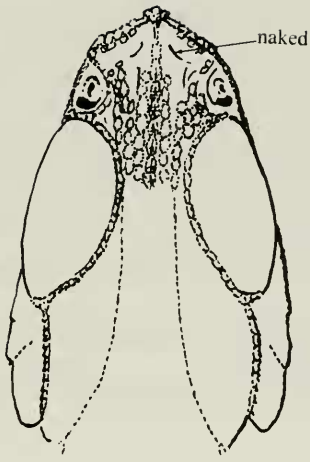

FIGURE 46. Dorsal view of snout of *Caelorinchus parvifasciatus* showing naked areas behind leading edge.

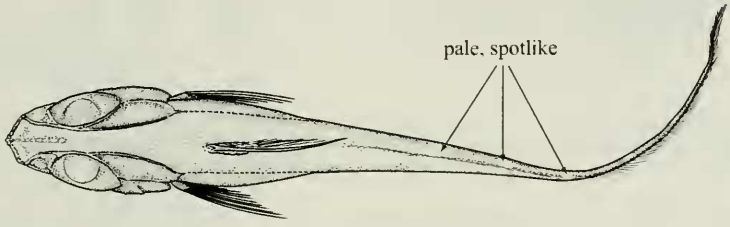

FIGURE 47. Diagrammatic dorsal view of *Caelorinchus parvifasciatus* showing pale spotlike interspaces between saddle marks on tail.

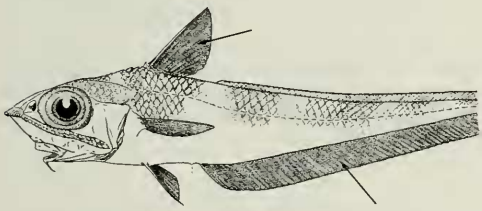

FIGURE 48. Diagrammatic illustration of *Caelorinchus fasciatus* showing banding pattern and pigmentation of first dorsal and anal fins.

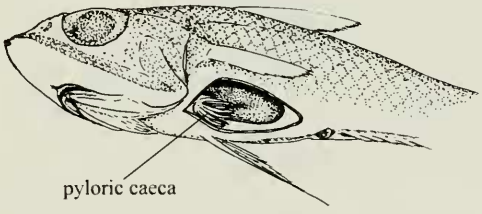

FIGURE 49. Ventrolateral view of a *Caelorinchus* showing cut-away of left abdominal wall exposing stomach and pyloric caeca.

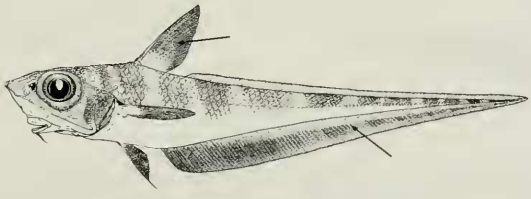

FIGURE 50. Diagrammatic illustration of *Caelorinchus maurofasciatus* showing banding pattern and pigmentation on first dorsal and anal fins.

7a. Trunk completely encircled with broad bluish band (Fig. 51); pyloric caeca 10–14; anterolateral margin of snout incompletely supported by bone (Fig. 52) . . . . . *C. kaiyomaru*
7b. Trunk not encircled by bluish band; pyloric caeca 7–9; anterolateral margin of snout completely supported by bone . . . . . *C. innotabilis*

8a. Body with about 8–10 pale longitudinal stripes; light organ relatively large, extending forward to about midpoint between pelvic and anal fin bases . . . . . *C. australis*
8b. Body lacking longitudinal stripes; light organ small, usually not extending to midpoint between anal and pelvic fins . 9

9a. Anterior one-half to one-third of anal fin black, remainder pale; trunk completely encircled by dark band; orbit equal to or longer than snout length . . . . . *C. matamuus* (Fig. 53)
9b. No sharp contrast in anal fin pigmentation; trunk not encircled by dark band; orbit diameter much shorter than snout length 10

10a. Anterolateral snout margin completely supported by bone; spinule rows on body scales 3–8, widely divergent (Fig. 54a). 11
10b. Anterolateral snout margin incompletely supported by bone; spinule rows on body scales 3–13, more or less parallel (Fig. 54b) 13

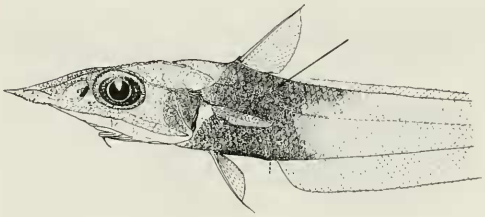

FIGURE 51. Diagrammatic illustration of *Caelorinchus kaiyomaru* showing broad dark band encircling trunk.

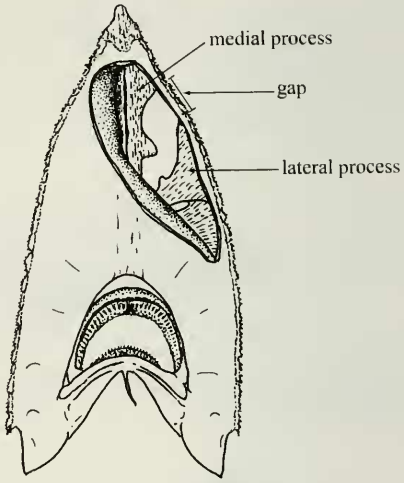

FIGURE 52. Diagrammatic ventral view of head of a *Caelorinchus* sp. showing partial cut-away of ventral snout surface to expose lateral and medial processes of nasal bone (a wide gap between processes).

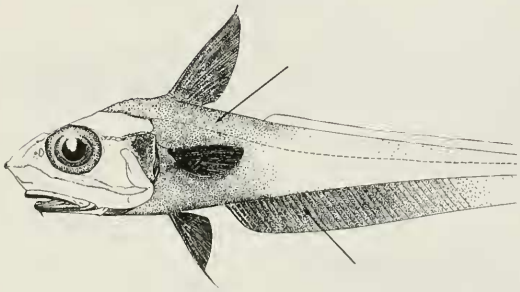

FIGURE 53. Diagrammatic illustration of *Caelorinchus matamuus* showing broad dark band encircling trunk and black anterior portion of anal fin.

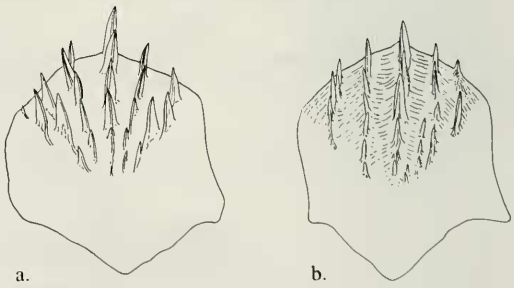

FIGURE 54. Diagrammatic illustrations of *Caelorinchus* body scales taken from region below anterior end of second dorsal fin. (a) *C. smithi*—spinule rows widely divergent, (b) *C. mycterismus*—spinule rows more or less parallel.

11a. Snout length in adults 1.5–1.7 times orbit diameter (1.7–2.0 in young); GR-II (total inner) 6–7; scale rows below origin of first dorsal fin 5–6 . . . . . *C. smithi*
11b. Snout length 1.7–2.5 times orbit diameter; GR-II (total inner) 8–10; scale rows below origin of first dorsal fin 6–8 . 12

12a. GR-I 8 total; scales rows below origin of first dorsal fin 6–7, lateral line scales over a distance equal to predorsal length 38–44; orbit diameter 1.27–1.44 into postorbital length . . . . . *C. macrorhynchus*
12b. GR-I 9–10 total; scales rows below origin of first dorsal fin 8, lateral line scales over a distance equal to predorsal length 53–55; orbit diameter 0.97–1.08 into postorbital length . . . . . *C. supernasutus*

13a. Scale rows below origin of first dorsal fin 8.0–10.0, below second dorsal fin 5.0–7.5; nasal fossa usually naked, sparsely scaled in some (Fig. 55a) . . . . . *C. acanthiger*
13b. Scale rows below origin of first dorsal fin 4.0–7.0, below second dorsal fin 3.5–7.0; nasal fossa naked or scaled ventrally (Fig. 55b) 14

14a. Scales on head ridges notably coarse and sharply spined; 5–13 parallel rows of spinules on body scales (Fig. 56a); overall color dark grayish with violet tinge; fins all blackish . . . . . *C. trachycarus*
14b. Scales on head not especially coarse; 4–9 more or less parallel rows of spinules on body scales (Fig. 56b); overall color tawny to grayish brown, not tinged with violet; fins dusky to blackish 15

15a. Snout 1.9–2.2 into HL; anal fin dusky except pale near posterior tip; snout slightly upturned (Fig. 57a) *C. mycterismus*
15b. Snout 2.4–2.6 into HL; anal fin dusky to blackish overall; snout lacking upturned tip (Fig. 57b) . . . . *C. kermadecus*

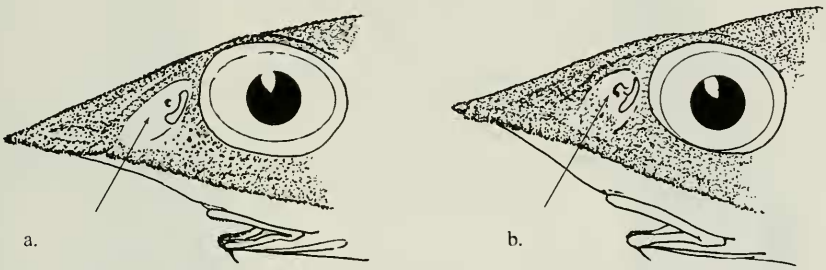

FIGURE 55. Nasal fossa in *Caelorinchus* spp. showing (a) fossa surface naked and (b) fossa surface scaled ventrally.

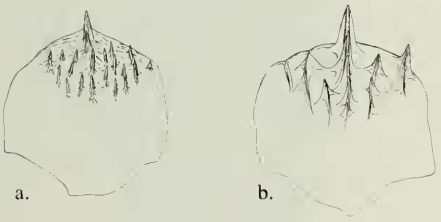

FIGURE 56. Scales from region below anterior end of second dorsal fin of (a) *Caelorinchus trachycarus* and (b) *C. kermadecus*.

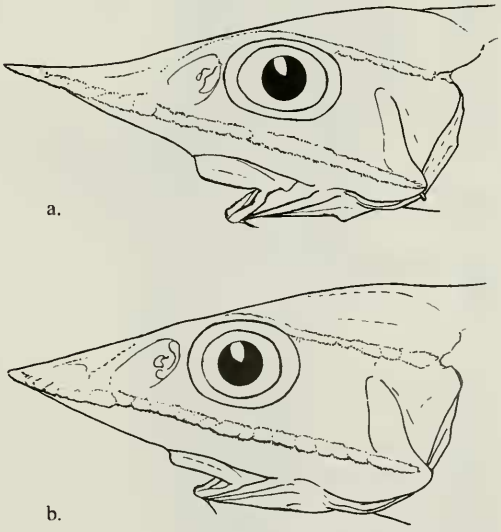

FIGURE 57. Lateral view of snout of (a) *Caelorinchus mycterismus* showing upturned tip and (b) *C. kermadecus* with straight tip.

***Caelorinchus acanthiger* Barnard, 1925**
Fig. 58

DISTINGUISHING FEATURES. — 1D II,8–9; P i17–i19; V 7; GR-I 8–9 total; scales below 1D 8–10, below 2D 5–7.5, lat.l. about 33–49; pyloric caeca 9–12. Snout about 2/5ths of head length, with straight to slightly concave dorsal profile; anterolateral margin incompletely supported by bone. Underside of head covered with small scales; nasal fossa usually entirely naked; body scales with 3–5 parallel spinules rows, middle row longest, other rows usually much shorter. Small black fossa immediately anterior to anus.

SIZE. — To 50 cm.

DISTRIBUTION. — Southern Africa, southern Australia (NSW, Vic., Tas., SA, WA), and New Zealand in mid-slope depths of about 800 m to at least 1200 m.

NSW CAPTURES. — Relatively abundant between Crowdy Head and Gabo Island in 790–1200 m. *Caelorinchus acanthiger* was recorded from 224 *Kapala* stations, including 66% of tows in 800–900 m and all tows deeper than 900 m. Between 10 and 50 specimens were captured in most trawls.

REMARKS. — Among grenadiers, *C. acanthiger* is second only to *Coryphaenoides serrulatus* in abundance in mid-slope depths off NSW. The species is distinguished from two similar species, *C. kermadecus* and *C. mycterismus*, by its higher scale-row counts below the first dorsal fin and by the absence of scales on the nasal fossa (present ventrally in other two species). *C. mycterismus* also has a noticeably longer snout. *C. trachycarus* has much more spiny scales, especially on head ridges, more spinule rows on body scales, a darker overall color, black fins, and fewer scale rows below the first dorsal fin. *C. macrorhynchus, C. smithi*, and *C. supernasutus* have the anterolateral snout margins completely supported by bone.

REFERENCE SPECIMENS. — AMS I.19860-017 (1 spec.); K76-24-03. AMS I.20068-010 (5 spec.); K77-23-13. AMS I.20098-023 (1 spec.); K77-23-07. AMS I.20099-018 (3 spec.); K77-23-12. AMS I.21722-002 (1 spec.); K79-20-13. AMS I.21724-011 (1 spec.); K79-20-15. AMS I.24037-012 (6 spec.); K78-26-16. AMS I.24054-004 (1 spec.); K83-06-02. AMS I.24056-007 (2 spec.); K83-08-02. AMS I.24059-007 (1 spec.); K83-09-02. AMS I.24060-007 (1 spec.); K83-09-01. AMS I.24100-001 (6 spec.); K83-07-11. AMS I.24157-006 (1 spec.); K83-12-04. AMS I.25273-007 (1 spec.); K84-11-09. AMS I.28475-002 (1 spec.); K88-04-06. AMS I.28745-004 (1 spec.); K88-04-06. AMS I.28749-002 (2 spec.) and AMS I.28749-003 (1 spec.); K88-17-03. AMS I.29798-011 (4 spec.); K89-12-04. AMS I.29807-002 (1 spec.); K89-07-05.

REFERENCES. — Trunov (as *C. pseudoparallelus*) (1983); Gomon et al. (1994); Iwamoto and Anderson (1994); Iwamoto and Williams (1999).

***Caelorinchus australis* (Richardson, 1839)**
Fig. 59

DISTINGUISHING FEATURES. — 1D II, 9–11; P i13–i18; V 7; GR-I 7–9 total; scales below 1D 3.5–5.5, below 2D 3.5–4.5, lat.l. about 24–32; pyloric caeca 31–34. Snout about one-third of head length; anterolateral margin incompletely supported by bone. Underside of head covered with small scales; nasal fossa with small scales over ventral surfaces; body scales with as many as 20 parallel rows of short, small spinules. Large black fossa of light organ extends forward from anus about halfway to pelvic fin insertions. About 8–10 pale longitudinal stripes on dorsolateral aspects of body; first dorsal fin black on distal half; anal fin dusky to blackish along distal margin, mostly blackish posteriorly. (Adapted from Arai and McMillan 1982)

SIZE. — To at least 55 cm.

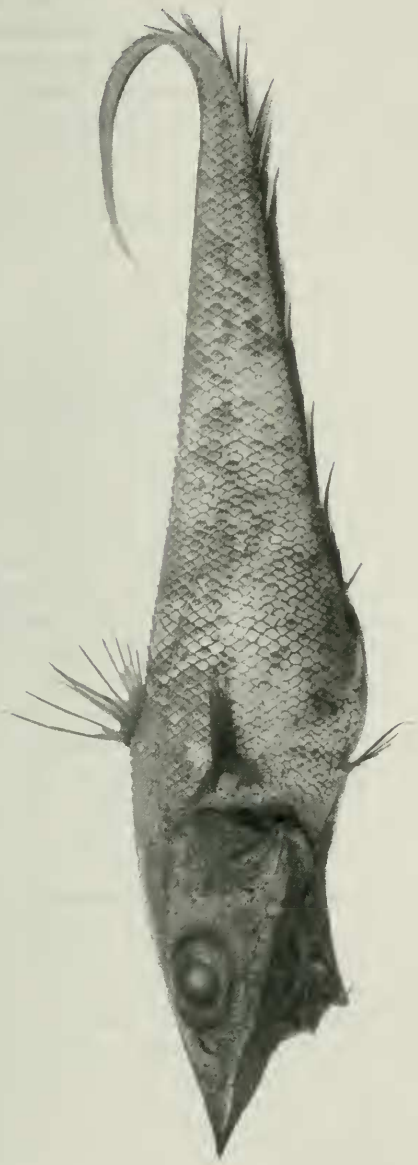

FIGURE 58. *Caelorinchus acanthiger* Barnard, 1925. AMS I.25273-007. From *Kapala* stn K84-11-09, east of Nowra, NSW, in 1161–1207 m.

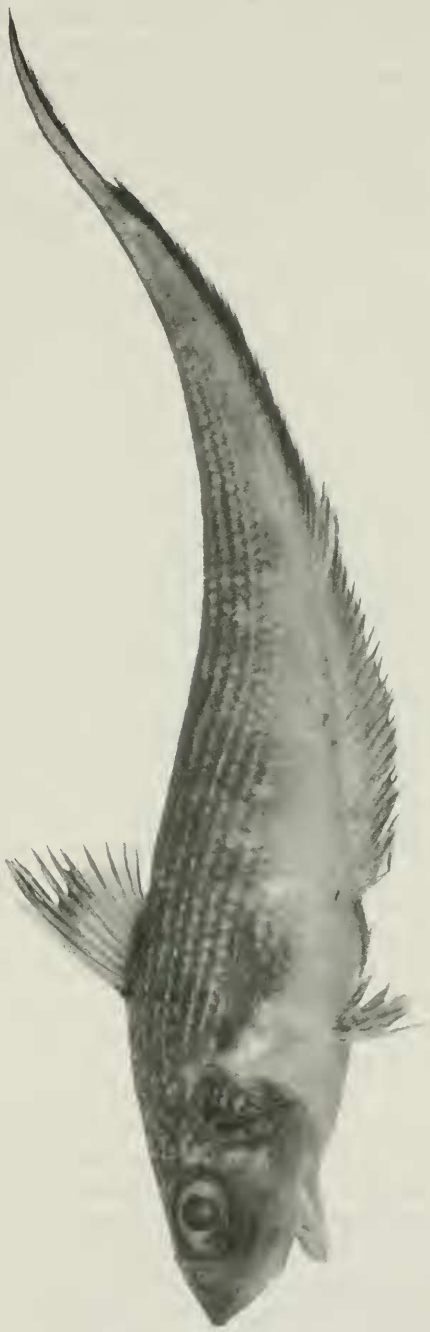

FIGURE 59. *Caelorinchus australis* (Richardson, 1839). AMS I.29385-002. From *Kapala* stn K89-03-15, southeast of Gabo I., Vic., in 152–159 m.

DISTRIBUTION. — Southeastern Australia (NSW, Vic., Tas., SA) on shelf and upper slope in about 100–450 m. Off Tasmania, Last et al. (1983) stated that the species "is commonly trawled between 80 and 300 metres but on rare occasions has been collected in shallow coastal waters."

NSW CAPTURES. — Caught by *Kapala* only south of Batemans Bay in depths of 130–440 m. Moderately abundant, *C. australis* was caught in 22% of all tows in 100–400 m but was most common in 200–300 m (present in 55% of tows in that depth range). This species of relatively large adult size has no commercial value, but its numbers off southern NSW appear to have been reduced by trawling over the last 20 years. During 1976–77 it was recorded in 80% of *Kapala* tows in 200–400 m, and catches were mostly greater than 20 specimens per tow; in comparison, it was present in only 23% of 1996–97 tows, with an average of 3 per tow.

REMARKS. — The species name was previously applied to a common grenadier of New Zealand waters until Arai and McMillan (1982) determined that *C. australis* was confined to southeastern Australia. The New Zealand species for which the name was being applied is endemic and was undescribed until Arai and McMillan named it. Note that fig. 21.12 in Last et al. (1983) is of *C. biclinozonalis*.

REFERENCE SPECIMENS. — AMS I.29385-002 (2 spec.); K89-03-15.

REFERENCES. — Arai and McMillan (1982); Last et al. (1983); Gomon et al. (1994)

***Caelorinchus* sp. cf. *cingulatus* Gilbert and Hubbs, 1920**
Fig. 60

DISTINGUISHING FEATURES. — I D II, 8–9; P i16–i19; V 7; GR-I 6–8 total; scales below 1D 5–7, below 2D 4.5–6.0, lat.l. about 30–40. Snout two-fifths to one-half of head length; anterolateral margin incompletely supported by bone. Underside of head naked; nasal fossa naked or sparsely scaled; body scales with short, spikelike, recumbent spinules in 7–15 parallel to slightly divergent rows. Light organ extends forward from anus to chest, dilated at each end, anteriorly with a shallow, scaled fossa. Rays of second dorsal fin about as high as opposites of anal fin; interspace between first and second dorsal fins short, usually less than length base of first dorsal. A saddle extending from base of first dorsal to base of pectoral fin; a second faint saddle usually visible below origin of second dorsal fin; a darker third saddle below 9th–12th rays of second dorsal extending anteroventrally and leveling off midlaterally; faint saddles posteriorly on body, but usually not extending ventrally below lateral line; first dorsal with a dark midlateral band.

SIZE. — To about 30 cm.

DISTRIBUTION. — New Caledonia, and ne. Australia (Qld, NSW). Depth range about 250–550 m.

NSW CAPTURES. — Five specimens collected by *Kapala* from three stations in 550 m off the Qld-NSW border (about 28°S).

REMARKS. — Iwamoto and Merrett (1997) first reported this species as *C. cingulatus* from specimens collected in the New Caledonian region. In their subsequent study (Merrett and Iwamoto 2000), they realized that their specimens, though closely similar, did not entirely agree with descriptions of *C. cingulatus* Gilbert and Hubbs, 1920, especially in regards to certain body markings, but they did not describe it as new. The species is readily distinguished from other NSW members of the genus by the combination of its distinctive pattern of saddles; moderately prolonged spinous first dorsal ray, high second dorsal, the rays about equal in length to opposites of anal fin; and relatively long span between the isthmus and anal fin origin.

REFERENCE SPECIMENS. — AMS I.20518-012 (2 spec.); K78-09-05. AMS I.20459-014 (3 spec.) and I.20459-019 (1 spec.); K78-17-10. AMS I.20651-014 (1 spec.); K78-23-09.

REFERENCES. — Iwamoto and Merrett (1997); Merrett and Iwamoto (2000).

***Caelorinchus fasciatus* (Günther, 1878)**
Fig. 61

DISTINGUISHING FEATURES. — 1D II,9–10; P i14–i18; V 7; GR-I 8–9 total; scales below 1D 3.5–5.0, below 2D 3.5–4.5, lat.l. about 21–29; pyloric caeca 12–23. Snout 18–33% of head length, much shorter than huge orbit, which is about two-fifths or more of head length; anterolateral margin of snout incompletely supported by bone. Underside of head naked; dorsal surface of snout lacking clear scaleless areas; nasal fossa with small scales over ventral surfaces. Body scales large, rather deciduous, exposed fields covered with 7–12 parallel rows of spinules. Narrow fossa of light organ extends forward from anus about halfway to pelvic-fin insertions. A series of 8–12 dark saddle marks on body beginning on nape. First dorsal fin black on distal half or more; anal fin dusky to blackish along distal margin, mostly blackish posteriorly.

SIZE. — To at least 35 cm.

DISTRIBUTION. — Southeastern Australia (NSW, e. Vic.), New Zealand, and South America. Depth range off NSW about 600–1000 m, much more restricted than the 200–1000 m off New Zealand (P. McMillan, pers. commun. with Graham). Off Chile and Argentina, Iwamoto (unpublished records) has verified records only from much shallower depths of about 75–450 m.

NSW CAPTURES. — Uncommon off NSW; 19 specimens captured in eight tows by *Kapala* in 630–960 m, from just south of Sydney (34°15′S) to Gabo Island (37°40′S).

REMARKS. — It is likely that the *Kapala* specimens treated here are the only Australian records definitely referable to *C. fasciatus*. Australian records of *C. fasciatus* in the literature prior to about 1990 most probably relate to *C. maurofasciatus* or *C. parvifasciatus* (e.g., Last et al. 1983; Munro 1957). In addition to NSW, Vic. and Tas., Last et al. (1983: 240) reported *C. fasciatus* from WA and SA, but Iwamoto and Williams (1999) found no specimens to verify those records. The species was not treated in *The fishes of Australia's south coast* (Gomon et al. 1994). Records of *C. fasciatus* off southern Africa were based on different species (see Iwamoto and Anderson 1994).

Caelorinchus fasciatus and *C. maurofasciatus* are closely similar and difficult to differentiate. Characters that appear to separate the two species include the presence in *C. fasciatus* of one or two large, thick, somewhat elevated scales on the median line of the nape two to four scales forward of the first dorsal fin. The pyloric caeca count also differs: 12–23 (x = 16.6) in *C. fasciatus* (data from McMillan and Paulin 1993), compared with 18–34 in *C. maurofasciatus* (McMillan and Paulin [1993] gave 22–32, x = 27.6). Compared to *C. maurofasciatus*, the overall body color of *C. fasciatus*, including banding, is duller, the anal fin lacks a dark stripe, the first dorsal fin is uniformly dusky to blackish, and the scales are more deciduous.

REFERENCE SPECIMENS. — AMS I.24774-001 (3 spec.); K84-08-05. AMS I.26998-003 (1 spec.); K87-14-02. AMS I.32431-002 (1 spec.); K89-07-04.

REFERENCES. — Last et al. (1983); McMillan and Paulin (1993).

***Caelorinchus innotabilis* McCulloch, 1907**
Fig. 62

DISTINGUISHING FEATURES. — 1D II,9–10; P i16–i19 V 7; GR-I 6–8 total; scales below 1D 6–7, below 2D 6.0–7.5, lat.l. about 32–40; pyloric caeca 7–9. Snout slender and sharp, two-fifths or more of HL, much longer than orbit diameter, which is about one-third of HL; anterolateral margin sharp, completely supported by bone. Underside of head naked anteriorly, but some small, nonimbricate scales in small patches above and behind mouth; nasal fossa naked; body scales with 9–13 parallel rows of short, slender spinules. Light organ externally inconspicuous, not generally visible without dissection, relatively short, extending forward from anus to level of pelvic fin insertions; anus re-

FIGURE 60. *Caelorinchus* sp. cf. *cingulatus*. AMS I.20459-019. From *Kapala* stn K78-17-10, off Danger Pt, NSW-Qld border, in 549 m.

FIGURE 61. *Caelorinchus fasciatus* (Günther, 1887). AMS I.24774-001. From *Kapala* stn K84-08-05, off Batemans Bay in 805–850 m.

moved from anal fin origin by 2 or 3 scale rows. No distinct markings on body or fins; second dorsal fin rays about as long anteriorly as anal fin rays.

SIZE. — To about 35 cm.

DISTRIBUTION. — Southern Australia (NSW, Vic., Tas., SA. WA) and New Zealand.

NSW CAPTURES. — Captured by *Kapala* between Crowdy Head and Gabo Island in 450–1075 m. Recorded from 227 tows (about half of all tows between 500 and 1100 m), with greatest abundance in 700–900 m (in 93% of tows at that depth range). Frequently more than 50/tow in trawls with small-meshed codends.

REMARKS. — This is a plain fish with no distinguishing pigment pattern, an almost-cylindrical body, and a sharp suborbital ridge that is completely supported by bone along the leading edge of the snout. These features separate *C. innotabilis* from most other NSW members of the genus (*C. smithi* and *C. macrorhynchus* also have complete support of the leading snout margin). *Caelorinchus innotabilis* might be confused with *C. kaiyomaru*, but the dark, broad band girdling the trunk in *C. kaiyomaru* is distinguishing.

REFERENCE SPECIMENS. — AMS I.7893 (holotype, 138 mm TL); off Sydney, 800 fm [1463 m; but see note in Historical Perspective]; *Woy Woy*. AMS I.15973-010 (1 spec.); K71-07-03. AMS I.15976-001 (1 spec.); K71-09-01. AMS I.16589-003 (1 spec.); K72-05-05. AMS I.18726-027 (5 spec.); K75-01-02. AMS I.18770-009 (2 spec.); K75-02-08. AMS I.18838-010 (1 spec.); K75-05-03. AMS I.18839-001 (28 spec.) and AMS I.18839-037 (25 spec.); K75-05-04. AMS I.19198-002 (2 spec.); K76-05-04. AMS I.19202-002 (1 spec.); K76-06-03. AMS I.19859-002 (10 spec.); K76-24-04. AMS I.19860-009 (1 spec.); K76-24-03. AMS I.19862-008 (2 spec.); K76-23-01. AMS I.20098-011 (2 spec.); K77-23-07. AMS I.20452-015 (1 spec.); K75-05-05. AMS I.21722-008 (3 spec.); K79-20-13. AMS I.21724-013 (1 spec.); K79-20-15. AMS I.21806-001 (3 spec.); K77-07-10. AMS I.23885-014 (1 spec.); K78-27-05. AMS I.24055-006 (2 spec.); K83-08-01. AMS I.24056-005 (6 spec.); K83-08-02. AMS I.24059-008 (4 spec.); K83-09-02. AMS I.24060-005 (1 spec.), I.24060-008 (3 spec.), and I.24060-016 (2 spec.); K83-09-01. AMS I.29756-005 (1 spec.); K89-15-04. QM I.23010 (1 spec.); e. of Terrigal, NSW, in 446 fm; Oct. 1978.

REFERENCES. — Gomon et al. (1994); Last et al. (1983); Iwamoto and Williams (1999).

***Caelorinchus kaiyomaru* Arai and Iwamoto, 1979**
Fig. 63

DISTINGUISHING FEATURES. — 1D II,7–10; P i16–i20, V 7; GR-I 6–9 total; scales below 1D 5–8, below 2D 5.0–6.5, lat.l. about 31–41, usually 35–40; pyloric caeca 10–14. Snout slender and sharp, two-fifths to almost half of head length, much longer than orbit diameter (25–30% of HL); anterolateral margin incompletely supported by bone. Underside of head naked or with 1 or 2 isolated scales above posterior end of mouth; nasal fossa naked; body scales with 8–10 parallel or slightly divergent rows of small spinules. Light organ short, seen only as a small blackish area before anus; anus removed from anal fin origin by 1 or 2 scale rows. Entire trunk encircled by broad dark, bluish band; blackish orbital ring.

SIZE. — To 40 cm.

DISTRIBUTION. — Australia (NSW, Vic., Tas.), New Zealand, South Atlantic off Falkland Is., in about 845–1150 m.

NSW CAPTURES. — Caught by *Kapala* in 880–1150 m on all grounds south of Crowdy Head. Relatively common in mid-slope depths and recorded from 148 stations (present in 76% of all tows between 900 and 1100 m), frequently more than 10 specimens per tow.

REMARKS. — This slender species is readily recognized by the prominent dark blue color completely encircling the trunk. In NSW *Caelorinchus* species, this character is found only in *C. matamuus*, a large-sized, heavy-bodied species.

FIGURE 62. *Caelorinchus innotabilis* McCulloch, 1907. From *Kapala* stn K86-01-07 off Sydney in 819–889 m.

FIGURE 63. *Caelorinchus kaiyomaru* Arai and Iwamoto, 1979. AMS I.24060-012. From *Kapala* stn K83-09-01, east of Sydney in 942–950 m.

REFERENCE SPECIMENS. — AMS I.24055-002 (1 spec.); K83-08-01. AMS I.24059-005 (7 spec.); K83-09-02. AMS I.24060-012 (3 spec.), I.24060-015 (2 spec.); K83-09-01. AMS I.24150-007 (1 spec.); K83-13-01. AMS I.24157-005 (1 spec.); K83-12-04. AMS I.24173-008 (3 spec.); K83-14-06. AMS I.24355-009 (2 spec.); K83-18-02. AMS I.24356-001 (1 spec.); K83-14-05. AMS I.24462-002 (1 spec.); K83-15-02. AMS I.24565-001 (1 spec.); K83-14-03. AMS I.24980-005 (4 spec.); K84-16-15. AMS I.29737-005 (1 spec.); K89-19-01.

REFERENCES. — Arai and Iwamoto (1979); Gomon et al. (1994).

***Caelorinchus kermadecus* Jordan and Gilbert, 1904**

Fig. 64

DISTINGUISHING FEATURES. — 1D II,7–9; P i16–i19; V 7; GR-I 7–9 total; scales below 1D 4.5–6.0, below 2D 4.5–6.0, lat.l. about 32–38; pyloric caeca 10–12. Snout 2.4–2.6 into head length in adults (longer in smaller specimens); anterolateral margin incompletely supported by bone. Underside of head covered with small scales; nasal fossa finely scaled ventrally; body scales with 4–7 more-or-less parallel rows of broadly triangular spinules, middle row largest. Light organ short, not externally visible. Overall color grayish brown; all fins dusky to blackish; mouth dark gray to blackish; area around anus bluish, but color not extending to bases of pelvic fins.

SIZE. — To about 60 cm.

DISTRIBUTION. — Kermadec Is., New Zealand, s. of New Caledonia, and Australia (NSW), in about 800–1150 m.

NSW CAPTURES. — Only seven specimens taken at five *Kapala* stations between Crowdy Head and Batemans Bay.

REMARKS. — The *Kapala* specimens are the only Australian records of this species, but it can be expected off Queensland. *Caelorinchus kermadecus* is most similar to *C. acanthiger*, differing principally in squamation features. Body scales are larger (fewer scale rows below the dorsal fins) than in *C. acanthiger*, and the nasal fossa is scaled ventrally (naked in *C. acanthiger*).

REFERENCE SPECIMENS. — AMS I.24991-003 (1 spec.); K84-16-05. AMS I.28100-001 (1 spec.); K88-08-06. AMS I.29750-001 (1 spec.), AMS I.29750-004 (1 spec.), and AMS I.29750-005 (1 spec.); K89-17-04. AMS I.29798-013 (1 spec.); K89-12-04. AMS I.29807-003 (1 spec.); K89-07-05.

REFERENCES. — McMillan and Paulin (1993); Iwamoto and Merrett (1997).

***Caelorinchus macrorhynchus* Smith and Radcliffe, 1912**

Fig. 65

DISTINGUISHING FEATURES. — 1D II,8–9; P i16–19; V 7; GR-I 8–10 total; scales below 1D 6–7, below 2D 5.5, lat.l. about 38–44. Snout length 47–50% HL; interorbital width 19–20%; suborbital width 11–12% HL; postorbital length (30–31%); length orbit to angle of preopercle (32–34%); upper jaw length (24–25%), outer gill slit length 11–13%; and barbel length (8–9%). Snout narrow, sharply pointed, about one-half of head length; anterolateral margin completely supported by bone. Underside of head covered with small scales; nasal fossa mostly covered with small scales; body scales with 5–8 divergent rows of broad-based spinules. Light organ small, a black streak extends forward from ventral fossa to midway between anus and pelvic fin base. Overall color swarthy to black; mouth and fins blackish.

SIZE. — To about 50 cm.

DISTRIBUTION. — Philippines, Indonesia, and Australia (Qld, NSW, WA), in about 500–1100 m.

NSW CAPTURES. — Uncommon; taken only six times (7 specimens) by *Kapala* between Newcastle (33°S) and Jervis Bay (35°S), in 550–950 m. One AMS specimen (I.26806-003) was collected

FIGURE 64. *Caelorinchus kermadecus* Jordan and Gilbert, 1904. AMS I.28100-001. From *Kapala* stn K88-08-06, east of Tuncurry, NSW, in 1024–1079 m.

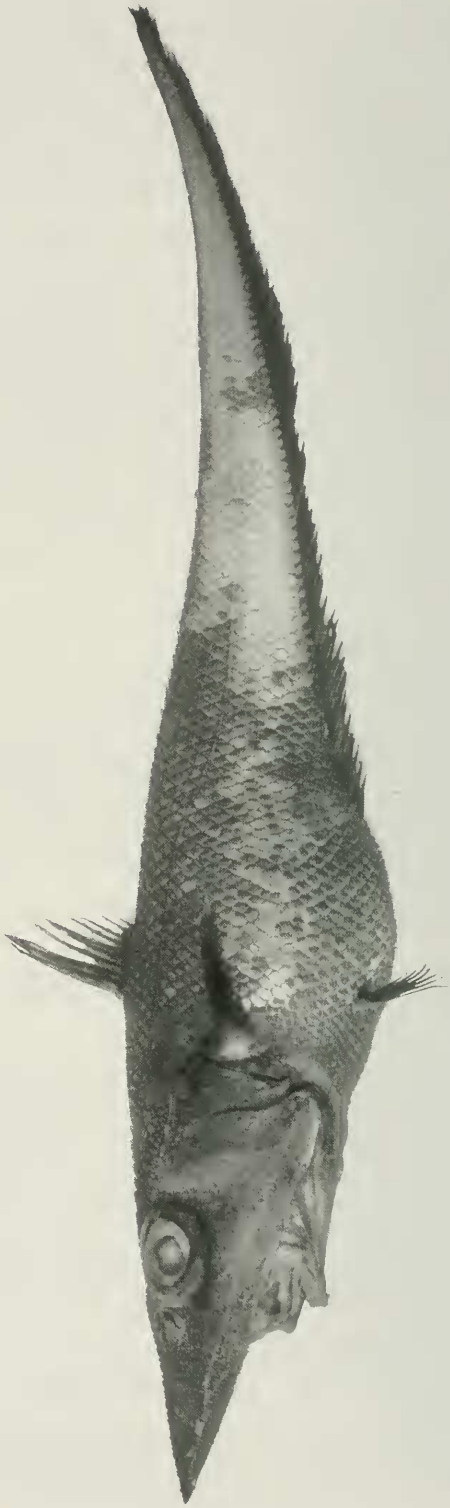

FIGURE 65. *Caelorinchus macrorhynchus* Smith and Radcliffe, 1912. AMS I.24778-001. From *Kapala* stn K84-08-02, east of Nowra, NSW, in 814–850 m.

by a commercial trawler in 550 m off Port Stephens. A juvenile (CAS 214042, 145+ mm TL) was collected recently off Montague I. (36°12′S) in 500 m.

REMARKS. — A notably long snout, dark color, and divergent spinule rows distinguish *Caelorinchus macrorhynchus* from most other NSW members of the genus. The species resembles *C. supernasutus* in its notably long snout, small orbits, and small ventral light organ. *Caelorinchus supernasutus*, however, has smaller scales (8 rows below 1D origin, 5.5 below mid-base of 1D, and 53–55 lateral line scales over a distance equal to predorsal length), and shorter measurements of suborbital (9–10% HL), postorbital (24–25%), orbit to angle of preopercle (26%), upper jaw (20–21%), and barbel (4–6%). One specimen (AMS I.29601-001) listed under this species has a noticeably short (1.5 times orbit) broad snout, very unlike that in most other specimens examined, and more like that in *C. smithi*. However, scale features distinguish that specimen from *C. smithi,* and other characters appear to be the same as those of *C. macrorhynchus*. Because of the short snout in the specimen, it will not key out properly in the key to species. More specimens are needed to adequately delimit the range of variation in snout length and shape in *C. macrorhynchus*.

REFERENCE SPECIMENS. — AMS I.21722-007 (1 spec.); K79-20-13. AMS I.24625-005 (1 spec.); K84-06-06. AMS I.24778-001 (2 spec.); K84-08-02. AMS I.26806-003 (1 spec.); FV *Vincenzann*; e. of Port Stephens, 550 m; 25 Oct. 1986. AMS I.29600-001 (1 spec.); K87-24-01. AMS I.29601-001 (1 spec.); K88-08-08. AMS I.29825-001 (1 spec.); K89-09-09. CAS 214042 (1 spec.); FV *Shelley H*, off Montague I. (36°12′S, 150°24′E); 490-525 m; 1 Mar. 2000.

REFERENCES. — Radcliffe (1912); Iwamoto and Williams (1999).

***Caelorinchus matamuus* (McCann and McKnight, 1980)**
Fig. 66

DISTINGUISHING FEATURES. — 1D II,8–10; P i16–i19; V 7; GR-I 12–13 total; scales below 1D 7–10, below 2D 7–9; pyloric caeca 18–29. Snout bluntly conical, anterolateral margin not completely supported by bone; mouth large, upper jaw extends to below middle of orbit; orbit about one-third of HL. Underside of head scaled; head ridges stout but not especially spiny; nasal fossa covered with scattered small scales; body scales with 8–11 slightly divergent rows of low spinules. Light organ small, immediately before anus, not externally visible. Trunk completely encircled by a broad, blue-black band; anterior half to one-third of anal fin black, remainder pale.

SIZE. — To about 65 cm.

DISTRIBUTION. — Southeastern Atlantic to southern Africa, across Indian Ocean to southern coast of Australia (NSW, Vic., Tas., SA, WA), and New Zealand, in about 650–1100 m.

NSW CAPTURES. — Caught frequently in small numbers by *Kapala* in depths between 690 and 1010 m on all grounds south of Broken Bay (33°25′S). Overall, about 200 specimens captured in 44 *Kapala* trawls; most frequently caught in 700–900 m, where it was recorded in 44% of all tows in that depth range.

REMARKS. — *Caelorinchus matamuus* is a distinctive, widespread species of the Southern Ocean having a geographical distribution similar to that of *C. acanthiger*. The large size, broad bulky head, blunt snout, prominent blackish trunk band, and black anterior part of anal fin immediately identify the species.

REFERENCE SPECIMENS. — AMS I.18726-024 (2 spec.); K75-01-02. AMS I.19860-012 (1 spec.); K76-24-03. AMS I.20099-005 (1 spec.), I.20099-009 (1 spec.), I.20099-017 (1 spec.); K77-23-12. AMS I.20485-015 (1 spec.); K77-23-06. AMS I.23885-005 (1 spec.); K78-27-05. AMS I.24054-002 (3 spec.); K83-06-02. AMS I. 24157-007 (1 spec.); K83-12-04. AMS I.24613-006 (1 spec.); K75-05-05.

REFERENCES. — McCann and McKnight (as *Mahia matamua*) (1980); Sazonov and Shcherbachev (1982a); Last et al. (1983); Iwamoto and Williams (1999).

***Caelorinchus maurofasciatus* McMillan and Paulin, 1993**
Fig. 67

DISTINGUISHING FEATURES. — 1D II,9–10; P i15–i19; V 7; GR-I 7–9 total; scales below 1D 4.5–6.0, below 2D 4–5, lat.l. about 22–31; pyloric caeca 18–34. Snout about one-third or less of head length, much less than huge orbit; anterolateral snout margin incompletely supported by bone. Underside of head naked; nasal fossa partially scaled; no broad naked areas above leading edge of snout; body scales with 11 or more rows of short, small spinules. Slender fossa of light organ between pelvic and anal fins. About 9–11 prominent saddle marks, the first beginning forward on nape and ending below anterior portion of first dorsal fin, the second saddle beginning under posterior end of first dorsal fin and ending two scale rows behind origin of second dorsal fin; most fins dark distally; first dorsal fin blackish distally, with paler base; anal fin with dark stripe; mouth dark.

SIZE. — To at least 50 cm.

DISTRIBUTION. — Southern Australia (NSW, Vic., Tas., SA, WA) and New Zealand, in about 300–900 m.

NSW CAPTURES. — Absent off northern NSW, but recorded south of about 32°20′S in 320–820 m. Very abundant on upper slope, particularly in 400–700 m. During 1996–97, *C. maurofasciatus* was caught in 74 *Kapala* tows in 400–650 m (94% of all tows in that depth range) between Sydney and Gabo Island, with an average catch of 57/tow.

REMARKS. — *Caelorinchus maurofasciatus* is most similar to *C. fasciatus*, with which it has been confused (see description of that species for comparison). The prominent black saddle markings and the black stripe along the anal fin distinguish the species from similar NSW members of the genus.

REFERENCE SPECIMENS. — AMS I.15970-005 (1 spec.); K71-06-04. AMS I.18839-014 (10 spec.), AMS I.18839-016 (8 spec.); K75-05-04. AMS I.19197-001 (1 spec.); K76-04-03. AMS I.23470-006 (5 spec.); K82-17-01. AMS I.23862-001 (10 spec.); K81-18-05. AMS I.24854-003 (1 spec.); K84-14-01. AMS I.28713-001 (1 spec.); K84-13-03. NMV A2460 (1 spec.); K81-17-03.

REFERENCES. — McMillan and Paulin (1993); McMillan *in* Gomon et al. (as *Caelorinchus* sp. 1, the "false banded whiptail") (1994); Iwamoto and Williams (1999).

***Caelorinchus mirus* McCulloch, 1926**
Fig. 68

DISTINGUISHING FEATURES. — 1D II,9–10; P i17–i19; V 7; GR-I 7–8 total; scales below 1D 5.0–5.5, below 2D 4.0–5.5, lat.l. about 23–26; pyloric caeca about 40. Snout less than one-third of head length, much less than large orbit; anterolateral snout margin incompletely supported by bone. Underside of snout and suborbital anteriorly naked, lower jaw and preopercle scaled; nasal fossa and lunate areas above leading edge of snout naked; body scales with 9–20 rows of small spinules. Naked fossa of light organ large, extends to origin of pelvic fin. No saddle markings except in juveniles (<100 mm TL) with banding pattern; pectoral fin with small black spot at ventral corner, pelvic fin with black blotch; other fins dusky to pale, but anal fin with blackish distal margin posteriorly.

SIZE. — To about 30 cm.

DISTRIBUTION. — Australia (Qld, NSW, e. Vic., WA) in about 100–500 m.

NSW CAPTURES. — One of the most abundant species of genus and found along entire coast of NSW in depths between 110 and 500 m. Recorded from 293 *Kapala* stations, with most tows at depths between 200 and 400 m. Despite the large codend mesh (90 mm) used during 1996–97 surveys, *C. mirus* was caught in 43 tows between 200 and 350 m (65% of all tows in that depth range), with a mean catch of 153/hour tow; some individual catches were in excess of 1000 fish. *Caelorinchus mirus* is one of only two NSW grenadiers (also *C. australis*) inhabiting outer shelf depths as well as the slope. It is

FIGURE 66. *Caelorinchus matamuus* (McCann and McKnight, 1980). From *Kapala* stn K83-09-04, east of Nowra, NSW, in 951–978 m.

FIGURE 67. *Caelorinchus maurofasciatus* McMillan and Paulin, 1993. From *Kapala* stn K82-14-16, southeast of Gabo I., Vic., in 730 m.

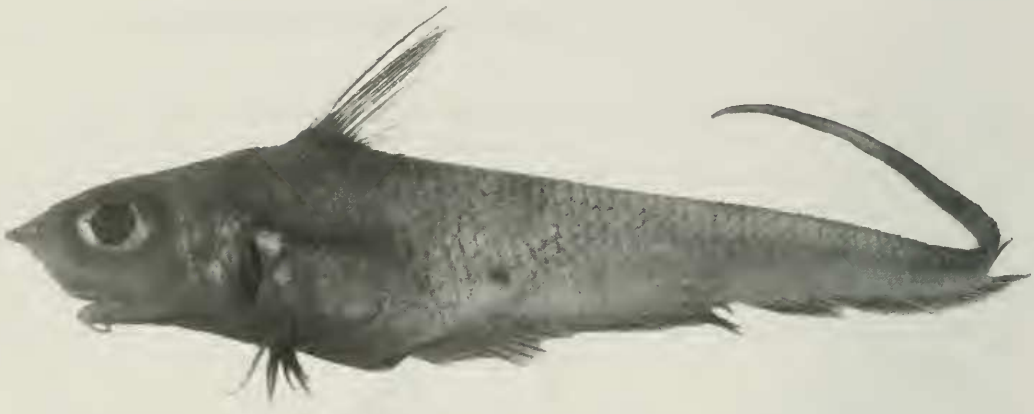

FIGURE 68. *Caelorinchus mirus* McCulloch, 1926. AMS I.26221-002. From *Kapala* stn K85-20-10, off Port Stephens, NSW, in 154–157 m.

caught at night by prawn trawlers off northern NSW in depths as shallow as 110 m (K. Graham, pers. observ.).

REMARKS. — *Caelorinchus mirus* is endemic to Australia. It has been erroneously recorded off New Zealand, but McMillan and Paulin (1993) have determined that it does not exist there. There are no confirmed records of *C. mirus* from Tas., western Vic., or SA. This apparent disjunct distribution between the east coast and WA (including the Great Australian Bight) is similar to those of *Gadomus* sp. cf. *colletti* (see above) and a number of endemic Australian sharks and rays (see Last and Stevens 1994).

REFERENCE SPECIMENS. — AMS I.19205-004 (4 spec.); K76-07-01. AMS I.21793-010 (2 spec.); K78-17-11. AMS I.23993-008 (2 spec.); K78-17-14. AMS I.25932-006 (1 spec.); K85-21-06. AMS I.26221-002 (3 spec.); K85-20-10. Others listed in Iwamoto and Williams (1999).

REFERENCES. — McMillan and Paulin (1993); McMillan *in* Gomon et al. (1994); Iwamoto and Williams (1999).

Caelorinchus mycterismus McMillan and Paulin, 1993

Fig. 69

DISTINGUISHING FEATURES. — 1D II,7–9; P i16–i19; V 7; GR-I 6–8 total; scales below 1D 4–5, below 2D 5–7; pyloric caeca 8–11. Snout 1.9–2.2 into head length in adults (longer in smaller specimens), upturned anteriorly; anterolateral margin incompletely supported by bone. Underside of head covered with small scales; nasal fossa finely scaled; body scales with 4–9 parallel to slightly divergent rows of triangular spinules, middle row highest and longest, lateral rows lower and shorter. Light organ short; no black, lens-like fossa. Overall color in alcohol tawny to brownish; all fins dusky except posterior part of anal fin pale; mouth dark; area around anus bluish.

SIZE. — To about 50 cm.

DISTRIBUTION. — New Zealand, s. of New Caledonia (on Norfolk Ridge), and Australia (NSW, possibly WA) in about 850–1150 m.

NSW CAPTURES. — Two juveniles, one taken east of Crowdy Head in 1050 m, the other off Nowra in 950–978 m.

REMARKS. — New South Wales is probably outside its normal range, but the species may be expected off Qld. Two juveniles of less than 25 cm TL were tentatively recorded by Iwamoto and Williams (1999) from the North-West Shelf off WA. *C. mycterismus* bears close resemblance to several

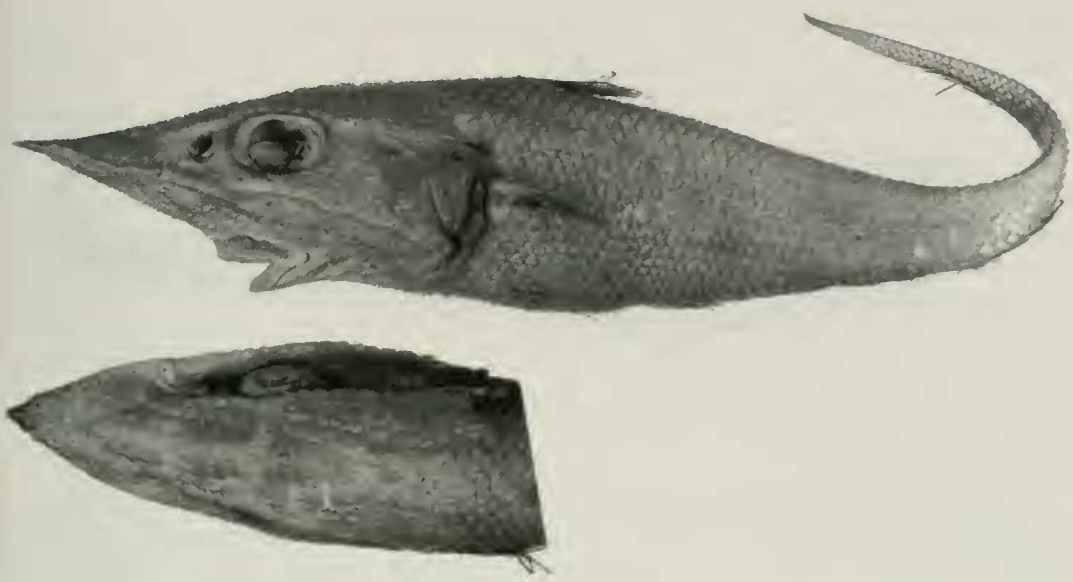

FIGURE 69. *Caelorinchus mycterismus* McMillan and Paulin, 1993. AMS I.24057-004. From *Kapala* stn K83-09-04, east of Nowra, NSW, in 951–978 m.

other members of the genus from the southwestern Pacific, including *C. acanthiger, C. trachycarus,* and *C. kermadecus.* The first two are immediately distinguished by their naked nasal fossae (among other characters). The longer snout with slightly upturned tip and the pale posterior end of the anal fin generally suffice to distinguish *C. mycterismus* from *C. kermadecus.*

REFERENCE SPECIMENS. — AMS I.24057-004 (1 spec.); K83-09-04. AMS I.29750-007 (1 spec.); K89-17-04.

REFERENCES. — McMillan and Paulin (1993); Iwamoto and Williams (1999).

***Caelorinchus parvifasciatus* McMillan and Paulin, 1993**
Fig. 70

DISTINGUISHING FEATURES. — 1D II,9–12 (usually 10); P i17–i20; V. 7; GR-I 7–8 total; scales 1D 5–6, 2D 4.5–5.5, lat.l. 26–28; pyloric caeca 19–26. Snout short, broad, blunt; anterolateral margins incompletely supported by bone; orbit longer than snout length. Naked fossa of light organ extends forward close to line connecting pelvic fin insertions. Underside of head naked or with 1–3 small scales above angle of lower jaw; broad, naked, translucent areas dorsally behind leading edges of snout; nasal fossa naked. Seven or eight faint, sometimes almost obscure, saddles posteriorly on body, more pronounced posteriorly; narrow pale bands occupying one or two scale rows at dorsomedial line separating saddle marks, pale areas often with appearance of white dorsal spots; mouth and gill cavities dark.

DISTRIBUTION. — Southeastern Australia (NSW, Vic., Tas.) and New Zealand.

NSW CAPTURES. — Commonly captured by *Kapala* between Crowdy Head and eastern Bass Strait in depths of 220–600 m; a single record off the Clarence River. This species of relatively small size is possibly the most abundant *Caelorinchus* off central and southern NSW and was recorded from more than 250 *Kapala* upper-slope stations. During the 1996–97 *Kapala* survey, 95 trawls (75% of total) in 250–550 m averaged almost 200 *C. parvifasciatus* per tow, despite the 90 mm codend mesh.

SIZE. — To about 30 cm.

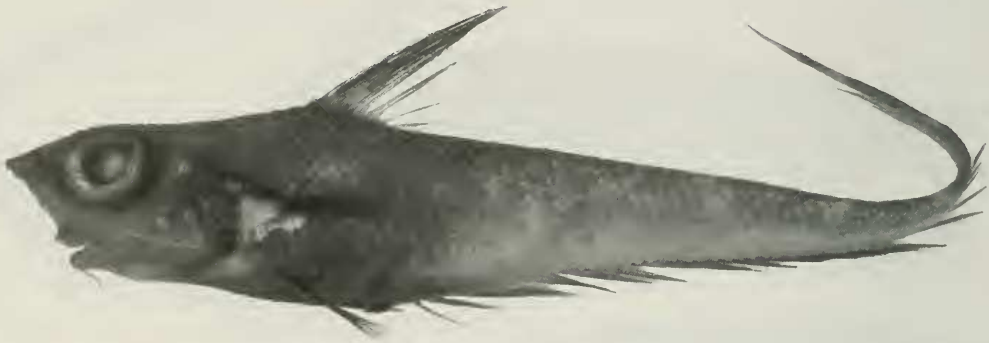

FIGURE 70. *Caelorinchus parvifasciatus* McMillan and Paulin, 1993. AMS I.26240-001. From *Kapala* stn K85-17-02, east of Broken Bay, NSW, in 421–457 m.

REMARKS. — Our Australian specimens agreed in most respects with the New Zealand type-specimens (see McMillan and Paulin, 1993, from which we gleaned the following comparative data). We noted some differences in the ranges of certain measurements and in the count of pectoral fin rays (i17–i20 in Australia cf. i15–i18 in types); snout length 27–31% of HL cf. 29–34%; preoral length 26–34% cf. 21–35%; orbit diameter 44–49% cf. 31–46%; suborbital width 16–18% cf. 13–16%; upper jaw length 26–33% cf. 20–30%; and barbel length 9–14% cf. 5–11%. The anterior dermal window of the light organ was generally larger in New Zealand specimens, but there was overlap in the proportional measurements of that length. Our specimens were also darker than described for the species, especially the fins. The first dorsal fin is dark, almost blackish with a pale base, compared with dusky in the type-specimens; the pectoral fins are dark dusky to blackish, compared with pale; the pelvic fins are blackish with the outer ray distally white, compared with "dusky blackish"; and the anal is blackish overall, paler posteriorly, compared with "pale with a dusting of melanophores diffuse anteriorly." Finally, our specimens completely lacked the one to three small scales on the ventral surface of the head above the articulation of the lower jaws, and the count of pyloric caeca in 31 of our specimens ranged somewhat lower than that given in the original description (19–26, $x = 21.8$, compared with 22–28, $x = 25.3$).

Caelorinchus parvifasciatus closely resembles *C. mirus,* but its relatively small light organ distinguishes it from that species. It differs from *C. fasciatus* and *C. maurofasciatus* in having less prominent saddle marks, spotlike pale markings along the dorsal midline of the tail, and broad naked areas behind the leading edge of the snout. The last two species also attain a much larger size than does *C. parvifasciatus.*

A NSW specimen of *C. parvifasciatus* (AMS I.15975-036) was misidentified by Iwamoto and Williams (1999:128) as *C. amydrozosterus.* That species has a different banding pattern without spotlike pale interspaces, a slightly larger dermal window of the light organ, and fewer pyloric caeca. *Caelorinchus amydrozosterus* has yet to be recorded from the Australian east coast, although it is commonly caught with *C. parvifasciatus* off Portland, western Victoria (K. Graham, pers. observ.).

REFERENCE SPECIMENS. — AMS I.15968-013 (5 spec.); K71-05-04. AMS I.15970-027 (4 spec.); K71-06-04. AMS I.15973-008 (3 spec.); K71-07-03. AMS I.15994-007 (35 spec.); K71-13-02. AMS I.16565-003 (1 spec.); K72-04-01. AMS I.18774-001 (1 spec.); K75-03-02. AMS I.18838-017 (19 spec.); K75-05-03. AMS I.18839-054 (1 spec.); K75-05-04. AMS I.19205-003 (4 spec.); K76-07-01. AMS I.20301-006 (1 spec.); K77-13-12. AMS I.24127-001 (1 spec.); K75-05-02. AMS I.26240-001 (1 spec.); K85-17-02.

REFERENCES. — McMillan and Paulin (1993); McMillan *in* Gomon et al. (as *Caelorinchus* sp. 3, "little whiptail") (1994).

***Caelorinchus smithi* Gilbert and Hubbs, 1920**
Fig. 71

DISTINGUISHING FEATURES. — 1D II,8–10; i15–i19; V 7; GR-I 7–8 total; scales below 1D 5.0–6.0, below 2D 4.5–6.0, lat.l. about 29–37; pyloric caeca 19–26. Snout 1.9–2.4 into head length; anterolateral margin completely supported by bone. Underside of head covered with small scales; nasal fossa finely scaled anteriorly and ventrally to almost naked; body scales with 3–7 divergent rows of stout, triangular spinules, middle row strongest, with 4–6 spinules; all rows complete to edge of scale. Light organ short, externally visible as short black fossa before anus. Overall color dark brown to swarthy; all fins blackish; mouth blackish; belly region bluish.

SIZE. — To about 35 cm.

DISTRIBUTION. — Philippines to Indonesia and Australia (Qld, NSW, NT), in about 400–750 m.

NSW CAPTURES. — Only one specimen caught by *Kapala* in 740 m off Qld-NSW border.

REMARKS. — *Caelorinchus smithi* is a tropical species and may be confused in NSW waters only with *C. macrorhynchus*, which has a longer snout (about 2 in HL cf. 2.0–2.3 in *C. smithi*), smaller orbit (4–5 in HL cf. 3.5–4.2), and somewhat more gill rakers on first arch (8–10 cf. 7–8).

REFERENCE SPECIMEN: AMS I.21795-012 (1 spec.); K78-23-08.

REFERENCES. — Gilbert and Hubbs (1920); Iwamoto and Williams (1999).

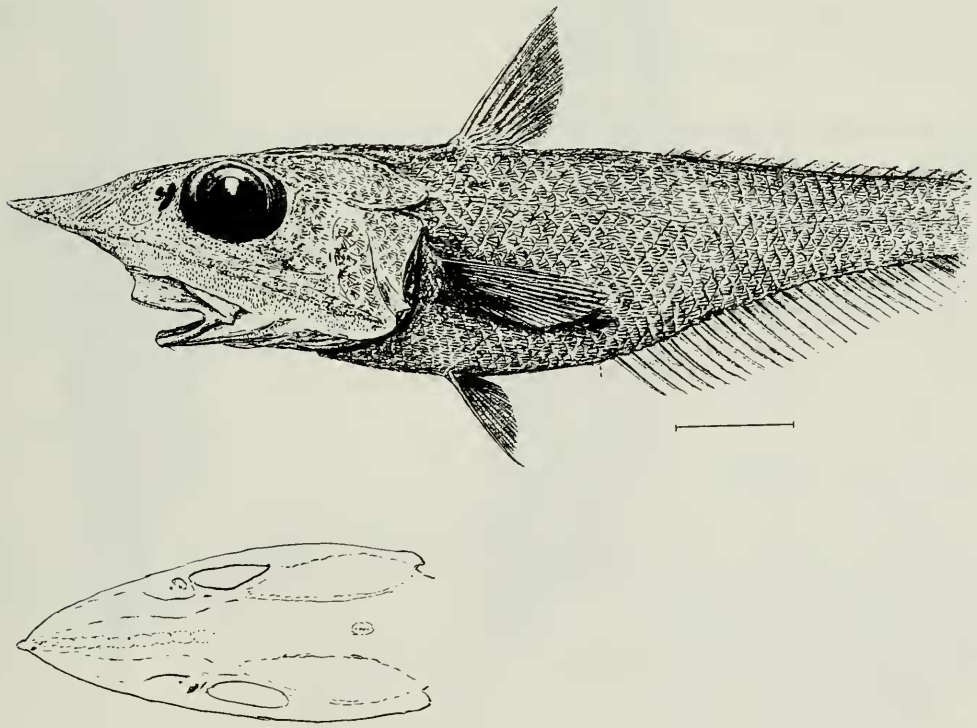

FIGURE 71. *Caelorinchus smithi* Gilbert and Hubbs, 1920 (from Iwamoto and Williams 1999:fig. 22).

***Caelorinchus supernasutus* McMillan and Paulin, 1993**
Fig. 72

DISTINGUISHING FEATURES. — 1D II,9; P i18–19; V 7; GR-I 9–10 total; scales below 1D 8, below 2D 6.5, lat.l. about 53–55. Snout length 52–54% HL; interorbital width 17–18%; suborbital width 10–11% HL; postorbital length (24–25%); length orbit to angle of preopercle (26%); upper jaw length (20–21%), outer gill slit length 9%; and barbel length (4–6%). Snout long, narrow, tipped with a broad, flat diamond-shaped scute; length about one-half of head length; anterolateral margin completely supported by bone. Underside of head covered with small scales; nasal fossa mostly covered with small scales; body scales with 5–8 divergent rows of broad-based spinules. Light organ small but externally visible with black dermal window before anus. Overall color darker dorsally and blackish over abdomen and gill covers; lips, gums, mouth lining dark; ridge of median nasal bone dark; first dorsal fin blackish, other fins pale to dusky.

SIZE. — To about 64 cm.

DISTRIBUTION. — Australia (NSW) and New Zealand, in about 500–900 m.

NSW CAPTURES. — Taken twice by *Kapala,* off Crowdy Head and Nowra, in 500–900 m.

REMARKS. — The small size and few captures suggest that NSW is outside the normal range of this primarily New Zealand species. In having a long snout, small orbit, and small dermal window of the light organ immediately before the anus, *Caelorinchus supernasutus* most closely resembles *C. macrorhynchus* (the two species are compared in the description of *C. macrorhynchus*). Our two NSW specimens of *C. supernasutus* are juveniles of 162 and 280 mm TL; they were not compared with the much larger (418–635 mm TL) paratypes from New Zealand. Specimens of comparable size from the two areas should be compared to verify our identification.

REFERENCE SPECIMENS. — AMS I.27609-001 (1 spec.); K87-23-02. AMS I.29738-001 (1 spec.); K87-24-05.

REFERENCE. — McMillan and Paulin (1993).

***Caelorinchus trachycarus* Iwamoto, McMillan, and Shcherbachev, 1999**
Fig. 73

DISTINGUISHING FEATURES. — 1D II,7–9; P i15–i18; V 7; GR-I 7–9 total; scales below 1D 4.5–7.0, below 2D 3.5–6.0, lat.l. about 28–37; pyloric caeca 7–9. Snout about 2.0–2.5 of head length, with straight to slightly concave dorsal profile; anterolateral margin incompletely supported by bone. Underside of head scaled; nasal fossa naked to suborbital ridge; head ridges especially spiny and coarse; body scales with 5–13 parallel spinules rows, middle row longest and highest, other rows usually much shorter and lower. Light organ small, not externally visible.

SIZE. — To about 50 cm.

DISTRIBUTION. — Southern Australia (NSW, Vic., Tas., SA, WA), New Zealand, and Norfolk Ridge s. of New Caledonia, in 622–1730 m.

NSW CAPTURE: Only one confirmed specimen from off Jervis Bay in 1130 m.

REMARKS. — *Caelorinchus trachycarus* is relatively more abundant in deeper, more southern waters of New Zealand and Australia, especially in the Great Australian Bight. Almost all reported captures were from depths greater than 1000 m. It is likely to be confused with the common *C. acanthiger,* which has smaller scales, more spinules rows on body scales, weaker spines on head ridges, paler body and fin color, and absence of a violet tinge to the body.

REFERENCE SPECIMEN: AMS I.28475-004 (1 spec.); K88-04-06.

REFERENCES. — Iwamoto et al. (1999); Iwamoto and Williams (1999).

FIGURE 72. *Caelorinchus supernasutus* McMillan and Paulin, 1993. AMS I.29738-001 (280 mm TL). From *Kapala* stn K87-24-05.

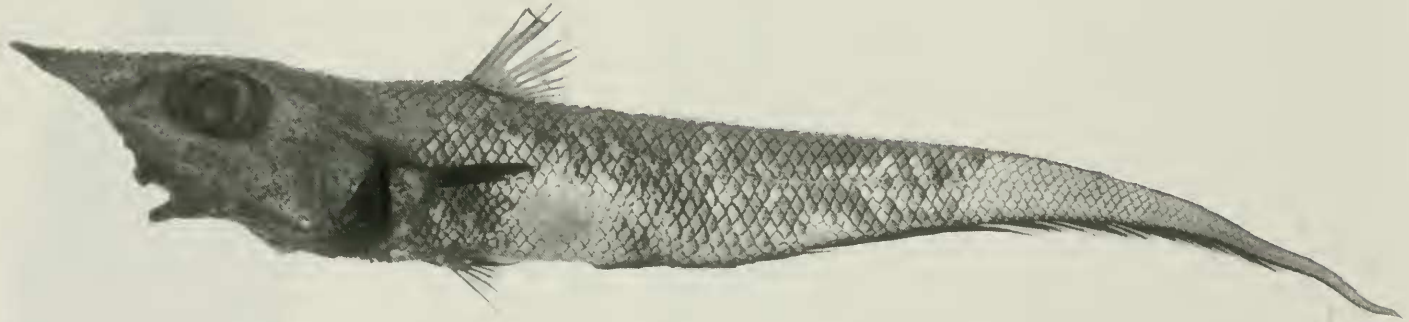

FIGURE 73. *Caelorinchus trachycarus* Iwamoto, McMillan and Shcherbachev, 1999. AMS I.28475-004. From *Kapala* stn K88-04-06, off Jervis Bay, NSW, in 1130 m.

Genus *Cetonurus*

DISTINGUISHING FEATURES. — Branchiostegal rays 7. Head massive, globose, with capacious, fluid-filled chambers; head ridges lacking thick modified scales. First dorsal fin short, high, with steep base; slightly prolonged spinous ray serrated along leading edge. Anus surrounded by broad, circular naked area, the anterior edge of which extends most of distance between anal and pelvic fins. Scales small, densely covered with short, erect spinules; head entirely scaled, including branchiostegal membranes and usually gular membrane. Grooved lateral line interrupted, not continuous; scales along, and anterior to, second dorsal fin base enlarged, usually with enlarged spinules.

REMARKS. — Two widespread species: *C. globiceps,* the only species found in NSW, and *C. crassiceps* (Günther, 1878).

REFERENCE. — Sazonov and Shcherbachev (1985).

Cetonurus globiceps (Vaillant *in* Filhol, 1884)

Fig. 74

DISTINGUISHING FEATURES. — 1D II,7–11, usually 9–10; P i15–i19; V 8–11, usually 9–10; GR-I 10–14; pyloric caeca 7–11. Orbit diameter 24–32% of HL; interorbital width 36–48%.

SIZE. — To about 40 cm.

DISTRIBUTION. — Widespread in central Atlantic, southern Africa, Indian Ocean, Australia (NSW, Vic., SA, WA), New Zealand, and Japan.

NSW CAPTURES. — Caught by *Kapala* between Crowdy Head and Batemans Bay in 940–1200 m. A total of 99 specimens was caught in 34 tows (19% of all tows deeper than 900 m).

REMARKS. — Sazonov and Shcherbachev (1985) provided important information on the two species of the genus. *Cetonurus globiceps* can be distinguished from *C. crassiceps* by the former having a larger orbit, narrower interorbital, and somewhat more scale rows below first dorsal fin (13–19 vs. 11–14).

REFERENCE SPECIMENS. — AMS I.24057-002 (1 spec.); K83-09-04. AMS I.24187-001 (1 spec.); K83-14-02. AMS I.24355-006 (3 spec.) and AMS I.24355-011 (3 spec.); K83-18-02. AMS I.24624-002 (1 spec.); K84-04-10. AMS I.25273-002 (6 spec.); K84-11-09. AMS I.29605-005 (2 spec.); K89-09-07.

REFERENCES. — Sazonov and Shcherbachev (1985); Gomon et al. (1994); Paxton et al. (1989) as *C. crassiceps.*

FIGURE 74. *Cetonurus globiceps* (Vaillant *in* Filhol, 1884). AMS I.24057-005. From *Kapala* stn K83-09-04, east of Nowra, NSW, in 951–978 m.

Genus *Coryphaenoides*

DISTINGUISHING FEATURES. — Branchiostegal rays 6. Anus at or close to anal fin origin; no associated light organ. Spinous second ray of first dorsal fin serrated along leading edge (sometimes rudimentary or lost). Rays of second dorsal fin much shorter than opposite rays of anal fin. Outer gill rakers present (sometimes rudimentary) on first gill arch.

REMARKS. — The members of this genus are mostly found at mid-slope to lower-slope depths, but a few range down to abyssal levels. The genus is represented in all ocean basins, from polar to equatorial seas. Of the more than 60 species found worldwide, 11 were captured off NSW, with *Coryphaenoides serrulatus* one of the most abundant of all grenadiers. In contrast, the deepest-living *Coryphaenoides* species were represented by only one or a few specimens, probably reflecting the paucity of sampling in depths greater than 1200 m.

REFERENCES. — Gilbert and Hubbs (1920); Iwamoto (1990); Iwamoto and Shcherbachev (1991). Shcherbachev and Iwamoto (1995).

KEY TO THE SPECIES OF *CORYPHAENOIDES* FROM NSW

1a. Pelvic fin rays 7, rarely 6 or 8; spinules on body scales lanceolate 2
1b. Pelvic fin rays 8 or more; spinules on body scales needlelike. 3

2a. Chin barbel rudimentary; a greatly elongated ray in pectoral fin; inner gill rakers on first arch 16–19 . *C. subserrulatus*
2b. Chin barbel well developed, 20–30% of head length; no elongated ray in pectoral fin; inner gill rakers on first arch 11–15. . . . . *C. serrulatus*

3a. Snout completely scaled or naked surfaces confined to midventral swath and along ventral snout margin 4
3b. Snout entirely or almost entirely naked ventrally (and often on dorsal surface) 7

4a. Outer gill slit greatly restricted, 4–9% of head length; inner rakers on first gill arch 9 or 10 total . . . . . *C. rudis*
4b. Outer gill slit 14% of head length or greater; inner rakers on first gill arch 11 or more total. 5

5a. Pelvic fin rays 8, rarely 7 or 9 . . . . . *C. dossenus*
5b. Pelvic fin rays 11 or 12 6

6a. Preopercle with 4 spikelike struts (Fig. 75); head about 6 times into total length; teeth rather small and weak, somewhat deciduous. . . . . *C. grahami*
6b. Preopercle lacking spikelike struts; head about 5.5 times into total length; teeth strong, tightly attached . . *C. striaturus*

7a. Chin barbel less than 5% of head length, usually a mere stump; pelvic fin rays 8, rarely 9; inner gill rakers on outer arch 16–19. . . . . *C. mcmillani*
7b. Chin barbel 5% of head length or longer; pelvic fin rays 9–12; inner gill rakers on outer arch 9–16 8

8a. Inner gill rakers on outer arch 14–16; chin barbel 23–26% of head length; outer gill slit 20–22% of head length · *C. murrayi*
8b. Inner gill rakers on outer arch 9–13; chin barbel 4–16% of head length; outer gill slit 12–19% of head length· 9

9a. Long spinous ray of first dorsal fin with numerous serrations along leading edge; outer gill rakers on first arch 6–13· 10
9b. Long spinous ray of first dorsal fin with few or no serrations along leading edge; outer gill rakers on first arch 3–6 · · · · · · · · · · · · · · · · · · *C. filicauda*

10a. Snout distinctly pointed in lateral view, protruding beyond mouth a distance about equal to half orbit diameter; chin barbel 9–16% of head length · · *C. carapinus*
10b. Snout blunt, scarcely protruding beyond mouth, ventral profile steep; chin barbel short, 5–9% of head length · *C.* sp. cf. *fernandezianus*

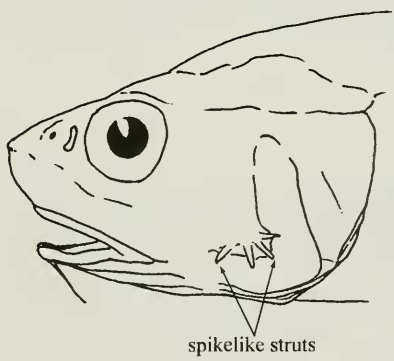

FIGURE 75. Preopercle of *Coryphaenoides grahami* showing spikelike struts.

Coryphaenoides carapinus **(Goode and Bean, 1883)**
Fig. 76

DISTINGUISHING FEATURES. — 1D II,8–9; P i16–i20; V 9–10; GR-I (total, outer/inner series) 6–9/11–13; pyloric caeca 6–9. Snout length 33–37% of HL; orbit diameter 17–21%; interorbital width 34–39%; suborbital width 12–16%; upper jaw length 35–40%. Head about 5–6 in TL; chin barbel short, thin, 9–13% of HL. Dentition in upper jaw three or four teeth across at widest portion, outer series slightly enlarged; teeth in lower jaw in one row except at symphysis in about two rows. Outer gill rakers of first arch short, flaplike. Head lacking stout ridges of modified scales; leading edge of snout with row of small, deciduous, tubercular scales; snout otherwise naked. Body scales large, deciduous; spinules on exposed field reduced or lacking. Long spinous ray of first dorsal fin with numerous short, reclined spinules along leading edge. Pectoral fin relatively long, about 50–70% HL. Outer pelvic ray slightly produced, its length 50–80% HL. Color in alcohol overall gray to brownish, somewhat darker on head; blackish over operculum, gill membranes, and jaws; fins pale except for blackish spinous ray of first dorsal, uppermost ray of pectoral, and outer ray of pelvic.

SIZE. — To about 40 cm.

DISTRIBUTION. — Worldwide at bathyal depths; recorded around southern Australia (NSW, Vic., Tas., SA, WA) in 1000–3000 m, but range to 4900 m in eastern North Atlantic.

NSW CAPTURES. — A single NSW record (6 specimens) by ORV *Franklin* off Nowra in 1600–1900 m.

REMARKS. — Probably occurs too deep to have been sampled by *Kapala*. The description above for *Coryphaenoides carapinus* is based on Australian specimens only. Specimens from other areas differ from Australian specimens in certain counts and measurements, and we are uncertain if these differences are indicative of separate taxa or populations.

REFERENCE SPECIMENS. — NMV A7003 (6 spec., 85–254 mm TL); 67 km off Nowra, NSW, 34°41.97′S, 151°22.44′E, in 1896–1642 m; ORV *Franklin* stn CSIRO FR9/88, Slope 59; 22 Oct 1988.

REFERENCES. — Marshall and Iwamoto (1973); Haedrich and Polloni (1976).

Coryphaenoides dossenus **McMillan, 1999**
Fig. 77

DISTINGUISHING FEATURES. — 1D II,9–10; P i17–i21; V 8 (rarely 7 or 9); GR-I (total, outer/inner series) 7–9/11–13, GR–II 9–12/11–13; scales below 1D 9.5–11, below 2D 7–12, lat.l. 38–48; pyloric caeca 10–18. Snout length 25–29% HL; orbit diameter 19–23%; interorbital width 16–20%; suborbital width 9–13; upper jaw length 40–45%. Head long, shallow, its width about half its length,

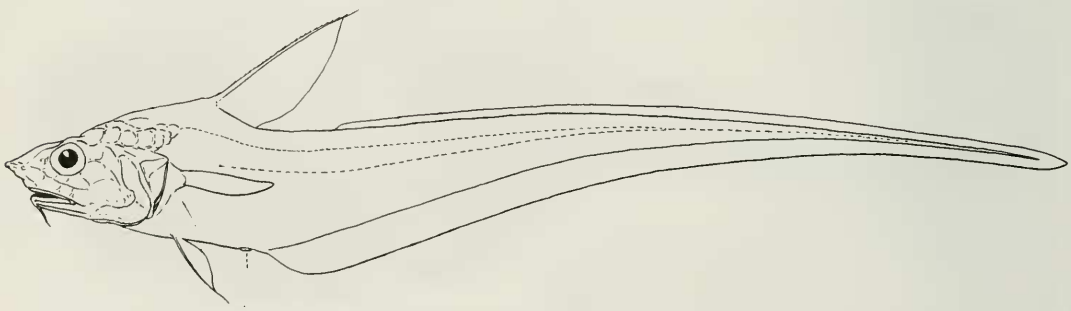

FIGURE 76. *Coryphaenoides carapinus* (Goode and Bean, 1883). CAS 58671, from eastern Indian Ocean, about 300 n.mi. w. of Perth, Western Australia.

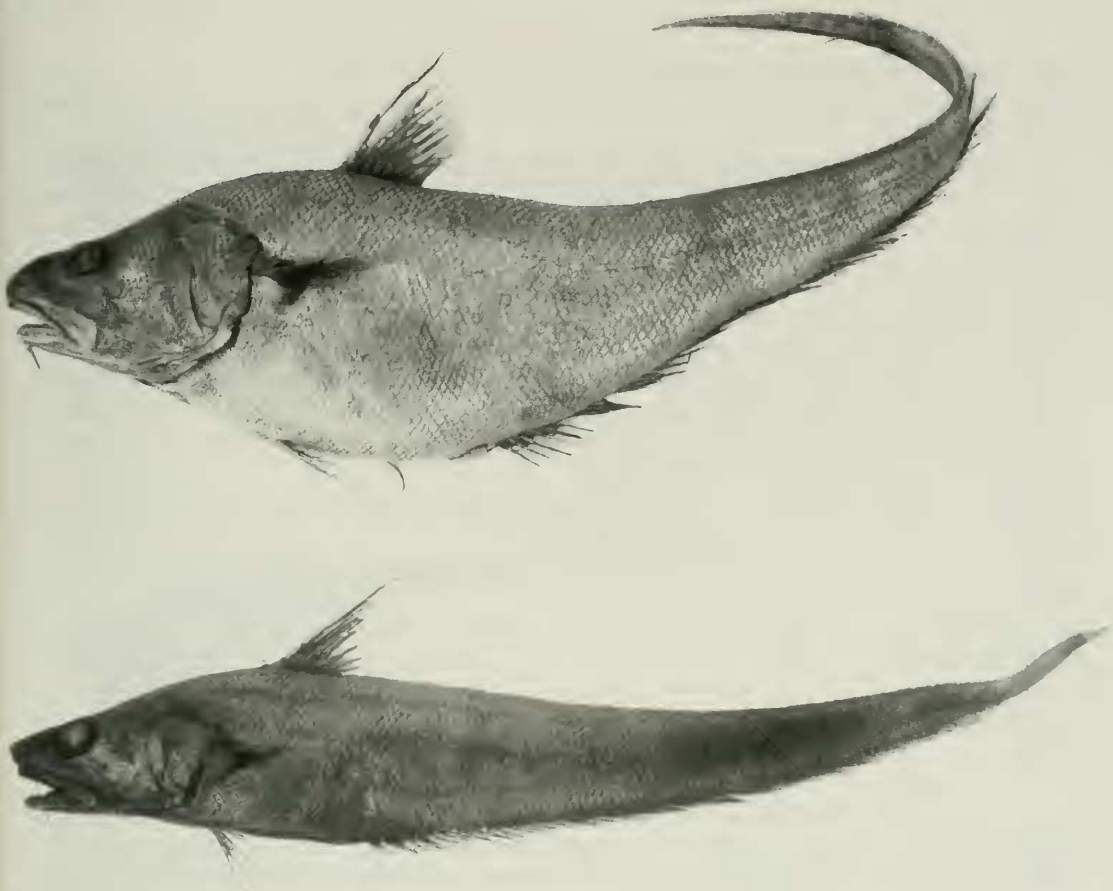

FIGURE 77. *Coryphaenoides dossenus* McMillan, 1999. (a) Female, AMS I.24658-001, from *Kapala* stn K84-08-03, east of Nowra, NSW, in 869–924 m; (b) male, AMS I.26245-015, from *Kapala* stn K86-01-07, off Sydney, NSW, in 819–899 m.

about 4.2–5.6 in TL (in females, more in males); snout low, blunt, barely protruding; chin barbel well developed, its length 21–34% HL. Upper jaw teeth in broad band, with outer series enlarged and widely spaced; lower jaw teeth in 3 or 4 irregular rows laterally. Gill rakers somewhat tablike. Head ridges not especially prominent and not reinforced by enlarged, thickened scales; underside of snout mostly covered with small scales, although narrow ventral margin naked; body scales rather large, with numerous subparallel to slightly convergent rows of small, needlelike spinules. Tip of outer pelvic ray barely or not reaching anal fin origin. Color in alcohol variable from light brown to swarthy overall, fins dusky to blackish, mouth and gill cavities dark.

SIZE. — Males to about 50 cm; females to more than 85 cm.

DISTRIBUTION. — Widespread around New Zealand, New Caledonia and the Coral Sea, Australia (Qld, NSW, Vic., Tas., SA, WA) and in the Indian Ocean; also in the southeastern Atlantic from South Africa north to the Gulf of Guinea. Depth range from about 700 to 1600 m, but most commonly around 900–1200 m.

NSW CAPTURES. — Captured frequently but in small numbers on all mid-slope grounds between Crowdy Head and Gabo Island in depths from 695 to 1200 m. It was present in 143 *Kapala* trawls including 51% of those deeper than 700 m; average catch about 3 per tow.

REMARKS. — Females (Fig. 77a) are more robust and attain a much larger size than males (Fig. 77b); larger individuals generally have a well-marked humped nape. Specimens of *C. dossenus* are

unlikely to be mistaken for other members of the genus owing to the combination of low, scarcely protruding snout, large mouth, large size, few pelvic fin rays, relatively high number of gill rakers, and long barbel.

REFERENCE SPECIMENS. — AMS I.17866-007 (1 female); K72-07-01. AMS I.17867-007 (2 females); K72-07-04. AMS I.18726-026 (1 female); K75-01-02. AMS I.19859-012 (1 female); K76-24-04. AMS I. 20477-002 (1 female); K77-23-10. AMS I.20485-006 (1 female), AMS I.20485-011 (1 female); K77-23-06. AMS I.21724-003 (7 males), AMS I.21724-006 (1 male); K79-20-15. AMS I. 24037-006 (3 females); K78-26-16. AMS I.24055-012 (1 female); K83-08-01. AMS I.24056-004 (2 females); K83-08-02. AMS I.24059-016 (2 females); K83-09-02. AMS I.24173-015 (1 female); K82-14-06. AMS I.24613-005 (1 female), AMS I.24613-007 (3 females); K75-05-05. AMS I.24624-001 (3 males), AMS I.24624-006 (2 females); K84-04-10. AMS I.24658-002 (1 female); K84-08-03. AMS I.24771-002 (1 female); K84-10-08. AMS I.24980-006 (1 female); K84-16-15. AMS I.24981-003 (2 females); K84-17-04. AMS I.24992-002 (2 females); K84-11-07. AMS I.25273-005 (1 female); K84-11-09. AMS I.25415-001 (1 female); K84-04-11. AMS I.25933-005 (1 female); K79-20-06. AMS I.26245-003 (2 females) and I.265245-015 (1 male); K86-01-07. AMS I.28717-003 (1 female); K88-10-04. NMV A6842 (2 spec.); 56 km off Nowra, NSW, 34°44.0′S, 151°14.5′E, in 817-1009 m; ORV *Franklin* stn CSIRO FR9/88, Slope 58; 22 Oct 1988.

REFERENCES. — McMillan *in* Gomon et al. (1994); Shcherbachev and Iwamoto (1995); McMillan (1999).

***Coryphaenoides* sp. cf. *fernandezianus* (Günther, 1887)**
Fig. 78

DISTINGUISHING FEATURES. — 1D II,8; P i17; V 9–10; GR-I (total, outer/inner series) 10–11/11–12. Snout length 27–36% of HL; preoral length 16–18% of HL; orbit diameter 18–20%; interorbital width 31–37%; suborbital width 15–16%; upper jaw length 40–41%. Head about 5 in TL; chin barbel short, thin, 5–9% of HL. Dentition in upper jaw in two series; teeth in lower jaw in one row. Outer gill rakers of first arch short, flaplike. Head lacking stout ridges of modified scales; few small, deciduous scales on suborbital and lower jaw, snout naked ventrally and along anterior part of dorsal surface. Body scales deciduous; spinules on exposed field reduced or lacking. Long spinous ray of first dorsal fin with numerous short, reclined spinules along leading edge. Outer pelvic ray slightly produced, its length about 70% HL. Color in alcohol overall dark brownish, somewhat darker on head; blackish over operculum, gill membranes, and jaws; fins dark.

SIZE. — To at least 16 cm.

DISTRIBUTION. — Australia (NSW and Lord Howe Rise) in 1600–2500 m.

NSW CAPTURES. — Two juveniles captured by ORV *Franklin,* one off Nowra in about 1800 m, the other on the Lord Howe Rise in 2450 m.

REMARKS. — We are uncertain of the identity of these two small specimens, but many of their characters are similar to those of *C. fernandezianus* (Günther, 1887), a species known only from the holotype taken off Juan Fernandez Island off the west coast of Chile. Our two specimens differ sufficiently from one another that they may represent separate species. The Nowra specimen has a longer snout (36% of HL vs. 27% in the Lord Howe Rise specimen), broader interorbital (37% of HL vs. 31%), shorter orbit to preopercle distance (48% HL vs. 54%), and fewer pelvic fin rays (9 vs. 10). More specimens are needed to resolve the identification questions.

REFERENCE SPECIMENS. — AMS I.29316-005 (1 spec.); Lord Howe Rise, 29°42.06′S, 159°48.31′E; 2450 m; ORV *Franklin*, 3 May 1989. NMV A7002 (1 spec.); 67 km off Nowra, 34°41.97′S, 151°22.44′E, 1896-1642 m; ORV *Franklin*, Slope 59, stn FR 9/88, 22 Oct. 1988.

REFERENCES. — Günther (1887); Iwamoto and Sazonov (1988).

FIGURE 78. *Coryphaenoides* sp. cf. *fernandezianus*. AMS I.29316-001. From ORV *Franklin* stn off Lord Howe Island, in 2450 m.

Coryphaenoides filicauda Günther, 1878
Fig. 79

DISTINGUISHING FEATURES. — 1D II,8–10; P i16–i19; V 9–10; GR-I (total, outer/inner series) 3–6/9–10; pyloric caeca 6–8. Snout length 33–38% of HL; orbit diameter 16–18%; interorbital width 30–33%; suborbital width 12–17%; upper jaw length 33–37%. Head about 5–6 in TL; chin barbel short, thin, 4–12% of HL. Upper jaw teeth in narrow band, with slightly enlarged outer series; lower jaw teeth in narrow band tapering to one row posteriorly. Outer gill rakers of first arch few, weakly de-

FIGURE 79. *Coryphaenoides filicauda* Günther, 1878. AMS I.27643-004. From *Kapala* stn K88-12-02, southeast of Crowdy Head, NSW, in 990–1020 m.

veloped. Head lacking stout ridges of modified scales; tip and lateral angles of snout armed with small tubercular scales with upturned spinules; snout otherwise naked. Body scales large, deciduous; spinules on exposed field reduced or lacking. Long spinous ray of first dorsal fin with few or no spinules along leading edge. Pectoral fin relatively long, 50–70% HL; rays fine, none thickened or notably prolonged beyond others. Outer pelvic ray slightly produced, its length 40–60% HL. Color in alcohol overall pale to brownish, flesh translucent over anal pterygiophores; blackish over abdomen, operculum, and somewhat dusky on underside of head; fins pale except for blackish spinous ray of first dorsal, uppermost ray of pectoral, and outer ray of pelvic.

SIZE. — To about 41 cm.

DISTRIBUTION. — High latitudes of southern hemisphere; known off Australia (NSW, including Lord Howe Rise, Tas., SA); capture depths range about 1000–5100 m, but most from 3500–5000 m.

NSW CAPTURES. — A single *Kapala* specimen in 990–1020 m off Crowdy Head and three *Franklin* specimens from 2450 m on the Lord Howe Rise.

REMARKS. — *Coryphaenoides filicauda* is primarily an abyssal species, and the *Kapala* capture at mid-slope depths off NSW is the shallowest record for the species. The three juveniles (17.5–20.1 mm HL) from the Lord Howe Rise differed from others examined (including from other areas) in a number of features, including slightly more gill rakers on first arch (6–8 outer rakers; 11 inner rakers), somewhat longer snout (30–37% HL), wider interorbital (32–29% HL), longer upper jaw (38–39% HL), and longer barbel (12–13% HL). We are uncertain whether these differences reflect ontogenetic change or different taxa. A closely related species, *C. carapinus*, can be distinguished from *C. filicauda* by its well-serrated leading edge of the spinous dorsal ray, longer barbel (9–15% HL), more numerous and better-developed gill rakers (GR-I 6–10/9–13), and more adherent, more heavily spinulated scales.

REFERENCE SPECIMENS. — AMS I.27643-004 (1 spec.); K88-12-02. AMS I.29316-004 (3 spec.); Lord Howe Rise, 29°42.06′S, 159°48.13′E; 2450 m; ORV *Franklin* stn FR0589-17; 3 May 1989.

REFERENCES. — Iwamoto and Sazonov (1988); Gon and Heemstra (1990).

***Coryphaenoides grahami* Iwamoto and Shcherbachev, 1991**
Fig. 80

DISTINGUISHING FEATURES. — 1D II,8–9; P i19–i23; V 12; GR-I (total, outer/inner series) 8–10/11–14; scales below 1D 7.5–9.0, below 2D 8.0–9.5, lat.l about 26–31; pyloric caeca about 10. Snout length 25–29% of HL; orbit diameter 21–23%; interorbital width 28–31%; suborbital width 11–14%; upper jaw length 39–42%; barbel length 13–23%. Head about 6 in TL; preopercle with 4 spikelike struts. Teeth small, weak, somewhat deciduous, in single row in lower jaw. Head lacking

FIGURE 80. *Coryphaenoides grahami* Iwamoto and Shcherbachev, 1991. AMS I.29798-010. From *Kapala* stn K89-12-04, off Tuncurry, NSW, in 1033–1079 m.

stout ridges of large, modified scales and large tubercular scale at snout tip; underside of head (except gill membranes) entirely scaled; body scales deciduous, about 8–10 parallel rows of small spinules. Color fresh ivory white with silvery sheen; in alcohol overall dark gray to brown, blackish over ventral surfaces and lips, mouth, gill membranes, gill chamber, and most fins.

SIZE. — To about 40 cm.

DISTRIBUTION. — South Atlantic off South Africa, southern Indian Ocean, eastern Australia (NSW), in about 1050–1300 m.

NSW CAPTURES. — Six specimens collected at four *Kapala* stations between Crowdy Head and Jervis Bay in 1040–1140 m.

REMARKS. — *Coryphaenoides grahami* has not been collected from any other Australian state. It is likely to be mistaken only for *C. striaturus,* which is similar in shape, and shares many counts, measurements, and scale features. *Coryphaenoides grahami* is, however, darker overall and has a broader interorbital, smaller, weaker teeth, and spikelike processes on the preopercle.

REFERENCE SPECIMENS. — AMS I.29737-002 (paratype), and I.29737-004 (2 spec.); K89-19-01. AMS I.29742-003 (paratype); K89-17-07. AMS I.29745-005 (paratype); K89-18-02. AMS I.29798-010 (paratype); K89-12-04.

REFERENCE. — Iwamoto and Shcherbachev (1991).

***Coryphaenoides mcmillani* Iwamoto and Shcherbachev, 1991**
Fig. 81

DISTINGUISHING FEATURES. — 1D II,9–11; P i17–i20; V 8–9; GR-I (total, outer/inner series) 11–16/16–19; scales below 1D 7.5–9.0, below 2D 6.5–9.5, lat.l about 31–34; pyloric caeca about 9–10. Snout length 28–31% of HL; orbit diameter 27–31%; interorbital width 26–30%; suborbital width 11–12%; upper jaw length 46–50%. Head about 4.5–6 in TL; sensory pores prominent; chin barbel rudimentary, stumplike. Upper jaw teeth in narrow band, with slightly enlarged outer series; lower jaw teeth in single row. Outer gill rakers of first arch relatively long and flat, triangular to saber-shaped. Head lacking stout ridges of large, modified scales; snout naked except for small tubercular scale at tip and lateral angles; body scales deciduous, about 8–10 parallel rows of slender, conical spinules. Pectoral fin relatively long, 70–90% HL, but rays fine, none thickened or notably prolonged beyond others. Outer pelvic ray elongated, its length 70–90% HL. Color in alcohol overall swarthy, blackish over abdomen behind pelvic fins; operculum and most head membranes black; fins blackish to dusky.

SIZE. — To about 35 cm.

DISTRIBUTION. — New Zealand, Australia (NSW, Tas., SA), southern Indian Ocean, southern Africa, South Atlantic off Whale Ridge, in 950–1400 m.

NSW CAPTURES. — Captured once by ORV *Franklin* off Nowra in 817–1009 m.

REMARKS. — *Coryphaenoides mcmillani* was not collected by *Kapala* despite the holotype coming from an area and depth extensively trawled. It is either very rare off NSW or was misidentified in the field as *C. subserrulatus*, which was commonly recorded from the type area. *C. mcmillani* is distinguished from the similar *C. subserrulatus* by having more pelvic fin rays and shorter pectoral and pelvic fins.

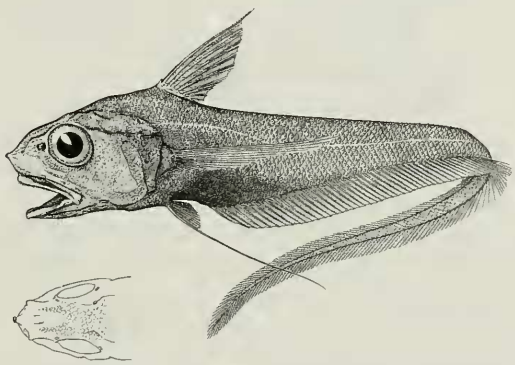

FIGURE 81. *Coryphaenoides mcmillani* Iwamoto and Shcherbachev, 1991 (from original illustration of holotype).

REFERENCE SPECIMEN: NMV A6794 (holotype); NSW, 56 km off Nowra, 34°44′S, 151°14.3′E, in 1009–817 m; ORV *Franklin* stn CSIRO FR5/86, Slope 9.

REFERENCE. — Iwamoto and Shcherbachev (1991).

Coryphaenoides murrayi Günther, 1878

Fig. 82

DISTINGUISHING FEATURES. — 1D II,8–10; P i18–i20; V 10–12(usually 12); GR-I (total, outer/inner series) 9–11/14–16; scales below 1D 9–11, below 2D 9–11, lat.l about 33; pyloric caeca about 9–10. Snout length 28–30% of HL; orbit diameter 20–23%; interorbital width 28–34%; suborbital width 13–17%; upper jaw length 42–45%. Head broad, width about two-thirds its length; chin barbel slender, about equal to or longer than orbit. Upper jaw teeth in broad band, with outer series slightly enlarged; lower jaw teeth in one row. Head lacking ridges of large, stout, modified scales; a row of small scales along leading edge of snout; snout naked on underside, with broad naked areas on dorsal surface behind leading edge; body scales rather deciduous, about 5–8 parallel rows of weak, slender, conical spinules. Color in alcohol overall dark brownish to swarthy.

SIZE. — To at least 37 cm.

DISTRIBUTION. — Western Indian Ocean to southeastern Australia (NSW, Vic.), New Zealand, and Fiji, in depths of 1196–2350 m.

NSW CAPTURE. — Taken once by ORV *Franklin* off Nowra in 1896–1642 m.

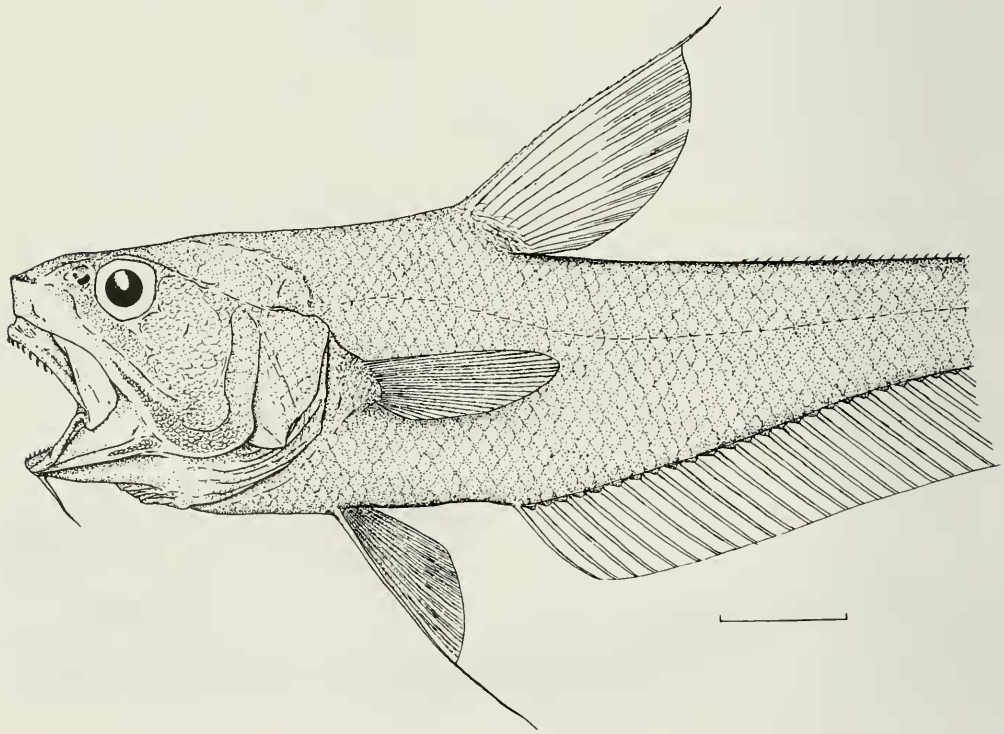

FIGURE 82. *Coryphaenoides murrayi* Günther, 1878. Holotype, BMNH 1887.12.7.113, *Challenger* stn 168, off New Zealand, in 2012 m. Fins and scales reconstructed.

REMARKS. — This is a species of lower-slope depths known mostly from captures off New Zealand. The only Australian specimens are from off NSW and eastern Victoria.

REFERENCE SPECIMENS. — NMV A7004 (1 spec.); 67 km off Nowra, NSW, 34°41.97′S, 151°22.44′E, in 1896–1642 m; ORV *Franklin* stn CSIRO FR9/88, Slope 59, 22 Oct 1988. NMV A6793 (1 spec.); 85 km s. of Pt. Hicks, 38°31.4′S, 149°21.1′E, in 1986–1360 m.

REFERENCE. — Iwamoto and Shcherbachev (1991).

***Coryphaenoides rudis* Günther, 1878**
Fig. 83

DISTINGUISHING FEATURES. — 1D II,9–11; P i16–i21; V 8–11 (usually 9 or 10, rarely 8 or 11); GR-II (total, outer/inner series) 7–10/9–10; scales below 1D 9, below 2D 6.5, lat.l about 37; pyloric caeca about 14. Head broad, width about two-thirds its length; snout low, scarcely protruding in large adults, length about 23–29% HL; orbit small, 16–26% HL; interorbital width 26–30% HL; mouth large, upper jaw extending to below posterior margin of orbit, 37–43% HL; chin barbel slender, 10–23% HL. Upper jaw teeth in moderately broad band, with outer series enlarged; lower jaw teeth in 1–3 irregular rows. Head lacking ridges of large, stout, modified scales; snout completely scaled; body scales with small spinules. Color in alcohol overall brownish to brownish gray.

SIZE. — One of the largest known grenadiers, attaining at least 120 cm in TL. The two NSW specimens measured 71 and 95 cm in length.

DISTRIBUTION. — Broadly distributed in central and western Pacific, Indian Ocean, and middle to low latitudes in the Atlantic, in depths of 1,000–2,400 m. Recorded from Australia off NSW and WA.

NSW CAPTURES. — Only two specimens caught by *Kapala*, one in 1050 m off Newcastle, the second in 1150 m off Sydney.

REMARKS. — Juveniles of this large species have a more protruding snout and proportionately larger orbits than do the adults, which affects the relative dimensions of the interorbital, suborbital, and postorbital. *Coryphaenoides rudis* is a large, widely distributed species originally described from the Kermadec Islands, but subsequently recorded from other areas under the names *C. paradoxus* and *C. macrocephalus*, as well as *C. rudis*. It appears to be rare wherever found.

REFERENCE SPECIMENS. — AMS I.28477-001 (1 spec.); K88-16-04; AMS I.29340-001 (1 spec.); K89-13-02.

REFERENCES. — Sazonov and Iwamoto (1992); Shcherbachev and Iwamoto (1995); Iwamoto and Williams (1999).

***Coryphaenoides serrulatus* Günther, 1878**
Fig. 84

DISTINGUISHING FEATURES. — 1D II,8–11; P i18–i22; V 7 (rarely 6 or 8); GR-I (total, outer/inner series) 7–10/11–15, GR-II 10–14/10–14; scales below 1D 8–10, below 2D 6.5–8.5, lat.l 35–40; pyloric caeca 16–19. Snout length 27–30% HL; orbit diameter 30–33%; interorbital width 18–24%; suborbital width 11–14%; upper jaw length 39–44%. Head short and compressed, about 6 times in TL; chin barbel well developed, length 20–30% HL. Upper jaw teeth in relatively narrow band, with outer series enlarged; lower jaw teeth in one row. Gill rakers rather numerous, the outer rakers somewhat tablike. Suborbital ridge with row of stout, coarsely thickened scales; tip and lateral angles of snout with large, tubercular scales, snout otherwise uniformly covered with small scales; body scales rather large, covered with lanceolate spinules. Outer pelvic ray 50–80% HL, extending to anal origin or slightly beyond. Color in alcohol overall brownish, darker over abdomen and gill covers with bluish to blackish.

FIGURE 83. *Coryphaenoides rudis* Günther, 1878. AMS I.28477-001. From *Kapala* stn K89-13-02, off Sydney, NSW, in 1116–1170 m.

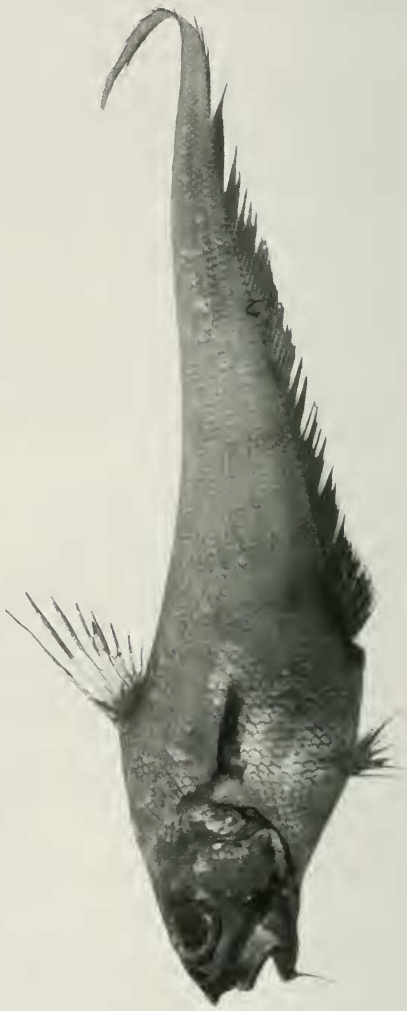

FIGURE 84. *Coryphaenoides serrulatus* Günther, 1878. AMS I.24172-006. From *Kapala* stn K83-14-01, off Ulladulla, NSW, in 978–1024 m.

SIZE. — To about 45 cm.

DISTRIBUTION. — New Zealand and Australia (NSW, Vic., Tas., SA, WA), in 550–1200 m.

NSW CAPTURES. — Caught on all mid-slope grounds south of Crowdy Head in 690–1200 m. The most abundant grenadier in *Kapala* mid-slope catches. Recorded from 253 stations and present in all but 5 trawls in depths between 800 and 1200 m. Average catch about 40 per tow.

REMARKS. — Two subspecies of this widely distributed species of the southern hemisphere were recognized by Iwamoto and Shcherbachev (1991), with *Coryphaenoides s. serrulatus* occurring off New Zealand and southern Australian waters and *C. s. oceanus* found in oceanic waters of the Indian Ocean. The latter subspecies differs from the former in having a longer outer pelvic ray that extends beyond the base of the 10th anal ray, as well as several differences in proportional measurements.

REFERENCE SPECIMENS. — AMS I.18726-025 (3 spec.); K75-01-02. AMS I.19859-001 (13 spec.); K76-24-04. AMS I.19860-006 (8 spec.); K76-24-03. AMS I.19862-004 (5 spec.); K76-23-01. AMS I.20096-007 (8 spec.); K77-22-06. AMS I.20098-006 (3 spec.); K77-23-07. AMS I.20484-002 (1 spec.); K77-21-01. AMS I.20485-007 (3 spec.); K77-23-06. AMS I.23885-015 (1 spec.); K78-27-05. AMS I.24037-004 (6 spec.); K78-26-16. AMS I.24054-013 (1 spec.); K83-06-02. AMS I.24055-009 (1 spec.); K83-08-01. AMS I.24172-006 (1 spec.); K83-14-01. AMS I.24613-001 (8 spec.); K75-05-05. AMS I.25933-006 (1 spec.); K79-20-06. NMV A17 (1 spec.) and NMV A9077 (2 spec.); 56 km off Nowra; 1009-817 m; ORV *Franklin* stn CSIRO FR5/86, Slope 9. NMV A5783 (1 spec.), off Nowra; 1100 m; ORV *Franklin* stn CSIRO FR9/88, Slope 58.

REFERENCES. — Last et al. (1983); Iwamoto and Shcherbachev (1991); McMillan *in* Gomon et al. (1994); Iwamoto and Williams (1999).

Coryphaenoides striaturus Barnard, 1925

Fig. 85

DISTINGUISHING FEATURES. — 1D II,8–10; P i18–i24; V 11–12; GR-I (total, outer/inner series) 7–11/12–16, GR-II 11–14/11–15; scales below 1D 7.5–10, below 2D 8–9, lat.l 30–36; pyloric caeca 9–12. Snout length 26–30% HL; orbit diameter 18–24%; interorbital width 23–30%; suborbital width 11–15%; upper jaw length 38–46%. Head robust, its width about equal to postorbital length, about 5.5 in TL; chin barbel well developed, length 18–26% HL. Upper jaw teeth in band, with outer series enlarged; lower jaw teeth in one row. Gill rakers somewhat tablike. Head ridges prominent but not reinforced by thickened scales; underside of snout covered with small scales; body scales rather large, with 9–11 parallel rows of small, needlelike spinules. Outer pelvic ray extends beyond anal fin origin,

FIGURE 85. *Coryphaenoides striaturus* Barnard, 1925. AMS I.29737-007. From *Kapala* stn K89-19-01, off Ulladulla, NSW, in 1116–1134 m.

usually to base of 6th–11th ray. Color in alcohol overall dark brown to swarthy, darker on underside of head and gill covers.

SIZE. — To about 55 cm.

DISTRIBUTION. — New Zealand, Australia (Qld, NSW, Vic., Tas., SA, WA), to the southeastern Atlantic off southern Africa, in depths of about 800 to 2000 m; most often taken in 1000–1400 m. Generally confined to cooler, temperate waters off southern coasts, although two AMS specimens were taken on the Lord Howe Rise off southern Qld and northern NSW.

NSW CAPTURES. — Collected from only three *Kapala* stations (5 specimens) south of 34°50′S in about 1100 m depth. A fourth NSW specimen was collected by ORV *Franklin* on the Lord Howe Rise in 1590 m.

REMARKS. — *Coryphaenoides striaturus* is normally an abundant species throughout its range, but off NSW it may be more common in depths greater than those trawled by *Kapala*. The uniformly and completely scaled snout, the pelvic fin ray count, and the highly arched nape help to distinguish this species from other Australian members of the subgenus *Chalinura*. The sympatric species *C. grahami* is closely similar but can be differentiated by its spikelike ridges of the preopercle, darker overall color, and less arched nape. Also, *C. striaturus* is a stouter, firmer-fleshed fish than is *C. grahami*.

REFERENCE SPECIMENS. — AMS I.24992-004 (2 spec.); K84-11-07. AMS I.29737-007 (2 spec.); K89-19-01. AMS I.29745-002 (1 spec.) and AMS I.29745-003 (1 spec.); K89-18-02. AMS I.29315-002 (1 spec.); Lord Howe Rise, 29°10.29′S, 160°29.78′E; 1590 m; 4 May 1989; ORV *Franklin* stn FR0589-21. AMS I.29339-001 (1 spec.); Lord Howe Rise, 27°39.8′S, 161°46.38′E; 1423 m; 1989; ORV *Franklin* stn FR0589-31.

REFERENCES. — Iwamoto and Shcherbachev (1991); Iwamoto and Williams (1999).

Coryphaenoides subserrulatus Makushok, 1976

Fig. 86

DISTINGUISHING FEATURES. — 1D II,9–11; P i13–i18; V 7; GR-I (total, outer/inner series)10–14/16–19, GR-II 16–18/14–17; scales below 1D 8–9, below 2D 6.5–8.5, lat.l 29–37; pyloric caeca 12–14. Snout length 25–29% HL; orbit diameter 30–34%; interorbital width 20–25%; suborbital width 7–10%; upper jaw length 44–49%. Head short and laterally compressed, more than 6 times

FIGURE 86. *Coryphaenoides subserrulatus* Makushok, 1967. AMS I.24054-006. From *Kapala* stn K83-06-02, off Wollongong, NSW, in 869–878 m.

in TL; chin barbel rudimentary. Upper jaw teeth in relatively narrow band, with outer series slightly enlarged; lower jaw teeth in one row. Gill rakers numerous for genus, the outer rakers on first arch somewhat tablike. Suborbital shelf narrow, with row of stout, coarsely thickened scales; tip and lateral angles of snout with large, tubercular scales, snout otherwise mostly naked ventrally and partly dorsally; body scales rather large, covered with lanceolate spinules. Uppermost developed pectoral fin ray stouter than other rays of fin and greatly elongated, 115–214% HL. Outer pelvic ray elongated, 158–221% HL, extending far beyond anal fin origin. Color in alcohol overall light to medium brown, darker over abdomen, gill covers bluish to blackish.

SIZE. — To 37 cm.

DISTRIBUTION. — Widely distributed off southeastern Australia (NSW, Vic., Tas.), New Zealand, Chile, and in the South Atlantic off Argentina and on the Agulhas Plateau. Depth range about 700–1200 m, but one capture off Chile at 470–440 m.

NSW CAPTURES. — Commonly caught on all grounds south of Crowdy Head in 720–1200 m. Recorded from 173 *Kapala* stations including 70% of stations deeper than 800 m; average catch about 10 per trawl.

REMARKS. — *Coryphaenoides subserrulatus* differs from the closely similar *C. mcmillani* in the relatively thick, greatly elongated uppermost pectoral fin ray (no prolonged ray in *C. mcmillani*), fewer pelvic fin rays (7 cf. 8 or 9), and lanceolate scale spinules (cf. needlelike, in parallel rows).

REFERENCE SPECIMENS. — AMS I.20068-005 (1 spec.); K77-23-13. AMS I.24037-003 (7 spec.); K78-26-16. AMS I.24054-006 (5 spec.); K83-06-02. AMS I.24055-004 (1 spec); K83-08-01.

REFERENCES. — Makushok (1967); McCann and McKnight (1980) (as *Coryphaenoides quadripennatus*); Iwamoto and Shcherbachev (1991).

Genus *Cynomacrurus*

DISTINGUISHING FEATURES. — Branchiostegal rays 6. Mouth large, upper jaw extending well past orbit. Anus located immediately before anal fin origin; no light organ. Swim bladder very small. Sensory pores large, prominent; orbit small, more than 5 in head length. One or more pairs of large fanglike teeth in upper jaw; lower jaw with single row of 4 to 11 fanglike teeth. Lateral line broken into two main segments, anterodorsal segment ending somewhat behind first dorsal fin, second segment midlateral, beginning below end of first segment.

REMARKS. — Monotypic genus; bathypelagic in Southern Ocean.

REFERENCES. — Dollo (1909); Marshall (1964); Iwamoto *in* Gon and Heemstra (1990).

Cynomacrurus piriei Dollo, 1909

Fig. 87

DISTINGUISHING FEATURES. — 1D II,8–9; P i13–i16; V 7–8; GR-I (outer/inner) 8 or 9 total/14–16 total; scale rows below 1D about 7; pyloric caeca 9 or 10. Head about 5 times in total length; snout not protruding. Extensive naked areas on head. Barbel absent. Spinous second ray of first dorsal fin smooth.

SIZE. — To about 46 cm.

DISTRIBUTION. — Southern Ocean, Australia (NSW), and New Zealand (*fide* Peter McMillan).

NSW CAPTURE: One specimen (the only Australian record) captured by *Kapala* off Ulladulla (35°30′S) when trawling in 1030–1070 m. It may have been captured in midwater when hauling the trawl.

REMARKS. — The species is abundant at bathypelagic depths of the Southern Ocean.

REFERENCE SPECIMEN: AMS I.24424-005 (1 spec.); K83-19-02.

FIGURE 87. *Cynomacrurus piriei* Dollo, 1900. AMS I.24424-005. From *Kapala* stn K83-19-02, off Ulladulla, NSW, in 1079–1116 m.

Genus *Haplomacrourus*

DISTINGUISHING FEATURES. — Branchiostegal rays 7. Head laterally compressed, snout rounded in profile; in larger specimens (>30 cm TL) upper jaws fall short of vertical through anterior margin of orbit and snout not protruding beyond mouth. Snout and ventral parts of head naked; scales small, those on head and anterior part of body lacking spinules. Anus about midway between anal and pelvic fins; a small dermal window of light organ between bases of pelvic fins. Spinous dorsal ray stout, flattened laterally, recurved and finely serrated along leading edge.

REMARKS. — A peculiar monotypic species of uncertain relationships.

REFERENCES. — Trunov (1980); Iwamoto and Merrett (1997).

Haplomacrourus nudirostris Trunov, 1980

Fig. 88

DISTINGUISHING FEATURES. — 1D II,9–10; P i25–i28; V 8–9; scales small, 15–18 below 1D, 15–17 below 2D; pyloric caeca about 30.

SIZE. — To about 60 cm.

FIGURE 88. *Haplomacrourus nudirostris* Trunov, 1980. AMS I.26247-004. From *Kapala* stn K85-21-04, east of Broken Bay, NSW, in 1024–1052 m.

DISTRIBUTION. — Southeastern Atlantic off Africa through Indian Ocean to Australia (NSW) and New Zealand, north to New Caledonia, in about 800–1600 m.

NSW CAPTURES. — Caught at eight stations (9 specimens) between Crowdy Head and Jervis Bay in 950–1100 m.

REMARKS. — All *Kapala* specimens were small (174–280 mm TL), overall bluish black (trunk blackish), with a rounded snout profile, and jaws extending posterior to a vertical through the anterior margin of the orbit. The small numbers and absence of large adults in *Kapala* catches suggests that *Haplomacrourus* more commonly inhabits depths greater than those fished, or the adults are avoiding the net, or that NSW is marginal to its normal distribution.

REFERENCE SPECIMENS. — AMS I.24057-005 (2 spec.); K83-09-04. AMS I.24993-001 (1 spec.); K84-16-14. AMS I.26247-004 (1 spec.); K85-21-04. AMS I.29752-001 (1 spec.); K89-17-08. AMS I.29754-004 (1 spec.); K89-17-03. AMS I.29797-002 (1 spec.); K89-12-05. AMS I.29799-001 (1 spec.); K89-06-02. AMS I.40272-004 (1 spec.); K80-20-05.

Genus *Hymenocephalus*

DISTINGUISHING FEATURES. — Branchiostegal rays 7. Head bones weakly ossified, head covering membranous, transparent. Spinous ray of first dorsal fin usually smooth (weakly serrated in subgenus *Hymenogadus*, species of which may occur off NSW but have yet to be recorded). Anus immediately before anal fin origin, without broad black naked perianal margin. Two lens-like structures of light organ, one on chest, the other immediately before anus; luminescent tissue, consisting of fine black striations between silver ground, cover parts of abdomen, chest, shoulder girdle and isthmus between gill membranes. Gill rakers tubercular, inner rakers of first arch usually more than 18. Most species small, usually < 20 cm TL. Color blackish, with silvery cover over most of head and ventral surfaces of body; but some species almost entirely black.

REMARKS. — Only three species of this widespread genus were identified from *Kapala* catches, but others could be expected off northern NSW, especially those species reported from New Caledonia by Iwamoto and Merrett (1997).

REFERENCES. — Gilbert and Hubbs (1920); Iwamoto and Merrett (1997).

KEY TO THE SPECIES OF *HYMENOCEPHALUS* IN NEW SOUTH WALES

1a. Chin barbel long, well developed; pelvic fin rays 8 . . . . . *H. longibarbis*
1b. Chin barbel absent or rudimentary; pelvic fin rays 11–14. 2

2a. Orbits small, 3.6–4.5 times into HL; midlateral dark stripe faint or inconspicuous; body rather uniformly dark, fading posteriorly; suborbital broad, 1.0–1.6 into orbit . . . . . *H. aterrimus*
2b. Orbits large, 3.2 or less times in HL; distinct midlateral dark stripe present extending to end of tail; suborbital 2–3 into orbit . . . . . *H. nascens*

Hymenocephalus aterrimus Gilbert, 1905

Fig. 89

DISTINGUISHING FEATURES. — V 12–14; total GR-I (outer/inner) 14–20/22–27. Chin barbel absent. Suborbital region broad, width 17–22% HL; interorbital broad, width 36–39% HL; orbit small, diameter 22–28% HL. Color uniformly black to dark brown in preserved specimens, generally paler on tail.

SIZE. — To about 19 cm.

DISTRIBUTION. — Widespread in warm waters of Indian, Atlantic, and Pacific oceans, including Australia (NSW). Questionably recorded from the southeastern Pacific off Sala-y-Gomez and Nazca ridges (Sazonov and Iwamoto 1992), but otherwise not present in tropical eastern Pacific.

FIGURE 89. *Hymenocephalus aterrimus* Gilbert, 1905. AMS I.29753-001. From *Kapala* stn K89-17-06, east of Crowdy Head, NSW, in 878–933 m.

NSW CAPTURES. — Collected twice in 820–830 m off Crowdy Head at the northern end of the mid-slope trawling ground.

REMARKS. — The NSW specimens are the only Australian records, but *H. aterrimus* can be expected off Queensland. Its small size and more tropical distribution could account for its rarity in *Kapala* trawls. This species deserves closer scrutiny, as specimens recorded from widely separated areas under the name may represent more than one species.

REFERENCE SPECIMENS. — AMS I.29742-001 (1 spec.); K89-17-09. AMS I.30304-006 (3 spec.); K89-17-06.

REFERENCES. — Gilbert (1905); Sazonov and Iwamoto (1992); Iwamoto and Merrett (1997).

***Hymenocephalus longibarbis* (Günther, 1887)**
Fig. 90

DISTINGUISHING FEATURES. — V 8; total GR-I (outer/inner) 12–16/19–22. Chin barbel well developed, its length 38–58% HL. Body long and slender, head rather shallow, suborbital region narrow, its width 8–10% HL, interorbital width 16–23% HL, orbit large, diameter 32–41% HL. Color when fresh overall silvery, with grayish dorsally and blackish ventrally on trunk and over gill membranes; in alcohol silvery color often lost, lateral stripe somewhat diffuse in larger specimens but prominent on trunk in smaller specimens. Ventral surfaces of tail lacking pigmentation.

DISTRIBUTION. — Fiji, New Caledonia region, Australia (Qld, NSW, possibly WA), and possibly Indonesia.

NSW CAPTURES. — Collected by *Kapala* between southern Queensland (27°50′S) and Ulladulla (35°30′S) in 360–820 m. Recently collected in small numbers southeast of Bermagui (36°30′S)(AMS I.40289-002). Recorded from 102 *Kapala* stations with its greatest abundance in 400–600 m off central and northern NSW. Because of its small size, few were collected in fish trawls fitted with 90 mm mesh codends (caught in only 6% of fish trawls in 400–600 m). In contrast, *H. longibarbis* was recorded from 62% of prawn trawl stations in 400–600 m (45 mm mesh nets). Tows with prawn trawls frequently captured 25–50 specimens.

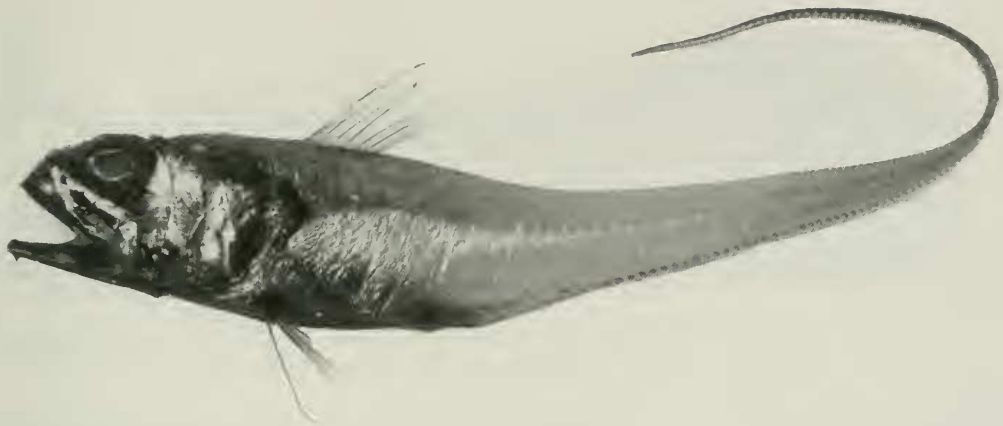

FIGURE 90. *Hymenocephalus longibarbis* Günther, 1877. From *Kapala* stn K83-01-08 off Sydney, NSW, in 490–570 m.

REMARKS. — *Hymenocephalus longibarbis* is abundant off Queensland, and Iwamoto and Williams (1999) also recorded the species from two captures on the North West Shelf off WA. Their specimens had notably different proportional measurements of the orbit diameter, interorbital width, and suborbital width, which led them to suggest that they might represent another species.

REFERENCE SPECIMENS. — AMS I.20071-041 (1 spec.); K77-19-05. AMS I.20118-034 (11 spec.); K77-13-10. AMS I.20301-024 (3 spec.); K77-13-12. AMS I.20518-005 (4 spec.), AMS I.20518-013 (1 spec.); K78-09-05. AMS I.21669-003 (3 spec.); K77-16-16. AMS I.21795-006 (3 spec.); K78-23-08. AMS I.21805-001 (2 spec.); K77-23-09. AMS I.21806-003 (1 spec.); K77-07-10. AMS I.23486-001 (1 spec.); K82-24-02. AMS I.24619-006 (1 spec.); K81-17-03. AMS I.24850-001 (3 spec.); K84-15-01. AMS I.24852-010 (1 spec.); K84-15-03. AMS I.29535-002 (7 spec.); K79-15-01. AMS I.30407-004 (3 spec.); K78-01-01. AMS I.40289-002 (3 spec.); FV *Shelley H*; 36°30′S, 150°21′E; 390-558 m; off Bermagui, NSW; 18 April 2000. AMS I.40292-002 (3 spec.); FV *Shelley H*; 36°26′S, 150°21′E; 428-468 m; off Bermagui, NSW; 2 May 2000.

REFERENCES. — Paxton et al. (1989)(as *H. longiceps,* in part); Iwamoto and Merrett (1997); Iwamoto and Williams (1999).

Hymenocephalus nascens Gilbert and Hubbs, 1920

Fig. 91

DISTINGUISHING FEATURES. — V 11–13, usually 11 or 12; total GR-I (outer/inner) 16–20/22–27. Chin barbel absent. Snout conically pointed in lateral view, projecting well beyond mouth. Suborbital region narrow, width 12–16% HL, interorbital width 1.0–1.4 into orbit, width 27–35% HL, orbit large, diameter 31–38% HL. Color mostly silvery ventrally on head and body; in preservative, a prominent dark lateral stripe present (silvery when fresh). (After Iwamoto and Merrett, 1997.)

SIZE. — To about 16 cm.

DISTRIBUTION. — Widespread in tropical western Pacific through Philippines, Indonesia, and northern Australia (Qld, NSW, WA) in depths of about 350–800 m.

NSW CAPTURES. — Captured only twice by *Kapala,* in 820–930 m off Crowdy Head (at same stations as *H. aterrimus*).

FIGURE 91. *Hymenocephalus nascens* Gilbert and Hubbs, 1920. AMS I.29753-012. From *Kapala* stn K89-17-06, east of Crowdy Head, NSW, in 878–933 m.

REMARKS. — As with *H. aterrimus*, this species is marginal to NSW, having its main distribution in warmer tropical waters; it is abundant in the New Caledonian region. Its small size also made it unlikely to be captured in *Kapala's* trawls.

REFERENCE SPECIMENS. — AMS I.29753-012 (1 spec.); K89-17-06. AMS I.30304-005 (1 spec.); K89-17-09.

REFERENCES. — Gilbert and Hubbs (1920); Iwamoto and Merrett (1997); Iwamoto and Williams (1999).

Genus *Kuronezumia*

DISTINGUISHING FEATURES. — Branchiostegal rays 7. Anus situated in an oval to teardrop-shaped (periproct) area between pelvic fin base and anal fin origin, usually closer to former; a small shallow black pit representing dermal window of light organ anterior to periproct and between pelvic fin bases. Body deep, laterally compressed, depth 90–110% HL. Head usually much deeper than wide; almost completely and uniformly covered with small spinulated scales, including those over broad, flat suborbital region; snout somewhat rounded or bluntly protruding; mouth moderate in size, upper jaw 30–44% HL. Second spinous ray of first dorsal fin serrated along leading edge. Teeth in broad bands in both jaws. Gill rakers on outer side of second arch 8–11 total. Color light gray to brown to swarthy, but lacking bluish or violet.

REMARKS. — Five species of this genus are currently recognized, with two represented in NSW. Members of the genus are similar to some species of *Nezumia*, especially in terms of their overall physiognomy, but they can be distinguished by their almost entirely scaled head and the absence of a well-developed double row of enlarged, thickened scales along the suborbital ridge.

REFERENCES. — Iwamoto (1974); Shcherbachev et al. (1992)

KEY TO THE SPECIES OF *KURONEZUMIA* IN NEW SOUTH WALES

1a. Pelvic fin rays 11–13; snout rounded, not terminating in a large tubercular scale; upper jaw length 35–44% HL; scales rows between origin of second dorsal fin and lateral line 12–15 . . . . . *K. bubonis*

1b. Pelvic fin rays 8–9, rarely 10; snout bluntly pointed, terminating in a large tubercular scale; upper jaw length 28–35% HL; scales between origin of second dorsal fin and lateral line 11–12 . . . . . *K. leonis*

Kuronezumia bubonis (Iwamoto, 1974)

Fig. 92

DISTINGUISHING FEATURES. — D II,10–12; P i21–i25; V 11–13; total GR-I (outer/inner) 6–8/8–11 total; scale rows below 1D about 14–21; pyloric caeca 35–39. Snout length 26–32% of HL, orbit diameter 23–31%, interorbital width 23–26%, height of first dorsal fin about 90%. Snout

FIGURE 92. *Kuronezumia bubonis* (Iwamoto, 1974). AMS I.24645-004. From *Kapala* stn K84-06-03, off Broken Bay, NSW, in 777–823 m.

rounded, scarcely protruding beyond mouth, not tipped with an enlarged spiny scute. A large, scaly, tubercular swelling between pelvic fin bases.

SIZE. — To more than 73 cm.

DISTRIBUTION. — Known from the western Atlantic, Hawaii, South China Sea, southern Indian Ocean, New Zealand, and eastern Australia (NSW) in depths of around 600 to about 1100 m.

NSW CAPTURES. — Uncommon; 31 specimens caught at 23 *Kapala* stations on grounds between Crowdy Head and Jervis Bay in 670–1010 m. Within its main depth range (700–900 m), *K. bubonis* was recorded in 21% of trawls.

REMARKS. — So far only reported in Australian waters from NSW; the record by Paxton et al. (1989) off Cape Everard, Vic., was a misidentification of *K. leonis*. It is somewhat peculiar that the only *Kuronezumia* collected off Western Australia by Iwamoto and Williams (1999) was a related species, *K. pallida* (Sazonov and Iwamoto, 1992), a species previously known only from the southeastern Pacific. The *Kuronezumia* specimens recorded from the Indian Ocean by Shcherbachev (1987) should be re-examined in this light.

REFERENCE SPECIMENS. — AMS I.17316-008 (1 spec.); K72-07-15. AMS I.17859-002 (2 spec.); K72-06-06. AMS I.17867-008 (2 spec.); K72-07-04. AMS I.18726-020 (1 spec.), AMS I.18726-021 (1 spec.); K75-01-02. AMS I.19860-015 (1 spec.); K76-24-03. AMS I.21722-001 (1 spec.); K79-20-13. AMS I.24054-001 (2 spec.); K83-06-02. AMS I.24101-010 (1 spec.); K83-06-01. AMS I.24645-004 (1 spec.); K84-06-03. AMS I.24991-002 (2 spec.); K84-16-05.

REFERENCES. — Iwamoto (1974); Shcherbachev et al. (1992).

***Kuronezumia leonis* (Barnard, 1925)**
Fig. 93

DISTINGUISHING FEATURES. — D II,9–10; P i19–i26; V 8–10; total GR-1 (outer/inner) 8–11/7–12; scale rows below 1D 17–20; pyloric caeca 14–18. Snout length 27–34% HL, orbit diameter 27–35%, interorbital width 22–30%, height first dorsal fin about 70–90%. Snout bluntly pointed, tipped with an enlarged, buttonlike spiny scute.

SIZE. — To about 50 cm.

FIGURE 93. *Kuronezumia leonis* (Barnard, 1925). AMS I.28071-001. From *Kapala* stn K88-04-09, off Broken Bay, NSW, in 905–969 m.

DISTRIBUTION. — South Atlantic, southern Indian Ocean, Australia (NSW, Vic., Tas., WA), and New Zealand, in depths of around 700–1100 m.

NSW CAPTURES. — Caught on all mid-slope grounds south of Crowdy Head in 730–1180 m. The species was common but never taken in large numbers; it was recorded from 147 *Kapala* stations (61% of trawls deeper than 800 m) with an average of four specimens per tow.

REMARKS. — *Kuronezumia leonis* was taken on three occasions with its congener *K. bubonis*, but that species has a generally shallower depth range and is much less common.

REFERENCE SPECIMENS. — AMS I.18726-017 (1 spec.); K75-01-02. AMS I. 19860-010 (1 spec.); K76-24-03. AMS I.20068-011 (4 spec.); K77-23-13. AMS I.20096-008 (1 spec.); K77-22-06. AMS I.20098-005 (4 spec.), AMS I.20098-017 (1 spec.), AMS I.20098-024 (1 spec.); K77-23-07. AMS I.20099-008 (1 spec.), AMS I.20099-019 (2 spec.); K77-23-12. AMS I.24054-005 (3 spec.), AMS I.24054-011 (1 spec.), AMS I.24054-018 (1 spec.); K83-06-02. AMS I.24056-002 (2 spec.); K83-08-02. AMS I.24060-013 (2 spec.); K83-09-01. AMS I.24157-003 (1 spec.); K83-12-04. AMS I.24356-004 (1 spec.), AMS I.24356-006 (1 spec.); K83-14-05. AMS I.24462-004 (1 spec.); K83-15-02. AMS I.25933-001 (2 spec.), AMS I.25933-003 (4 spec.); K79-20-06. AMS I.27637-003 (1 spec.); K88-14-04. AMS I.28071-001 (1 spec.); K88-04-09.

REFERENCES. — Iwamoto (1986); Shcherbachev et al. (1992); Iwamoto and Williams (1999).

Genus *Lepidorhynchus*

DISTINGUISHING FEATURES. — Branchiostegal rays 6. Anus immediately before anal fin. Head and body laterally compressed, much deeper than wide; head covering thin, somewhat transparent. Snout scarcely or not protruding. Mouth large, premaxillary extends to hind one-third of orbit. Small teeth in narrow band in upper jaw with outer row of widely spaced canines; lower jaw teeth in one row, teeth larger laterally. Scales thin, deciduous, covered with short needlelike spinules, none thickened or enlarged. Spinous dorsal fin ray smooth along leading edge. Light-producing tissue appearing as fine black striations cover broad areas ventrally on trunk forward to isthmus and dorsally onto pectoral girdle to pectoral base, over abdomen, and above anterior part of anal fin; a small naked fossa of light organ adjacent to anus. Color overall silvery; dorsum grayish green; gill membranes, lower jaw, and abdomen black.

REMARKS. — Monotypic. Relationships of the genus are obscure, but there are some resemblances to *Hymenocephalus*, especially in regards to the nature of the luminescent tissue on the body.

REFERENCES. — McCulloch (1926); McCann and McKnight (1980); Gomon et al. (1994).

***Lepidorhynchus denticulatus* Richardson, 1846**
Fig. 94

DISTINGUISHING FEATURES. — 1D II,10–11; P i16–i18; V 8–9; total GR-1 (outer/inner) about 9/16–19. Orbit large, diameter about 30–40% HL, much greater than interorbital space. Chin barbel small.

SIZE. — To about 55 cm.

DISTRIBUTION. — Southern Australia (NSW, Vic., Tas., SA, WA), New Zealand, Kermadec Islands, in depths less than 100 to more than 1000 m, but most frequent at 300–700 m.

NSW CAPTURES. — Probably the most abundant grenadier off NSW. Captured by *Kapala* in 603 trawls on all slope grounds south of the Clarence River (29°40′S) in 230–1080 m, the greatest depth range recorded for any NSW grenadier (apart from some bathyal species). It was most abundant between 300 and 900 m, where it was captured at over 70% of stations. In the 1996–97 survey using nets with 90 mm codend mesh, the species was caught in 117 of 165 tows between 220 and 630 m, and the mean catch was 164 per one-hour tow.

REMARKS. — This species is the most common grenadier off southeastern Australia. Juveniles are found mostly between 200 and 600 m, and adults usually in depths greater than 500 m. Last et al. (1983) reported that off Tasmania it is "frequently caught by the tonne as a large part of the bycatch of trawlers," and it "appears to be an important prey item for the economically important blue grenadier [*Macruronus novaezelandiae*]." Although of no market value at present, the species is frequently used as tuna longline bait.

REFERENCE SPECIMENS. — AMS I.15969-001 (2 spec.); K71-05-06. AMS I.18838-008 (14 spec.); K75-05-03. AMS I. 21724-021 (2 spec.); K79-20-15. AMS I.24619-009 (4 spec.); K88-17-03.

REFERENCES. — McCann and McKnight (1980); McMillan *in* Gomon et al. (1994).

Genus *Lucigadus*

DISTINGUISHING FEATURES. — Branchiostegal rays 7. Anus removed from anal fin, closer to pelvic fin bases. Light organ well developed, two dermal windows, one immediately before anus, the second between bases of pelvic fins. Head smoothly rounded, without sharp or coarsely scaled ridges; snout rounded. Ventral region of body appearing to have swung far forward so that gill membranes

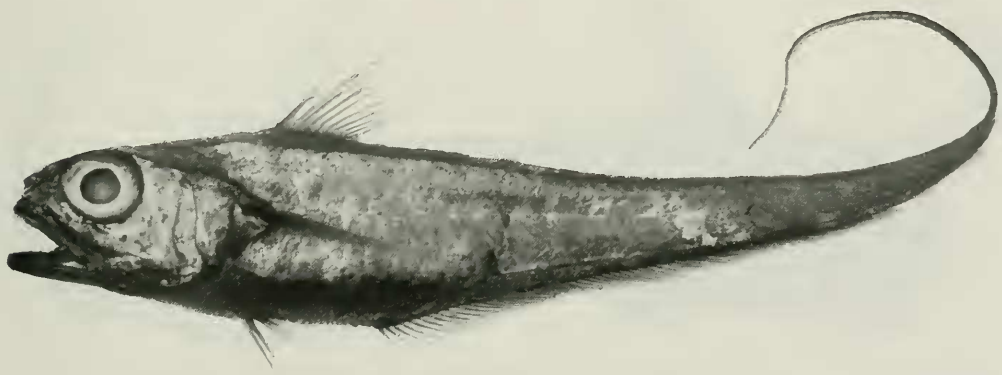

FIGURE 94. *Lepidorhynchus denticulatus* Richardson, 1846. From *Kapala* stn K83-01-08 off Sydney, NSW, in 490–570 m.

unite below orbits, pelvic fin origin below opercle, anal fin origin under first dorsal fin. Suborbital shelf covered with several rows of small scales, no sharp ridge of modified scales. Underside of snout all or mostly scaled. Spinous ray of first dorsal fin serrated along leading edge. Teeth in both jaws small, in tapered bands; premaxillary band not reaching beyond posterior edge of maxillary process. Scale spinules aligned in parallel rows. (From Iwamoto and Merrett 1997.)

REMARKS. — This genus is close to *Ventrifossa* and *Malacocephalus* and was formerly included in the former as a subgenus. The high, bluntly rounded snout, the short trunk with only 10 or 11 trunk vertebrae, the forward position of the ventral parts of the trunk, the shorter band of premaxillary teeth, the characteristic arrangement of spinule rows on the scales, and the frequent presence of scales on the branchiostegal membrane, in combination distinguish members of the genus from those of *Ventrifossa*. *Malacocephalus* species are readily distinguished by the longer jaws beset with larger teeth in fewer, longer rows.

REFERENCES. — Gilbert and Hubbs (1920); Iwamoto and Merrett (1997).

***Lucigadus microlepis* (Günther, 1878)**
Fig. 95

DISTINGUISHING FEATURES. — 1D II,10–12; P i20–i25; V 11–13; total GR-I (outer/inner) 8–10/11–12; scales below 2D 8.5–10.5. Snout length 24–31% HL, interorbital width 25–33%, orbit diameter 32–42%; suborbital width 12–16%; upper jaw length 34–40%; barbel length 18–30%; height 1D 102–128. A prominent black blotch at tip of first dorsal fin; body with banded pattern, the anal fin with distinct black margins under darkly banded areas; few or no scales on branchiostegal and gular membranes.

SIZE. — To about 20 cm.

DISTRIBUTION. — Western South Pacific from Wallis and Futuna islands, Fiji, New Caledonia, Norfolk Ridge, eastern Australia (Qld, NSW), and Arafura and Madura seas. Depth range about 200–700 m.

NSW CAPTURES. — The *Kapala* captured the species at 14 stations (36 specimens) on grounds north of Sydney in the relatively narrow depth range of 410 to 540 m. The small adult size of the species made capture in large-meshed trawls unlikely, and in fact, all records were from stations using prawn trawls. The species was taken from 17% of prawn trawls north of Sydney at 400–600 m depth.

FIGURE 95. *Lucigadus microlepis* (Günther, 1878). AMS I.25932-007. From *Kapala* stn K85-21-06, off Sydney, NSW, in 439–466 m.

The overall low capture rate by *Kapala* suggests that NSW is marginal to its normal tropical distribution.

REMARKS. — *Lucigadus microlepis* is readily distinguished from *L. nigromaculatus* by its banded body pattern, the head peppered with large melanophores, the location of the black dorsal fin blotch (to distal tip, compared to below distal tip in *L. nigromaculatus*), and its somewhat fewer pelvic fin rays (11–13 cf. 13–15).

REFERENCE SPECIMENS. — AMS I.20435-015 (1 spec.); K78-16-07. AMS I.21725-003 (1 spec.); K80-05-01. AMS I. 23689-002 (1 spec.); K78-17-07. AMS I.24850-002 (7 spec.); K84-15-01. AMS I.25932-007 (1 spec.); K85-21-06. AMS I.26394-001 (2 spec.); K86-01-05. AMS I.26446-008 (2 spec.); K85-17-02. AMS I.26453-004 (1 spec.); K86-10-07. AMS I.26756-005 (1 spec.); K86-10-14. AMS I.26932-004 (1 spec.); K79-15-03.

REFERENCES. — Paxton et al. (1989)(as *Ventrifossa fasciata*); Iwamoto and Merrett (1997); Iwamoto and Williams (1999).

***Lucigadus nigromaculatus* (McCulloch, 1907)**
Fig. 96

DISTINGUISHING FEATURES. — 1D II,10–11; P i18–i22; V 13–15; total GR-I (outer/inner) 9–11/12–16; scales below 2D 10–12. Snout length 25–30% HL, interorbital width 20–26%, orbit diameter 40–47%; suborbital width 12–18%, upper jaw length 39–45%; barbel length 18–26%; height 1D 101–134%. A prominent black blotch across anterior half to two-thirds of first dorsal fin; anterior margin of anal fin blackish. Scale patches present on lowermost branchiostegal rays.

SIZE. — To about 35 cm.

DISTRIBUTION. — Southeastern Australia (southern Qld, NSW, Vic., Tas.), New Zealand, and off Chile. Depth range about 200–1460 m, but most often taken at 400–800 m.

NSW CAPTURES. — Recorded from 222 *Kapala* stations along the entire NSW coast in depths between 380 and 850 m. In the 1996–97 survey, *L. nigromaculatus* was caught in 70% of tows in 440–630 m, with a mean catch of 15 per one-hour tow; most trawls took less than 20 specimens, but 150 were caught in a single tow in 500 m off Ulladulla.

REMARKS. — This species is captured frequently throughout its normal distribution range but seldom in great abundance. Mesh size may be a factor in its reported low abundance in commercial trawls, as the species is relatively small as an adult.

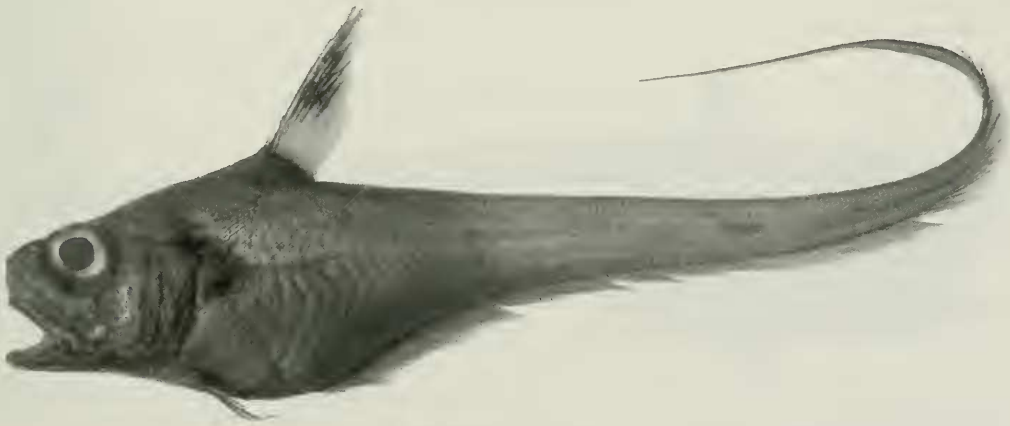

FIGURE 96. *Lucigadus nigromaculatus* McCulloch, 1907. From *Kapala* stn K84-18-03, off Nowra, NSW, in 732–750 m.

REFERENCE SPECIMENS. — AMS I.15974-008 (4 spec.); K71-08-03. AMS I.15975-032 (4 spec.); K71-08-05. AMS I.15987-001 (4 spec.); K71-11-09. AMS I.15995-011 (2 spec.); K71-13-06. AMS I.16577-009 (1 spec.); K72-04-02. AMS I.18838-035 (1 spec.); K75-05-03. AMS I.18839-005 (23 spec.), AMS I.18839-012 (4 spec.); K75-05-04. AMS I.19076-003 (1 spec.); K75-05-08. AMS I.19198-003 (3 spec.); K76-05-04. AMS I.20118-003 (2 spec.); K77-13-10. AMS I.20484-004 (3 spec.); K77-21-01. AMS I.21669-007 (1 spec.); K77-16-16. AMS I.21806-005 (2 spec.); K77-07-10. AMS I.24851-004 (1 spec.); K84-17-03. AMS I.24852-003 (1 spec.); K84-15-03. AMS I.26002-001 (1 spec.); K86-01-06. AMS I.26245-013 (1 spec.); K86-01-07.

REFERENCES. — Paxton et al. (1989)(as *Ventrifossa nigromaculata*); McMillan *in* Gomon et al. (1994).

Genus *Malacocephalus*

DISTINGUISHING FEATURES. — Branchiostegal rays 7. Anus removed from anal fin, closer to pelvic fin bases. Head laterally compressed; snout rounded, without coarse, thickened scales. Head surfaces uniformly scaled, no sharp ridge of modified scales, no naked areas; branchiostegal rays scaled. Spinous ray of first dorsal fin smooth or serrated along leading edge. Light organ well developed, two dermal windows, one immediately before anus, the second (large and somewhat bean-shaped) between bases of pelvic fins. Teeth in upper jaw in two rows to narrow band, outer series enlarged; lower jaw with a single row of wide-spaced, enlarged, canine-like teeth. Scales of body densely covered with small fine scales giving velvety surface. Pyloric caeca numerous, 50–100. Color light gray to swarthy, often with silvery flanks.

REMARKS. — There are seven named species, but the number of valid species is uncertain. Three Pacific species (*M. hawaiiensis, M. luzonensis, M. nipponensis*) are so closely similar to *M. laevis* that the four may eventually prove to be the same, in which case *M. laevis* has priority as the oldest name.

REFERENCES. — Iwamoto (1990); Sazonov and Iwamoto (1992).

Malacocephalus laevis (Lowe, 1843)

Fig. 97

DISTINGUISHING FEATURES. — 1D II,9–13; P i15–i21 (usually i17–i19); V 9; total GR-I (outer/inner) 0–8–11/11–14; scales below 2D 8.5–11.5. Snout length 26–31% HL, interorbital width 28–33%, orbit diameter 30–37%; suborbital width 10–13%, upper jaw length 44–50%; barbel length

FIGURE 97. *Malacocephalus laevis* (Lowe, 1843). From *Kapala* stn K83-01-08, off Sydney, NSW, in 490–570 m.

16–23%; height 1D about 60–70%. Two rows of teeth in upper jaw. Spinous ray of first dorsal fin smooth.

SIZE. — To more than 65 cm.

DISTRIBUTION. — Widespread in tropical to temperate waters throughout Atlantic and Indian oceans, and probably into Pacific (but greatly restricted in eastern Pacific). Depths approximately 200–1000 m, but most commonly in about 300–700 m. Known off Australia (Qld, NSW, ne. Vic., WA).

NSW CAPTURES. — Captured by *Kapala* on all grounds between the Qld-NSW border and Batemans Bay (35°42′S); single specimens were also caught in three trawls off ne. Vic. (37°37′–38°02′S). All stations but two were in 330–800 m; the two other records were in 1030–1080 m. Regularly taken in moderate numbers on the upper slope off NSW. *Malacocephalus laevis* was recorded 290 times by the *Kapala*; north of Jervis Bay, it was present in 78% of all trawls in 400–800m. Overall, the average catch was about 10 specimens per trawl, although some tows caught in excess of 100.

REMARKS. — *Malacocephalus laevis* is a well-known, apparently worldwide species with a mainly tropical and subtropical distribution. It appears to be found only in relatively warm waters around Australia. Off NSW few were caught south of 35°00′S, and it appears to be absent in Tasmanian and most of southern Australian waters. Off WA the species is reported from the western Great Australian Bight off Eucla (128°E) and to the north off Shark Bay.

REFERENCE SPECIMENS. — AMS I.15970-009 (1 spec.); K71-06-04. AMS I.15973-009 (1 spec.); K71-07-03. AMS I.18838-036 (6 spec.); K75-05-03. AMS I.18839-008 (6 spec.), AMS I.18839-023 (4 spec.); K75-05-04. AMS I.19085-001 (1 spec.); K75-07-03. AMS I.20099-004 (1 spec.); K77-23-12. AMS I.20118-032 (2 spec.); K77-13-10. AMS I.20459-029 (2 spec.); K78-17-10. AMS I.28189-003 (1 spec.); K87-24-03. AMS I.29812-003 (1 spec.); K89-15-02.

REFERENCES. — Last et al. (1983); McMillan *in* Gomon et al. (1994); Iwamoto and Merrett (1997); Iwamoto and Williams (1999).

Genus *Mataeocephalus*

DISTINGUISHING FEATURES. — Branchiostegal rays 6 or 7. Snout relatively long, somewhat flattened, tipped with two tubercular scales; a series of coarse, modified scales along, and a naked groove dorsally on each side behind, the leading edge. Mouth small, inferior, upper jaw length less than one-third of HL. Outer gill rakers on first arch 0–5. Spinous ray of first dorsal fin slightly prolonged, serrated along leading edge. Teeth on premaxillary in broad, short, truncated to slightly tapered band. Periproct far removed from origin of anal fin. Scale spinules short, needlelike to lanceolate, in numerous, more-or-less parallel rows.

REMARKS. — Two species in NSW, including an undescribed species that is problematically placed in *Mataeocephalus*. The genus is in need of revision and the characters in the generic diagnosis apply only to the two NSW species. Species of the genus are usually caught in more tropical waters. It is likely that central NSW is at the southern end of their normal distribution, as the two NSW species (six specimens in total) were caught north of Newcastle. The small size of the two species also makes capture by commercial-sized trawls difficult.

REFERENCES. — Iwamoto (1990); Iwamoto and Merrett (1997).

KEY TO THE SPECIES OF *MATAEOCEPHALUS* FROM NEW SOUTH WALES

1a. Underside of snout mostly scaled; pelvic fin rays 7 (rarely 8); teeth in broadly tapered bands extending at least to middle of jaws; branchiostegal rays 6 . . . . . *Mataeocephalus* sp.

1b. Underside of snout almost entirely naked; pelvic fin rays 8–9; teeth in broad, short bands confined to front of mouth; branchiostegal rays 7 . . . . . *M. acipenserinus*

FIGURE 98. *Mataeocephalus acipenserinus* (Gilbert and Cramer, 1897). AMS I.29753-009. From *Kapala* stn K89-17-06, east of Crowdy Head, NSW, in 878–933 m.

Mataeocephalus acipenserinus (Gilbert and Cramer, 1897)
Fig. 98

DISTINGUISHING FEATURES. — 1D II,8–10, spinous ray of 1D serrated along leading edge; P i19–i25; V 8–9; total inner GR-I 6–8; scales below 2D 8–9, lat.l. about 40–42; pyloric caeca 13–19; branchiostegal rays 7. Snout long, prominently protruding, length 39–44% HL; orbit diameter 29–34%; interorbital width 20–23%; mouth small, inferior, upper jaw length 20–28%; height 1D 50–63%. Underside of head naked except along front edge of snout; body scales with 4–6 parallel rows of short conical spinules. Periproct oval to pear-shaped, situated midway between pelvic fin and anal fin; small fossa of light organ anterior to anus. Overall color swarthy to pale brownish, darker (bluish to violet) over abdomen; fins blackish to dusky.

SIZE. — To about 25 cm.

DISTRIBUTION. — Widespread in Pacific and Indian oceans, including Australia (NSW, WA), in depths of about 600–900 m.

NSW CAPTURES. — Captured twice (five specimens) near Crowdy Head at somewhat greater depths (823–933 m) than previously reported for the species.

REMARKS. — See Sazonov and Iwamoto (1992) for a detailed description and discussion of related taxa.

REFERENCE SPECIMENS. — AMS I.29753-009 (4 spec.); K89-17-06. AMS I.30304-007 (1 spec.); K89-17-09.

REFERENCES. — Sazonov and Iwamoto (1992); Iwamoto and Merrett (1997).

Mataeocephalus sp.
Fig. 99

DISTINGUISHING FEATURES. — 1D II,8–10; i17–i20; V 7 (rarely 6); total inner GR-I 7–8; scales below 2D 5.5–7.5, lat.l. 31–35; pyloric caeca 16–18; branchiostegal rays 6. Snout of moderate length, protruding, 32–36% HL; orbit diameter 24–29%; interorbital width 21–24%; mouth small, inferior, upper jaw length 26–29%; height 1D 94–114%. Underside of head mostly scaled except for naked median swath under snout; body scales covered with dense rows of lanceolate spinules. Periproct small, anus closer to pelvic fin insertions than to anal fin origin. Few or no denticulations on spinous ray of first dorsal fin.

SIZE. — To at least 21 cm.

FIGURE 99. *Mataeocephalus* sp. AMS I.29804-002. From *Kapala* stn K89-09-01, off Newcastle, NSW, in 896–960 m.

DISTRIBUTION. — Southwestern Pacific off New Caledonia and adjacent waters, and Australia (Qld, NSW, WA), in depths of about 400 to almost 1000 m.

NSW CAPTURES. — Captured only once by *Kapala*, off Newcastle in 896–960 m.

REMARKS. — The six branchiostegal rays in this species set it apart from all other members of this tribe (Malacocephalini). This species probably should be included in the genus *Hyomacrurus* Gilbert and Hubbs, 1920. It awaits description by our Russian colleagues, Y. I. Sazonov and Y. N. Shcherbachev.

REFERENCE SPECIMEN: AMS I.29804-002 (1 spec.); K89-09-01.

REFERENCES. — Iwamoto and Merrett (1997); Iwamoto and Williams (1999)

Genus *Mesobius*

DISTINGUISHING FEATURES. — Branchiostegal rays 7. Anus situated in a broad oval periproct area immediately anterior to anal fin. Body relatively deep, laterally compressed. Head smoothly rounded, much deeper than wide, entirely covered with elongated scales with spinules aligned in 1–3 discrete longitudinal rows giving striated appearance to surface. Snout broadly rounded in lateral view; no stout or sharp ridges on head. Chin barbel absent. Overall color of body and fins black, tail somewhat paler.

REMARKS. — Two species, each sometimes taken in bathypelagic waters; only one species known from NSW.

REFERENCES. — Hubbs and Iwamoto (1977); Arai (1979); Shcherbachev et al. (1979).

Mesobius antipodum Hubbs and Iwamoto, 1977

Fig. 100

DISTINGUISHING FEATURES. — 1D II,9–10; P i13–i14; V 6–7; total GR-I (outer/inner) 7–10/13, GR-II 13–14/12–16; scales below 2D 9.5–10.5. Snout length 30–31% HL; orbit diameter 26–30%; interorbital width 33–34%; suborbital width 14–16%; postorbital length 48–49%; upper jaw length 44–47%. Posttemporal region extending posterior to vertical through origin of pectoral fin base.

SIZE. — To 67 cm.

DISTRIBUTION. — Southern hemisphere, from South Atlantic off South Africa, through southern part of Indian Ocean, southern coast of Australia (NSW, Vic., Tas., WA), to New Zealand, in 700–1300 m.

NSW CAPTURES. — Caught by *Kapala* on all mid-slope grounds south of Crowdy Head in 720–1200 m. Relatively common. *Mesobius antipodum* was recorded from 168 *Kapala* stations (including 69% of all trawls deeper than 800 m). The average catch was about eight specimens, although many trawls yielded more than 25 specimens.

FIGURE 100. *Mesobius antipodum* Hubbs and Iwamoto, 1977. AMS I.25095-007. From *Kapala* stn K84-20-05, off Broken Bay, NSW, in 1170–1207 m.

REMARKS. — Shcherbachev et al. (1979) recorded *Mesobius berryi* Hubbs and Iwamoto, 1977, the only congener of *M. antipodum*, from the Indian Ocean but not from off Australia. Those authors provided a good comparison of the two species. Recently, Iwamoto and Williams (1999) reported one specimen of *M. berryi* collected west of Cape Freycinet, Western Australia, in 1225–1240 m.

REFERENCE SPECIMENS. — AMS I.20068-028 (1 spec.); K77-23-13. AMS I.20098-004 (1 spec.); K77-23-07. AMS I.20485-003 (3 spec.); K77-23-06. AMS 25095-007 (1 spec.); K84-20-05. AMS I.25290-011 (4 spec.); K84-20-03. AMS I.25933-002 (1 spec.); K79-20-06.

REFERENCES. — McMillan *in* Gomon et al. (1994); Iwamoto and Williams (1999).

Genus *Nezumia*

DISTINGUISHING FEATURES. — Branchiostegal rays 7. Snout pointed, slightly to extensively protruding, tipped with paired, sometimes joined, thick tubercular scales. Chin barbel well developed. Spinous ray of first dorsal fin serrated along leading edge. Anus closer to pelvic fin insertions than to anal fin origin; periproct teardrop-shaped, a narrow connection to small dermal window of light organ situated between pelvic fins. Underside of snout usually with naked area; suborbital shelf formed of two rows of stout, coarsely modified scales. Teeth small, in band in both jaws, teeth in premaxillary not reaching beyond posterior edge of maxillary process. Pyloric caeca usually not branched with fewer than about 30 distal tips.

REMARKS. — More than 40 species known, but only four were found in NSW waters. In contrast, seven were recorded from Western Australia by Iwamoto and Williams (1999). Several species previously classified under *Nezumia* (e.g., Iwamoto 1990) have been subsequently removed to other genera, especially *Kumba* and *Kuronezumia*.

REFERENCES. — Iwamoto (1990); Iwamoto and Merrett (1997); Iwamoto and Williams (1999).

KEY TO THE SPECIES OF *NEZUMIA* FROM NEW SOUTH WALES

1a. Pelvic fin rays 13–17; first dorsal fin pale or lightly dusky with a prominent black tip . . . . . *N. propinqua*
1b. Pelvic fin rays 9–12; first dorsal fin dusky to black, without a prominent black tip. 2

2a. Dermal window of light organ about on line with pelvic fin insertions (Fig. 101a); dorsum rather uniformly pigmented, although area above abdomen often slightly darker · *N. coheni*

2b. Dermal window of light organ well posterior to line connecting pelvic fin insertions (Fig. 101b); dorsal aspects of trunk darker than comparable areas on tail, forming complete dark band around trunk · · · · · · · · · · · 3

3a. Pelvic fin rays 9–10; sensory pores on underside of head prominent · · · · · · · · · · · · · · · · · · *N. namatahi*

3b. Pelvic fin rays 11–12; sensory pores on underside of head small · · · · · · · · · · · · · · · · · · · *N. kapala*

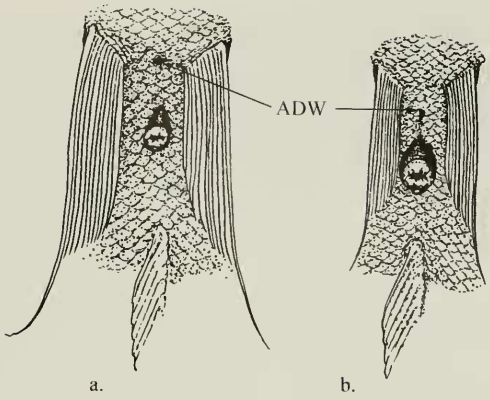

FIGURE 101. Ventral view of belly of *Nezumia* spp. showing position of anterior dermal window (ADW) of light organ in (a) *N. coheni* and (b) *N. namatahi.*

Nezumia coheni Iwamoto and Merrett, 1997
Fig. 102

DISTINGUISHING FEATURES. — 1D II,9–10; i20–i22; V 11 (rarely 10 or 12); total GR-I (outer/inner) 6–9/9–11, GR-II 8–10/10–11; scales below 1D 7–10, below 2D 7.0–8.5, lat.l. 34–40. Snout moderately protruding, length 30–34% HL; orbit diameter 29–34%; interorbital width 20–26%; distance orbit to angle of preopercle 38–44%; postorbital length 39–45%; upper jaw length 30–34%; height 1D about 80–95%. Underside of head mostly scaled except for naked median swath under snout; body scales covered with dense rows of lanceolate spinules. Periproct small, anus closer to pelvic fin insertion than to anal fin origin; ADW about on line connecting insertions of pelvic fins. Dark band encircling trunk faint or lacking.

SIZE. — To more than 40 cm.

DISTRIBUTION. — Australia (NSW, Vic., SA), New Caledonia, and the Kermadec Is., in 710–1032 m.

NSW CAPTURES. — Recorded from 60 *Kapala* stations on all mid-slope grounds south of Crowdy Head in 850–1200 m. *Nezumia coheni* was rare in catches south of Sydney, but two specimens taken at one station in 1050 m off Gabo Island (37°40′S). Between Crowdy Head and Sydney, the species was present in more than 40% of all trawls deeper than 900 m, with up to nine specimens per trawl.

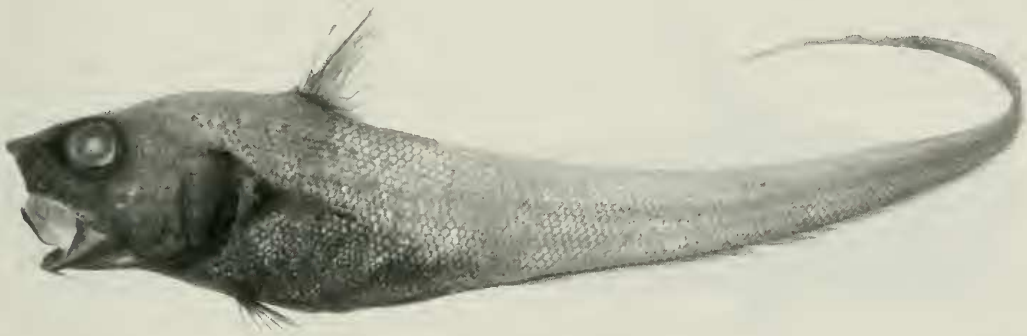

FIGURE 102. *Nezumia coheni* Iwamoto and Merrett, 1997. AMS I.24181-003. From *Kapala* stn K83-13-02, east of Newcastle, NSW, in 960–988 m.

REMARKS. — On first inspection, *N. coheni* can easily be confused with the closely similar *N. kapala* and *N. namatahi,* but those species have a prominent dark band completely encircling the trunk. *Nezumia namatahi* has 9 or 10 pelvic fin rays, in contrast to the predominantly 11 of *N. coheni,* and the anterior dermal window is well posterior to a line connecting the insertions of the pelvic fins. *Nezumia kapala* has a somewhat shorter orbit to angle of preopercle distance (34–39% HL) than does *N. coheni,* and its anterior dermal window is about on or (usually) well posterior to a line connecting the insertions of the pelvic fins. All three species were captured together in a number of *Kapala* trawls; of the 60 stations with *N. coheni*, 44 also contained *N. kapala* and/or *N. namatahi.*

REFERENCE SPECIMENS. — AMS I.21724-026 (2 paratypes); K79-20-15. AMS I.24057-007 (2 spec.) and AMS I.24057-008 (2 spec.); K83-09-04. AMS I.24173-006 (1 paratype); K83-14-06. AMS I.24181-003 (1 spec.); K83-13-02. AMS I.24355-005 (1 spec.); K83-18-02. AMS I.24357-002 (2 spec.); K83-18-01. AMS I.24993-007 (4 paratypes); K84-16-14. AMS I.25127-002 (1 paratype); K84-18-03. AMS I.25264-003 (3 paratypes); K84-19-04. AMS I.25266-000 (2 spec.); K84-22-02. AMS I.25290-006 (1 spec.); K84-20-03. AMS I.26247-005 (6 spec.); K85-21-04. AMS I.29340-007 (4 paratypes); K89-13-02. AMS I.29741-004 (1 paratype); K87-25-06. AMS I.29754-002 (1 paratype); K89-17-03. AMS I.29761-004 (1 spec.); K89-19-02. AMS I.29823-013 (2 paratypes); K89-13-01. AMS I.29827-003 (4 spec.); K89-15-01.

REFERENCES. — Iwamoto and Merrett (1997); Iwamoto and Williams (1999).

***Nezumia kapala* Iwamoto and Williams, 1999**
Fig. 103

DISTINGUISHING FEATURES. — 1D II,8–11; i18–i22; V 11–12; total GR-I (outer/inner) 6–9/8–10, GR-II 8–9/8–11; scales below 1D 8–12, below 2D 7.5–9.5, lat.l. 33–38. Snout moderately protruding, length 27–34% HL; orbit diameter 29–33%; interorbital width 18–25%; distance orbit to angle of preopercle 34–39%; postorbital length 40–45%; upper jaw length 26–31%; height 1D about 86–109%. Underside of head mostly scaled except for naked median swath under snout; body scales covered with dense rows of lanceolate spinules. Periproct small, anus closer to pelvic fin insertions than to anal fin origin; anterior dermal window about on, or usually well behind, line connecting insertions of pelvic fins. A prominent dark band encircling trunk.

SIZE. — To about 41 cm.

FIGURE 103. *Nezumia kapala* Iwamoto and Williams, 1999. AMS I.24178-003. From *Kapala* stn K83-14-08, off Broken Bay, NSW, in 978–1006 m.

DISTRIBUTION. — Australia (NSW, Tas., WA) in 842–1243 m. Can be expected off Vic. and SA.

NSW CAPTURES. — *Nezumia kapala* was not distinguished from *N. namatahi* in *Kapala* field records. Based on 15 AMS registrations, *N. kapala* was caught by *Kapala* between 32°01′S (Crowdy Head) and 35°30′S (se. of Ulladulla) in 930–1100 m. Either or both species were caught in 135 *Kapala* stations between Crowdy Head and Gabo Island; most catches were between 4 and 8 specimens.

REMARKS. — *Nezumia kapala* and *N. namatahi* are very similar in overall appearance, and as they are often caught together, they are susceptible to being confused with one another. The pelvic ray counts, however, readily distinguish the species (11 or 12 in *N. kapala*, 9 or 10 in *N. namatahi*). *Nezumia namatahi* also has more broadly lanceolate to shield-shaped scale spinules and larger sensory pores under the head. Specimens of *N. namatahi* and *N. kapala* in AMS were collected without knowledge of their distinction. Subsequently, both species were found together in five of the stations represented in the collection. This suggests that there is a high probability that both species, recorded as "*N. namatahi*," were present in a significant proportion of the 135 *Kapala* stations

REFERENCE SPECIMENS. — AMS 21724-005 (1 paratype); K79-20-15. AMS I.24057-001 (4 paratypes); K83-09-04. AMS I.24059-006 (4 paratypes), AMS I.24059-021 (2 spec.); K83-09-02. AMS I.24060-023 (1 paratype); K83-09-01. CAS 200228, formerly AMS I.24150-006 (1 paratype); K83-13-01. AMS I.24173-009 (1 spec.); AMS I.24173-010 (1 spec.); AMS I.24173-012 (1 spec.); K83-14-06. AMS I.24178-003 (1 spec.); K83-14-08. AMS I.24993-008 (holotype), AMS I.24993-010 (1 paratype); K84-16-14. AMS I.25127-006 (1 spec.); K84-18-03. AMS I.25264-002 (4 paratypes); K84-19-04. AMS I.25266-008 (2 paratypes); K84-22-02. AMS I.29741-005 (1 spec.); K87-25-06. AMS I.29754-007 (1 spec.); K89-17-03. AMS I.29761-002 (1 spec.); K89-19-02. AMS I.29797-006 (2 spec.); K89-12-05. AMS I.29827-004 (3 spec.); K89-15-01.

REFERENCES. — McMillan *in* Gomon et al. 1994; "darknose whiptail," in part; Iwamoto and Williams (1999).

Nezumia namatahi McCann and McKnight, 1980

Fig. 104

DISTINGUISHING FEATURES. — 1D II,9–10, rarely 11; i18–i21; V 9–10, usually 10; total GR-I (outer/inner) 5–8/7–9, GR-II 7–9/8–10; scales below 1D 8–11, usually 9–10, below 2D 7.5–9.5, lat.l. 32–38; pyloric caeca about 21–22. Snout length 29–33% HL; orbit diameter 32–38%; interorbital width 19–24%; distance orbit to angle of preopercle 33–37%; postorbital length 37–43%; upper jaw length 24–30%; barbel length 14–30%; height 1D about 90–121%. Underside of snout broadly naked, sensory pores on head prominent; body scales covered with broadly lanceolate to shield-shaped spinules in parallel to slightly convergent rows. Periproct small, anus closer to pelvic fin insertions than to anal fin origin; ADW usually well behind line connecting insertions of pelvic fins. A prominent dark band encircling trunk.

SIZE. — To at least 36 cm.

DISTRIBUTION. — Australia (NSW, Tas., Vic.?, to 138°E in SA) and New Zealand, in 700–1170 m.

NSW CAPTURES. — Based on 10 AMS registrations, the species was caught between 32°28′S (ne. of Port Stephens) and 34°55′S (Jervis Bay) in 730–1150 m. (See NSW Captures section for *N. kapala* for discussion of both species.)

REMARKS. — *Nezumia toi* McCann and McKnight, 1980 is a synonym of this species and was based on an immature specimen in rather poor condition. (See Remarks section for *N. kapala* for discussion of both species.)

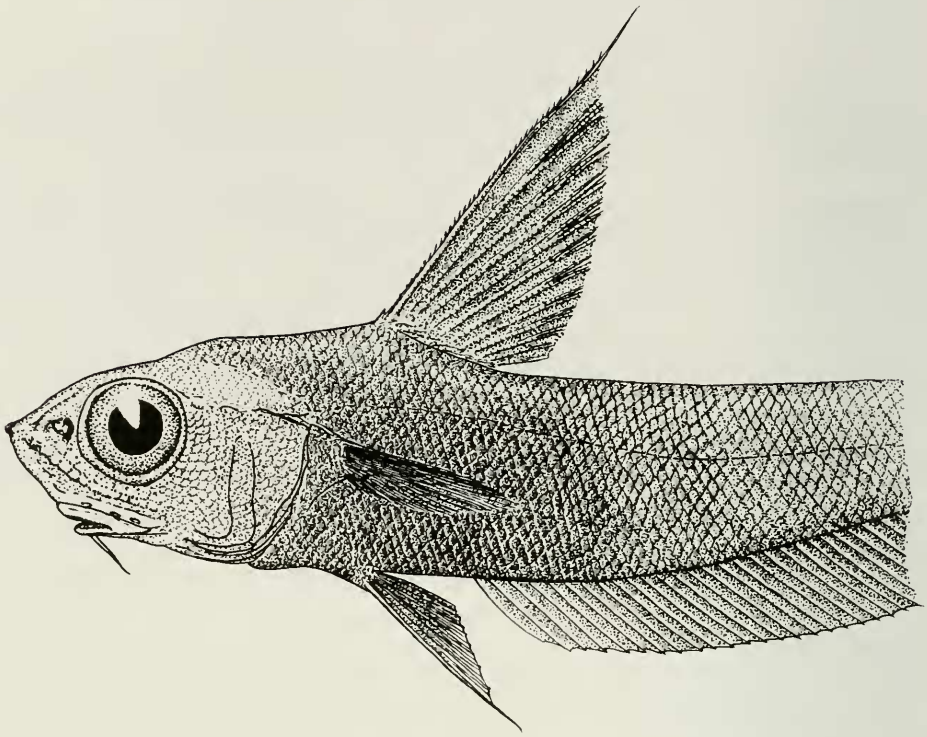

FIGURE 104. *Nezumia namatahi* McCann and McKnight, 1980.

REFERENCE SPECIMENS. — AMS 21724-002 (3 spec.); K79-20-15. AMS I.23460-001 (1 spec.); stn NZOI U-222; ne. of Newcastle, 32°49′S, 152°49′E; 1040-1075 m; 9 Oct. 1982. AMS I.24057-009 (1 spec.); K83-09-04. AMS I.24059-010 (1 spec.), AMS I.24059-022 (1 spec.); K83-09-02. AMS I.24060-017 (1 spec.); K83-09-01. AMS I.24980-004 (3 spec.); K84-16-15. AMS I. 25290-010 (1 spec.); K84-20-03. AMS I.29340—006 (2 spec.); K89-13-02. AMS I.29754-005 (1 spec.); K89-17-03. AMS I.29823-014 (1 spec.); K89-13-01.

REFERENCES. — McCann and McKnight (1980); Iwamoto and Williams (1999).

***Nezumia propinqua* (Gilbert and Cramer, 1897)**
Fig. 105

DISTINGUISHING FEATURES. — 1D II,10–12; i19–i22; V 13–17; total GR-I (outer/inner) 8–10/8–10, GR-II 7–9/9–10; scales below 1D 10–13, below 2D 8.5–10, lat.l. 36–42; pyloric caeca about 21–28. Snout length 29–34% HL; orbit diameter 30–34%; interorbital width 20–25%; distance orbit to angle of preopercle 30–39%; postorbital length 41–45%; upper jaw length 31–35%; barbel length 15–23%; height 1D about 97–113%. Underside of snout, suborbital, and lower jaw naked, sensory pores on naked areas small but prominent; body scales covered with spinules in 10–12 parallel to slightly convergent rows. Periproct large, situated about midway between pelvic fin insertions and anal fin origin; ADW slightly in advance of line connecting insertions of pelvic fins. First dorsal fin with prominent black tip; no dark band encircling trunk. (After Iwamoto and Williams 1999.)

SIZE. — To about 25 cm.

FIGURE 105. *Nezumia propinqua* (Gilbert and Cramer, 1897). AMS I.27722-002. From *Kapala* stn K88-08-09, east of Newcastle, NSW, in 704–750 m.

DISTRIBUTION. — Widespread in tropical waters of Pacific and Indian oceans, including Australia (Qld, NSW, WA). Capture depths about 400–1100 m.

NSW CAPTURES. — Recorded from 43 mid-slope stations (85 specimens) between Crowdy Head and Batemans Bay in 660–1100 m. Most captures were north of Sydney in 800–900 m; 38 of the 43 stations were with small-meshed nets, suggesting that the small *N. propinqua* was seldom retained in the larger-meshed trawls.

REMARKS. — There is some uncertainty as to the status of this and two closely similar species, *N. condylura* (Jordan and Gilbert, 1904) and *N. evides* (Gilbert and Hubbs, 1920). Iwamoto and Williams (1999) and Sazonov and Iwamoto (1992) briefly discuss the problems.

REFERENCE SPECIMENS. — AMS I.19859-009 (3 spec.); K76-24-04. AMS I.19860-018 (8 spec.); K76-24-03. AMS I.20484-003 (1 spec.); K77-21-01. AMS I.20485-005 (1 spec.); K77-23-06. AMS I.23710-002 (1 spec.); K79-20-04. AMS I.24037-005 (1 spec.); K78-26-16. AMS I.24613-003 (2 spec.); K75-05-05. AMS I.24979-001 (2 spec.); K84-16-04. AMS I.24980-002 (5 spec.); K84-16-15. AMS I.24981-001 (1 spec.); K84-17-04. AMS I.24989-002 (1 spec.); K84-17-01. AMS I.24990-002 (1 spec.); K84-16-13. AMS I.26000-003 (1 spec.); K86-01-08. AMS I.26002-003 (1 spec.); K86-01-06. AMS I.26245-014 (1 spec.); K86-01-07. AMS I.27722-002 (1 spec.); K88-08-09. AMS I.29591-002 (1 spec.); K88-12-03. AMS I.29601-002 (1 spec.); K88-08-08. AMS I.29743-001 (2 spec.); K89-20-01. AMS I.29749-001 (1 spec.); K89-17-02. AMS I.29753-004 (1 spec.); K89-17-06. AMS I.29754-006 (1 spec.); K89-17-03. AMS I.29757-001 (3 spec.); K89-15-03. AMS I.29762-006 (1 spec.); K89-12-03. AMS I.29797-007 (2 spec.); K89-12-05. AMS I.29803-002 (1 spec.); K89-07-01. AMS I.29805-002 (1 spec.); K87-24-04. AMS I.29811-004 (1 spec.); K89-08-01. AMS I.29823-004 (5 spec.); K89-13-01. AMS I.30304-002 (1 spec.); K89-17-09.

REFERENCE. — Sazonov and Iwamoto (1992); Iwamoto and Merrett (1997); Iwamoto and Williams (1999).

Genus *Odontomacrurus*

DISTINGUISHING FEATURES. — Branchiostegal rays 6. Long spinous ray of first dorsal fin smooth along leading edge. Mouth large, jaws armed with fanglike teeth in one row. Chin barbel absent. Anus midway between pelvic fin insertions and anal fin origin, preceded by a small fossa of light organ. Large, prominent sensory pores on head. Lateral line in two parts, anterior section short, dorsolateral, ending below hind margin of first dorsal fin.Swim bladder very small. Color overall black to swarthy.

REMARKS. — One widespread bathypelagic species. Known only from tropical and subtropical waters.

REFERENCES. — Norman (1939); Marshall (1964).

***Odontomacrurus murrayi* Norman, 1939**
Fig. 106

DISTINGUISHING FEATURES. — As for genus.

SIZE. — To about 55 cm.

DISTRIBUTION. — Widely distributed in Atlantic and Indian oceans; in western Pacific previously recorded only from South China Sea, but now known from off southeastern Australia (NSW, Tas.).

NSW CAPTURES. — Specimens were caught by *Kapala* in each of four midwater trawl stations between Port Stephens and Wollongong. Capture depths were 0–900 m in oceanic waters deeper than 2000 m.

REMARKS. — This species and *Cynomacrurus piriei* are among the few strictly bathypelagic species of grenadier. *Cynomacrurus* differs in having the anus immediately before the anal fin and a posterior midlateral section of the lateral line, and in lacking an abdominal fossa of the light organ. *Odontomacrurus murrayi* is a broadly distributed species but rarely captured, probably because large midwater trawls are seldom towed in oceanic waters (the *Kapala* specimens were taken when trawling for bathypelagic and mesopelagic fishes for AMS).

REFERENCE SPECIMENS. — AMS I.20064-023 (1 spec.); K77-18-01. AMS I.20314-047 (1 spec.); K77-24-10. AMS I.20315-050 (1 spec.); K77-24-11. AMS I.21369-004 (1 spec.); K79-19-07.

REFERENCES. — Norman (1939); Marshall (1964); Iwamoto (1970).

Genus *Sphagemacrurus*

DISTINGUISHING FEATURES. — Branchiostegal rays 7. Snout blunt, upturned, tip and lateral angles armed with spiny tubercular scales. Mouth cleft moderately to steeply oblique. Chin barbel present. Spinous ray of first dorsal fin serrated along leading edge. Ventral aspects of body shifted forward so that pelvic fin origin usually under opercle, anal fin origin under first dorsal fin, gill membranes united under preopercle. Broad, naked periproct region abutting anal fin origin; small fossa of light organ between pelvic fins but well posterior to pelvic fin base. Underside of snout variously naked; sub-

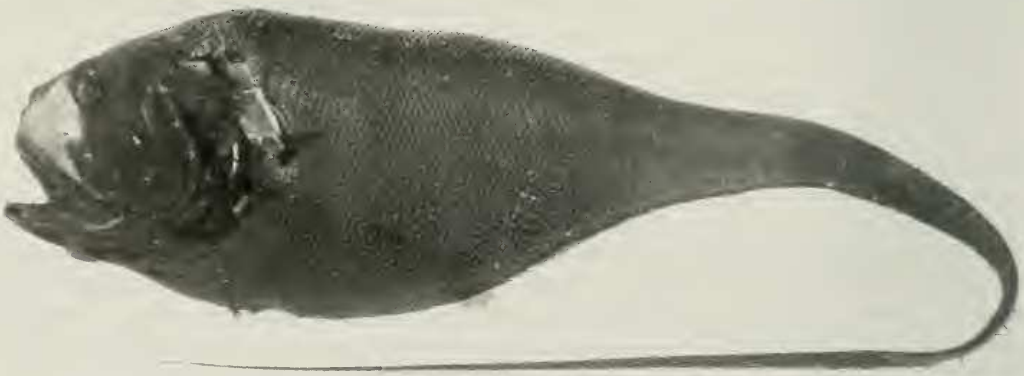

FIGURE 106. *Odontomacrurus murrayi* Norman, 1939. AMS I.20064-023. From *Kapala* stn K77-18-01, midwater trawl in 0–900 m, 42 n. mi. ese. of Sydney, NSW.

orbital shelf formed by two rows of stout, coarsely modified scales. Body scales covered with several rows of short, slender, conical spinules in parallel to slightly divergent rows. Teeth small, in narrow to moderately wide band in both jaws, teeth in premaxillary not reaching beyond posterior edge of maxillary process. Pyloric caeca usually less than 30.

REMARKS. — Six species recognized, but only one presently known from NSW. *Sphagemacrurus pumiliceps* (Alcock, 1894) could be expected, as the species is known from Qld, WA, New Caledonia, and other areas in the Indian and Pacific oceans.

REFERENCES. — Weber and de Beaufort (1929); Iwamoto (1990); Iwamoto and Williams (1999).

***Sphagemacrurus richardi* (Weber, 1913)**
Fig. 107

DISTINGUISHING FEATURES. — 1D II,9–11; i17–i20; V 8–11; total GR-I (outer/inner) 9–12/11–13, GR-II 9–11/11–13; scales below 1D 11–14, below 2D 8.5–9.5, lat.l. 37–43; pyloric caeca about 10. Snout length 30–37% HL; internasal width 28–33%; interorbital width 28–32%; orbit diameter 31–36%; distance orbit to angle of preopercle 39–44%; postorbital length 36–41%; upper jaw length 35–40%; barbel length 13–16%; height 1D about 85–100%; distance outer pelvic ray to anal fin origin about 30–40%. Body scales covered with short, fine spinules in 7–9 parallel rows. Periproct large, immediately before anal fin origin and spanning about half distance to pelvic fin insertion; ADW extending forward from periproct. Head relatively pale along sides, eye ring prominent; trunk and tail darker; abdomen and chest dark with violet hue; first dorsal, pectoral, and anal fins dusky, pelvic fin blackish.

SIZE. — To about 23 cm.

DISTRIBUTION. — Indonesia and Australia (NSW).

NSW CAPTURES. — Uncommon in *Kapala* catches; caught on 18 occasions (56 specimens) north of Sydney at 880–1100 m depth. A species of small adult size, most were caught in trawls with small-meshed codends and were probably more abundant than their capture rate suggests.

REMARKS. — The species appears to be closely similar to *S. decimalis* (Gilbert and Hubbs, 1920) from the Philippines, but that species has a lower gill raker count (about 7 on lower limb of first arch). *Sphagemacrurus pumiliceps* (Alcock, 1894) has somewhat higher pelvic fin ray counts (11–14), a longer barbel (16–22% HL), and narrower interorbital (23–26% HL).

REFERENCE SPECIMENS. — AMS I.26000-002 (1 spec.); K86-01-08. AMS I.26247-001 (1 spec.); K85-21-04. AMS I.27720-001 (1 spec.); K88-08-04. AMS I.27721-001 (3 spec.); K88-08-07. AMS I.28900-001 (3 spec.); K88-17-06. AMS I.28988-002 (5 spec.); K89-09-03. AMS I.29298-001

FIGURE 107. *Sphagemacrurus richardi* (Weber, 1913). AMS I.27721-001. From *Kapala* stn K88-08-07, east of Newcastle, NSW, in 1006–1079 m.

(4 spec.); K88-20-03. AMS I.29605-006 (5 spec.); K89-09-07. AMS I.29750-002 (6 spec.); K89-17-04. AMS I.29753-011 (2 spec.); K89-17-06. AMS I.29799-002 (6 spec.) and I.29799-007 (7 spec.); K89-06-02. AMS I.29809-001 (6 spec.); K88-20-01. AMS I.29823-012 (1 spec.); K89-13-01. AMS I.29827-005 (8 spec.); K89-15-01.

REFERENCES. — Weber (1913); Weber and de Beaufort (1929); Iwamoto (1990).

Genus *Trachonurus*

DISTINGUISHING FEATURES. — Branchiostegal rays 7. Snout rounded, lacking a prominently protruding terminal tubercle. Chin barbel present. Broad, naked black periproct region extending most of (relatively short) distance between pelvic and anal fins. Spinous ray of first dorsal fin flexible, smooth along leading edge. Origin of pelvic fin usually behind pectoral fin base. Head almost fully scaled except for patches or single scales on branchiostegal and gular membranes in some species; suborbital vertical in most, with smoothly rounded contours, lacking sharp or coarsely scaled ridges. Body scales covered with short, conical spinules in somewhat quincunx pattern. Teeth in narrow band in upper jaw with outer series usually somewhat enlarged, teeth in lower jaw in 2 or 3 rows or narrow band. Pyloric caeca usually less than 15. Color overall black or brown or gray.

REMARKS. — At least six species, two of which are recorded from NSW. Iwamoto and Williams (1999) were uncertain as to the identification of one specimen (AMS I.27718-010) from southern NSW off Ulladulla. Its characters did not agree well with the characters of *T. sentipellis* and may represent another species. The key provided below is adapted from Iwamoto and Williams (1999:212), but does not include *T. yiwardaus* Iwamoto and Williams, 1999, a species so far known only from WA and SA.

REFERENCES. — Iwamoto and McMillan (1997); Iwamoto and Merrett (1997); Iwamoto and Williams (1999).

KEY TO THE SPECIES OF *TRACHONURUS* FROM NEW SOUTH WALES

1a. Grooved lateral line present; body scales large, 8 or 9 rows between pelvic fin base and gill cover (Fig. 108a) . . . . . *T. sentipellis*

1b. Grooved lateral line absent; body scales relatively small, 10–14 rows between pelvic fin base and gill cover (Fig. 108b) . . . . . *T. gagates*

Trachonurus gagates Iwamoto and McMillan, 1997

Fig. 109

DISTINGUISHING FEATURES. — Grooved lateral line absent. Chin barbel short, length 4–8% of HL. Scale rows between pelvic fin and gill cover 10–14. Color uniformly black to dark brown.

SIZE. — To about 48 cm.

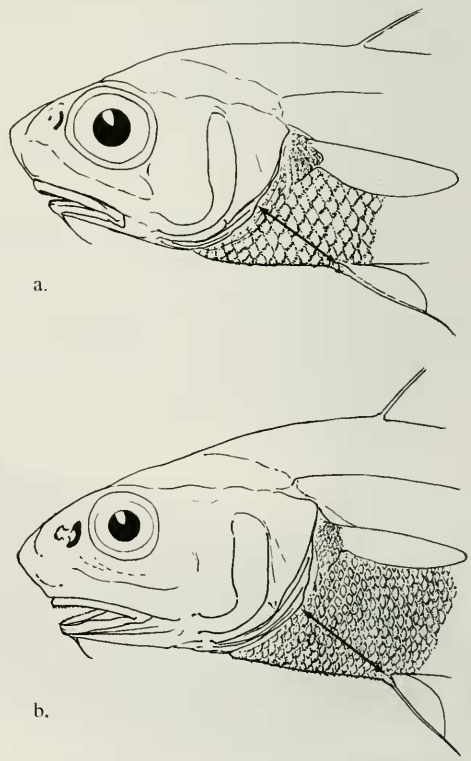

FIGURE 108. Diagrammatic lateral views of *Trachonurus* spp. showing method of counting scale rows between pelvic fin base and gill cover in (a) *T. sentipellis* and (b) *T. gagates*.

FIGURE 109. *Trachonurus gagates* Iwamoto, McMillan, 1997. AMS I.24059-009. From *Kapala* stn K83-09-02, east of Broken Bay, NSW, in 933–969 m.

DISTRIBUTION. — Australia (Qld, NSW, Vic., Tas., SA, WA) and New Zealand, in 435–1200 m.

NSW CAPTURES. — Recorded in 65 *Kapala* stations from Crowdy Head to se. of Gabo Island; depth range 890–1200 m. An average of two specimens was caught in the 65 stations; most were caught deeper than 1000 m where 47% of trawls contained *T. gagates*.

REMARKS. — This relatively large, dark species with small body scales is readily distinguished from its congeners by the absence of a grooved lateral line. One specimen (AMS I.20307-067) was taken by midwater trawl in oceanic waters.

REFERENCE SPECIMENS. — AMS I.20307-067 (1 spec.); K77-24-03). AMS I.24059-009 (holotype); K83-09-02. AMS I.24157-002 (1 spec.); K83-12-04. AMS I.24173-007 (3 spec.) and AMS I.24173-011 (7 spec.); K83-14-06. AMS I.24178-004 (1 spec.); K83-14-08. AMS I.24355-001 (1 spec.); K83-18-02. AMS I.24356-005 (3 spec.) and AMS I.24356-007 (1 spec.); K83-14-05. AMS I.24357-001 (1 spec.); K83-18-01. AMS I.24451-002 (2 spec.); K83-14-09. AMS I.24625-003 (3 spec.); K84-06-06.

REFERENCES. — Paxton et al. (1989)(as *T. villosus*); Iwamoto and McMillan (1997).

Trachonurus sentipellis Gilbert and Cramer, 1897

Fig. 110

DISTINGUISHING FEATURES. — Grooved lateral line present. Body scales relatively large, coarsely covered with stout, erect spinules, 26–34 lat.l. scales over distance equal to predorsal length, 4–7 scale rows below midbase of first dorsal fin, 5–7 below origin of second dorsal; 8 or 9 between

FIGURE 110. *Trachonurus sentipellis* (Gilbert and Cramer, 1897). AMS I.28100-003. From *Kapala* stn K88-08-06, east of Tuncurry, NSW, in 1024–1079 m.

pelvic fin base and gill cover. Small scale patch or none on gular membrane, few or no scales on branchiostegal rays. Teeth in both jaws small, outer premaxillary series scarcely enlarged. Chin barbel moderate, 9–14% of HL. Total GR-II (outer) 10–14. Pyloric caeca short, thick, 9–13. Color uniformly black to dark brown.

SIZE. — To 31+ cm.

DISTRIBUTION. — Hawaiian Is., Australia (NSW, WA), and New Caledonia, in 500–1136 m.

NSW CAPTURES. — Three specimens taken by *Kapala* in 940–1130 m off Crowdy Head at the northern end of the mid-slope grounds.

REMARKS. — Iwamoto and Williams (1999) listed four specimens as uncertain variants of this species. The four showed differences in scale distribution and spinulation, gill-raker and scale-row counts, and some proportional measurements, compared with their other specimens, indicating the possibility of more than one species being involved. One of the uncertain variants was from NSW (AMS I.27718-010, off Ulladulla in 1150 m).

REFERENCE SPECIMENS. — AMS I.24462-003 (1 spec.); K83-15-02. AMS I.28100-003 (1 spec.); K88-08-06. AMS I.29808-001 (1 spec.); K89-06-04.

REFERENCES. — Iwamoto and Merrett (1997); Iwamoto and Williams (1999).

Genus *Ventrifossa*

DISTINGUISHING FEATURES. — Branchiostegal rays 7. Snout moderately pointed to bluntly rounded, lacking thickened tubercular scales at lateral angles and (in most species) tip of snout. Chin barbel well developed. Spinous ray of first dorsal fin finely serrated along leading edge in NSW species. Anus closer to pelvic fin insertions than to anal fin origin; periproct teardrop-shaped, a narrow connection to small dermal window of light organ situated between pelvic fins. Underside of snout fully and uniformly scaled; suborbital ridge rounded, without coarsely modified scales. Teeth in bands in both jaws, outer premaxillary teeth enlarged, with tooth band extending beyond posterior edge of maxillary process. Pyloric caeca more than 30. Color often silvery along sides of head and body; lips usually black; leading edge of snout, suborbital shelf, and dorsal snout ridges in most species dark, or terminal snout scute blackish.

REMARKS. — More than 25 species. Only three species recorded from NSW waters, although seven are known from Western Australia (Iwamoto and Williams 1999).

REFERENCES. — Iwamoto (1990); Iwamoto and Merrett (1997); Iwamoto and Williams (1999).

KEY TO THE SPECIES OF *VENTRIFOSSA* FROM NEW SOUTH WALES

1a. A tubercular scale at tip of snout; suborbital shelf narrowly constricted anteriorly; lateral line scales over distance equal to predorsal length of head 64–75 . . . . . *V. johnboborum*
1b. No tubercular scale at tip of snout; suborbital shelf not especially constricted anteriorly; lateral line scales over distance equal to predorsal length of head less than 51 2

2a. A prominent blotch or dark streak across first dorsal fin; pelvic fin rays 8 or 9, usually 8 . . . *Ventrifossa nigrodorsalis*
2b. First dorsal fin dark overall, without blotch or streak; pelvic fin rays 9 or 10, usually 9 . . . . . *V. paxtoni*

Ventrifossa johnboborum Iwamoto, 1982

Fig. 111

DISTINGUISHING FEATURES. — 1D II,9–11; i17–i23; V 8–9; total GR-I (outer/inner) 9–12/13–15, GR-II 12–15/12–14; scales below 1D about 12–16, below 2D about 9–12, lat.l. 64–75. Snout moderately protruding, length 28–31% HL; orbit diameter 29–35%; interorbital width 25–30%; distance orbit to angle of preopercle 41–44%; postorbital length 41–44%; upper jaw length 36–41%; barbel length 7–13 (18)%; height 1D about 54–68%. Suborbital shelf extremely narrow an-

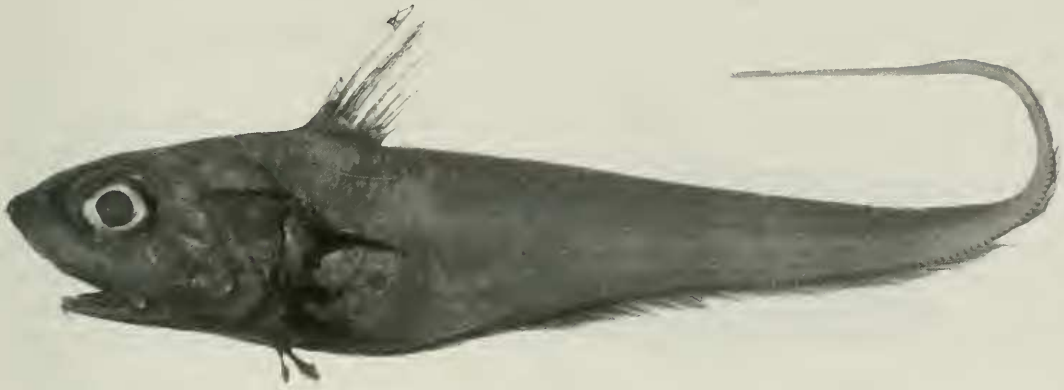

FIGURE 111. *Ventrifossa johnboborum* Iwamoto, 1982. AMS I.25126-001. From *Kapala* stn K84-18-06, east of Sydney, NSW, in 914–924 m.

teriorly, but broadening posteriorly. Body scales small, densely covered with small needlelike spinules. Spinous second ray of first dorsal fin with finely serrated leading edge. Tip of snout (and sometimes leading edge) blackish or dark dusky, other head ridges not marked. Lining of mouth dark.

SIZE. — To about 48 cm.

DISTRIBUTION. — Western Indian Ocean, east to Australia (Qld, NSW, WA) and New Caledonia, north to Philippines and South China Sea, and in the southeastern Pacific at Sala-y-Gomez Ridge. Depth range about 400–1100 m.

NSW CAPTURES. — Recorded from 23 *Kapala* stations (88 specimens) between Crowdy Head and Ulladulla, all but one station north of Sydney. Depth range 680–980 m, plus a single capture in 1070 m. Not commonly caught, *V. johnbororum was* present in only 20 of the 98 trawls in 700–1000 m north of Sydney. Most trawls caught less than five specimens, but 25 were taken in one station off Port Stephens.

REMARKS. — The northerly NSW distribution conforms to the generally tropical occurrence of the species. However, the NSW capture depths were somewhat greater than previously reported (412–855 m). Some questions remain as to the taxonomic status of the various populations of this apparently widespread species. *Ventrifossa fusca* Okamura, 1982 from the Kyushu-Palau Ridge and *V. misakia* Jordan and Gilbert, 1904 from Japan are closely related to this species, and the three compose the subgenus *Sokodara*.

REFERENCE SPECIMENS. — AMS I.19860-014 (1 spec.); K76-24-03. AMS I.25126-001 (1 spec.); K84-18-06. AMS I.27647-003 (1 spec.); K87-16-02. AMS I.28189-004 (1 spec.); K87-24-03. AMS I.29746-003 (2 spec.); K88-21-03. AMS I. 29747-004 (3 spec.); K88-21-02. AMS I.29749-007 (1 spec.); K89-17-02. AMS I.29756-003 (3 spec.); K89-15-04. AMS I.29762-005 (3 spec.); K89-12-03. AMS I.29806-001 (1 spec.); K89-09-06. AMS I.29811-002 (1 spec.); K89-08-01. AMS I.29813-007 (1 spec.); K89-06-05. AMS I.30737-002 (4 spec.); K87-24-02.

REFERENCES. — Sazonov and Iwamoto (1992); Iwamoto and Merrett (1997); Iwamoto and Williams (1999).

Ventrifossa nigrodorsalis Gilbert and Hubbs, 1920

Fig. 112

DISTINGUISHING FEATURES. — 1D II,9–11; i18–i23; V 8–9 (usually 8); total GR-I outer/inner) 8–12/13–16, GR-II 13–15/12–14; scales below 1D about 7–10, below 2D 7.5–10, lat.l. 39–42. Snout slightly protruding, length 26–33% HL; orbit diameter 29–35%; interorbital width 24–30%; distance

FIGURE 112. *Ventrifossa nigrodorsalis* Gilbert and Hubbs, 1920. From *Kapala* stn K83-01-08, off Sydney, NSW, in 490–570 m.

orbit to angle of preopercle 38–45%; postorbital length 40–46%; upper jaw length 37–45%; barbel length 16–27%; height 1D about 64–96%. Suborbital shelf uniformly broad. Body scales thin, rather deciduous, covered with small conical spinules in quincunx pattern. Spinous second ray of first dorsal fin with finely serrated leading edge. Dorsal surfaces of trunk and tail dark, contrasting with silvery (when fresh) or pale (when preserved) ventral body surfaces. Prominent black blotch or streak across anterior portion of first dorsal fin. Leading edge of snout, supranasal ridge (but not median nasal ridge), and suborbital shelf blackish.

SIZE. — To about 30 cm.

DISTRIBUTION. — Widespread in the western Pacific, from the Philippines, South China Sea, and Indonesia south to New Caledonia and Australia (Qld, NSW, WA). Depth range about 300–800 m.

NSW CAPTURES. — Relatively common in upper slope depths off central and northern NSW, particularly in 500–700 m. Captured by *Kapala* in 71 trawls on all grounds between the Qld-NSW border and Jervis Bay (35°00′S) in 360–790 m. Recently collected south of Bermagui to 36°46′S. Between 10 and 20 specimens were caught at most *Kapala* stations with small-meshed nets. Because of its small size, few were caught with large-meshed trawls.

REMARKS. — An apparently widespread, highly variable species deserving further study (see Iwamoto and Williams 1999).

REFERENCE SPECIMENS. — AMS I.15987-014 (1 spec.); K71-11-09. AMS I.18839-013 (1 spec.); K75-05-04. AMS I.20301-025 (1 spec.); K77-13-12. AMS I.20459-015 (17 spec.) and I.20459-027 (4 spec.); K78-17-10. AMS I.20518-008 (20 spec.) and I.20518-018 (2 spec.); K78-09-05. AMS I.21669-004 (3 spec.); K77-16-16. AMS I.21805-002 (25 spec.); K77-23-09. AMS I.21806-002 (3 spec.); K77-07-10. AMS I.23710-001 (4 spec.); K79-20-04. AMS I.24852-009 (1 spec.); K84-15-03. AMS I.29535-005 (1 spec.); K79-15-01. CAS 214043 (6 spec.); off Bermagui (36°46′S, 150°21′E); 530-549 m; FV *Shelley H*, 15 Feb. 2000. CAS 214044 (6 spec.); off Bermagui (36°12′S, 150°24′E); 421 m; FV *Shelley H*, 1 Mar. 2000.

REFERENCES. — Gilbert and Hubbs (1920); Iwamoto and Merrett (1997); Iwamoto and Williams (1999).

***Ventrifossa paxtoni* Iwamoto and Williams, 1999**
Fig. 113

DISTINGUISHING FEATURES. — 1D II,9–11; i20–i25; V 9–10 (usually 9); total GR-I outer/inner) 10–13/15–18, GR-II 14–18/15–18; scales below 1D about 8–12, below 2D 7.5–9.0, lat.l. 37–50. Snout rather blunt, length 24–31% HL; orbit diameter 27–38%; interorbital width 24–30%; distance orbit to angle of preopercle 42–48%; postorbital length 43–53%; upper jaw length 43–50%; barbel length 24–38%; height 1D about 63–73%. Suborbital shelf uniformly broad. Body scales covered with small conical spinules in subparallel rows. Spinous second ray of first dorsal fin with finely serrated leading edge. Color overall swarthy, especially dark over head, chest and abdomen. Fins all black or blackish. Leading edge of snout, lateral nasal ridges, and suborbital shelf black, median nasal ridge dusky to blackish.

SIZE. — To about 43 cm.

DISTRIBUTION. — Australia (Qld, NSW, WA) and the New Caledonian region, in about 800–1100 m.

NSW CAPTURES. — Captured at 27 *Kapala* stations between Crowdy Head and Sydney, with additional single captures off Nowra and Ulladulla; depth range 825–1050 m. Caught in about 20% of all trawls in 800–1100 m north of Sydney. Overall average catch about four per trawl, with highest catch numbers at stations north of Newcastle (up to 25 specimens).

REMARKS. — *Ventrifossa paxtoni* is a dark, blunt-snouted species similar to *V. macropogon*, a widespread species from the western North Atlantic, Western Australia, and New Caledonia. *Ventrifossa paxtoni*, however, has a somewhat shorter, thinner barbel, fainter median nasal streak, and higher gill raker counts. *Ventrifossa saikaiensis* Okamura, 1984 is also closely similar but has somewhat lower counts of pelvic fin rays (8 or 9), slightly higher counts of outer gill rakers (12–15), and lacks darkly marked head ridges, including the leading edge of the snout.

REFERENCE SPECIMENS. — AMS I.20099-006 (2 spec.); K77-23-12. AMS I.24150-004 (1 spec.); K83-13-01. AMS I.24990-001 (1 paratype); K84-16-13. AMS I.26981-005 (5 paratypes); K87-02-01. AMS I.27647-002 (holotype) and AMS I.27647-004 (1 paratype); K87-16-02. AMS I.28189-005 (2 paratypes); K87-24-03. AMS I.29753-008 (4 paratypes); K87-17-06. AMS I.29797-005 (4 spec.); K89-12-05. AMS I.29805-001 (1 paratype); K87-24-04. AMS I.30737-001 (4 spec.); K87-24-02.

REFERENCES. — Iwamoto and Merrett (1997); Iwamoto and Williams (1999).

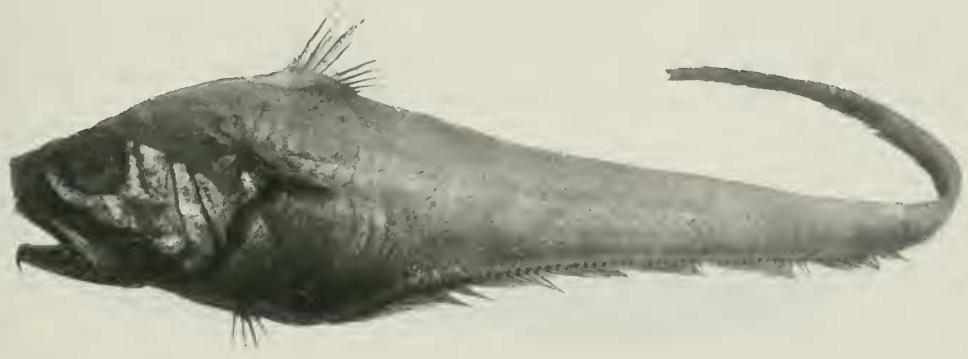

FIGURE 113. *Ventrifossa paxtoni* Iwamoto and Williams, 1999. AMS I.24150-004. From *Kapala* stn K83-13-01, from off Broken Bay, NSW, in 988–1015 m.

Subfamily Trachyrincinae

Distinguishing Features. — Branchiostegal rays 7. Outer gill slit wide and free, not restricted by folds of skin connecting upper and lower limbs of gill arch. Dorsal fins two, closely approximated, the first short-based and armed with a flexible leading spinous ray; the second long and continuous to end of tail. Anal fin long, height usually somewhat lower and length slightly shorter than second dorsal fin. A rudimentary caudal fin sometimes developed. Heavy scutelike scales forming long ridges along dorsal and ventral margins lateral to median fins. No light organ.

Remarks. — Two genera, *Idiolophorhynchus* (monotypic) and *Trachyrincus* (with six species, one of which is found off NSW). *Idiolophorhynchus* has leathery head ridges and scales that have low, flattened, or no spinules on exposed fields; a midlateral row of enlarged scutes on trunk; pelvic fin rays 3 or 4; no chin barbel; and no posttemporal pit. The single species, *I. andriashevi* Sazonov, 1981, may occur off NSW at depths greater than trawled by the *Kapala*.

References. — Iwamoto (1990); McMillan (1995).

Genus *Trachyrincus*

Distinguishing Features. — V 6 or 7. Snout strongly supported and pointed. A sensory pit in temporal region of head. Small chin barbel present. Scales on head and body covered with stout spinules. Pyloric caeca bifid.

Reference. — McMillan (1995).

Trachyrincus longirostris (Günther, 1878)

Fig. 114

Distinguishing Features. — Snout long, 41–46% of HL, ventral length 34–39%; upper jaw length 25–28%; pyloric caeca 35–62. Color pale brownish to grayish.

Size. — To about 50 cm.

Distribution. — Australia (NSW, Vic.), New Zealand, and southern Africa, in about 1100–1400 m.

NSW Captures. — Caught at four *Kapala* stations (five specimens) off Port Stephens, Broken Bay (2) and Gabo Island in 1050–1200 m. Possibly more abundant in depths greater than 1200 m.

Remarks. — *Trachyrincus aphyodes* McMillan, 1995 from New Zealand waters is closely similar to *T. longirostris*, but may be distinguished by its more numerous pyloric caeca (119–211), somewhat longer upper jaw (29–34% of HL), and shorter ventral snout length (26–34%). *Trachyrincus longirostris* is a smaller species, attaining about 50 cm, compared with 96 cm in *T. aphyodes*.

Reference Specimens. — AMS I.24644-003 (2 spec.); K84-06-07. AMS I.25266-004 (1 spec.); K84-22-02. AMS I.28749-004 (1 spec.); K88-17-03. AMS I.29812-001 (1 spec.); K89-15-02.

References. — McMillan *in* Gomon et al. (1994); McMillan (1995).

Figure 114. *Trachyrincus longirostris* (Günther, 1878). AMS I.25266-004. From *Kapala* stn K84-22-02, off Gabo Island, Vic., in 1052–1079 m.

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APPENDIX 1. Data for FRV *Kapala* stations cited in text. (Locations are approximate midpoints of trawls: latitude °S, longitude °E; * bottom depth for midwater trawl stations.)

Station	AMS Reg. No.	Date	Location	Depth (m)
K71-05-03	15967	6-IV-71	33°42', 151°52'	270-280
K71-05-04	15968	6-IV-71	33°42', 151°50'	366-366
K71-05-06	15969	7-IV-71	33°48', 151°47'	357-366
K71-06-04	15970	15-IV-71	33°46', 151°52'	503-503
K71-07-03	15973	21-IV-71	33°35', 151°59'	375-384
K71-08-03	15974	28-IV-71	32°52', 152°39'	366-375
K71-08-05	15975	29-IV-71	33°14', 152°21'	549-567
K71-09-01	15976	7-V-71	32°48', 152°44'	585-595
K71-11-09	15987	8-VII-71	34°59', 151°07'	366-366
K71-13-02	15994	30-VII-71	37°42', 150°15'	402-408
K71-13-06	15995	2-VIII-71	35°27', 150°49'	549-549
K72-04-01	16565	19-IX-72	33°45', 151°49'	457-457
K72-04-02	16577	19-IX-72	33°38', 151°55'	457-457
K72-05-05	16589	4-X-72	33°44', 151°53'	549-600
K72-06-05	17859	23-X-72	33°48', 151°47'	400-405
K72-07-01	17866	6-XI-72	33°57', 151°45'	729-730
K72-07-04	17867	9-XI-72	33°42', 151°56'	729-730
K72-07-15	17316	7-XII-72	33°50', 151°52'	770-780
K75-01-02	18726	2-IV-75	33°36', 151°59'	784-795
K75-02-08	18770	4-VI-75	34°57', 151°10'	732-805
K75-03-02	18774	11-VII-75	37°42', 150°13'	402-421
K75-05-02	24127	8-VIII-75	34°17', 151°26'	402-411
K75-05-03	18838	18-VIII-75	33°04', 152°33'	448-466
K75-05-04	18839	19-VIII-75	33°27', 152°05'	622-658
K75-05-05	20452	19-VIII-75	33°35'; 152°02'	805-841
K75-05-05	24613	19-VIII-75	33°35', 152°02'	805-841
K75-05-08	19076	21-VIII-75	34°30', 151°18'	494-512
K75-07-03	19085	16-IX-75	32°24', 152°59'	450-460
K76-04-03	19197	30-IV-76	33°46', 151°50'	485-494
K76-05-04	19198	4-V-76	33°45', 151°51'	604-604
K76-06-03	19202	11-V-76	33°12', 152°23'	600-604
K76-07-01	19205	26-V-76	33°30', 151°58'	375-384
K76-23-01	19862	13-XII-76	34°24', 151°25'	732-768
K76-24-03	19860	20-XII-76	33°33', 152°02'	823-823
K76-24-04	19859	21-XII-76	33°29', 152°06'	823-823
K77-07-10	21806	26-VI-77	33°30', 152°05'	604-604
K77-13-10	20118	23-VIII-77	29°52', 153°43'	503-512
K77-13-12	20301	23-VIII-77	29°53', 153°42'	503-503
K77-16-16	21669	28-IX-77	33°33', 152°02'	604-604
K77-18-01	20064	26-X-77	34°11', 152°03'	*2200-2380
K77-19-05	20071	3-XI-77	34°38', 151°16'	*2750-2930
K77-21-01	20484	21-XI-77	34°32', 151°20'	695-695
K77-22-03	20097	29-XI-77	37°41', 150°18'	732-732
K77-22-06	20096	30-XI-77	37°40', 150°20'	823-823
K77-23-06	20485	6-XII-77	33°38', 151°56'	713-732
K77-23-07	20098	6-XII-77	33°32', 152°03'	914-914
K77-23-09	21805	7-XII-77	33°09', 152°25'	585-594
K77-23-10	20477	7-XII-77	33°10', 152°24'	732-732
K77-23-12	20099	8-XII-77	33°34', 152°01'	823-823
K77-23-13	20068	8-XII-77	33°26', 152°10'	878-896
K77-24-03	20307	13-XII-77	33°21', 152°26'	*1830-2750
K77-24-10	20314	14-XII-77	33°32', 152°35'	*3660-3840
K77-24-11	20315	14-XII-77	34°09', 152°01'	*2470-2560
K78-01-01	30407	22-III-78	33°42', 151°51'	448-457
K78-09-05	20518	2-VI-78	28°02', 153°59'	549-549
K78-16-07	20435	2-VIII-78	29°47', 153°44'	421-439

Station	AMS Reg. No.	Date	Location	Depth (m)
K78-17-07	23689	16-VIII-78	28°00', 153°58'	411-411
K78-17-10	20459	17-VIII-78	28°01', 154°00'	549-549
K78-17-11	21793	17-VIII-78	28°03', 153°58'	411-411
K78-17-14	23993	17-VIII-78	28°17', 153°53'	174-201
K78-23-08	21795	6-XI-78	28°03', 154°04'	732-741
K78-23-09	20651	6-XI-78	27°56', 154°03'	549-549
K78-26-16	24037	7-XII-78	33°47', 151°55'	823-850
K78-27-05	23885	12-XII-78	34°55', 151°13'	801-827
K79-15-01	29535	2-X-79	33°48', 151°49'	439-439
K79-15-03	26932	3-X-79	33°31', 152°02'	402-402
K79-19-07	21369	28-XI-79	32°55', 153°02'	*3600-3700
K79-20-04	23710	4-XII-79	33°34', 152°04'	713-732
K79-20-06	25933	4-XII-79	33°36', 152°06'	914-933
K79-20-13	21722	6-XII-79	33°32', 152°06'	823-823
K79-20-15	21724	6-XII-79	33°37', 152°06'	1005-1010
K80-05-01	21725	13-V-80	33°42', 151°52'	439-550
K80-20-05	40274	9-XII-80	33°37', 152°03'	960-988
K81-17-03	24619	9-IX-81	33°46', 151°49'	439-475
K81-18-05	23862	15-IX-81	34°40', 151°15'	520-530
K82-17-01	23470	12-X-82	33°43', 151°53'	475-494
K82-24-02	23486	20-XII-82	33°47', 151°49'	457-475
K83-06-01	24101	25-VII-83	33°45', 151°55'	805-841
K83-06-02	24054	26-VII-83	34°36', 151°19'	869-878
K83-07-11	24100	10-VIII-83	33°04', 152°34'	960-997
K83-08-01	24055	18-VIII-83	33°45', 151°59'	933-942
K83-08-02	24056	18-VIII-83	33°37', 152°04'	860-896
K83-09-01	24060	22-VIII-83	33°47', 151°58'	942-960
K83-09-02	24059	23-VIII-83	33°30', 152°10'	933-969
K83-09-04	24057	24-VIII-83	34°53', 151°14'	951-978
K83-12-04	24157	27-IX-83	38°18', 149°48'	997-1015
K83-13-01	24150	17-X-83	33°38', 152°05'	988-1015
K83-13-02	24181	18-X-83	32°57', 152°43'	960-988
K83-14-01	24172	25-X-83	35°28', 150°53'	978-1024
K83-14-02	24187	25-X-83	35°28', 150°53'	988-1024
K83-14-03	24565	25-X-83	35°28', 150°53'	1033-1042
K83-14-05	24356	26-X-83	34°53', 151°15'	1042-1061
K83-14-06	24173	26-X-83	34°54', 151°14'	1097-1116
K83-14-08	24178	27-X-83	33°37', 152°06'	978-1006
K83-14-09	24451	27-X-83	33°32', 152°10'	1042-1061
K83-15-01	24419	2-XI-83	32°08', 153°07'	910-950
K83-15-02	24462	2-XI-83	32°04', 153°08'	942-978
K83-18-01	24357	30-XI-83	34°55', 151°14'	969-1024
K83-18-02	24355	30-XI-83	34°55', 151°16'	1105-1152
K83-19-02	24424	6-XII-83	35°29', 150°53'	1033-1070
K84-04-10	24624	11-IV-84	34°57', 151°13'	1097-1134
K84-04-11	25415	11-IV-84	34°54', 151°14'	988-1024
K84-06-03	24645	1-V-84	33°29', 152°08'	777-823
K84-06-04	24659	1-V-84	33°29', 152°09'	914-933
K84-06-06	24625	2-V-84	33°30', 152°10'	1042-1106
K84-06-07	24644	2-V-84	33°29', 152°14'	1170-1198
K84-08-02	24778	22-V-84	34°54', 151°13'	814-850
K84-08-03	24658	22-V-84	34°52', 151°14'	869-924
K84-08-05	24774	23-V-84	35°38', 150°44'	805-850
K84-10-03	24771	17-VII-84	32°55', 152°46'	963-1039
K84-10-06	24820	18-VII-84	32°04', 153°09'	960-969
K84-10-08	24988	19-VII-84	33°41', 152°04'	1097-1134
K84-11-07	24992	1-VIII-84	35°27', 150°55'	1079-1116
K84-11-09	25273	2-VIII-84	34°53', 151°16'	1161-1207
K84-13-03	28713	24-VIII-84	36°27', 150°20'	411-457

Station	AMS Reg. No.	Date	Location	Depth (m)
K84-14-01	24854	3-IX-84	34°17', 151°27'	439-512
K84-15-01	24850	10-IX-84	33°45', 151°51'	411-439
K84-15-03	24852	11-IX-84	33°34', 152°01'	512-530
K84-16-04	24979	25-IX-84	33°34', 152°03'	722-777
K84-16-05	24991	25-IX-84	33°36', 152°03'	814-832
K84-16-13	24990	27-IX-84	33°47', 151°58'	905-924
K84-16-14	24993	27-IX-84	33°42', 152°04'	1042-1070
K84-16-15	24980	27-IX-84	33°43', 152°01'	960-997
K84-17-01	24989	3-X-84	34°15', 151°30'	668-704
K84-17-03	24851	4-X-84	34°37', 151°19'	768-786
K84-17-04	24981	4-X-84	34°36', 151°20'	860-878
K84-17-05	24860	4-X-84	34°48', 151°16'	914-969
K84-18-03	25127	10-X-84	34°48', 151°13'	732-750
K84-18-06	25126	11-X-84	33°49', 151°56'	914-924
K84-19-04	25264	16-X-84	33°35', 152°08'	1025-1244
K84-20-03	25290	1-XI-84	33°43', 152°01'	969-1006
K84-20-04	24978	1-XI-84	33°37', 152°07'	1070-1125
K84-20-05	25095	1-XI-84	33°30', 152°13'	1170-1207
K84-22-02	25266	21-XI-84	37°40', 150°21'	1052-1079
K85-17-02	26240	14-XI-85	33°36', 151°57'	421-457
K85-17-02	26446	14-XI-85	33°36', 151°57'	421-457
K85-20-10	26221	10-XII-85	32°35', 152°49'	154-157
K85-21-04	26247	19-XII-85	33°34', 152°09'	1024-1052
K85-21-06	25932	19-XII-85	33°43', 151°53'	439-466
K86-01-05	26394	11-II-86	33°29', 152°06'	454-523
K86-01-06	26002	11-II-86	33°35', 152°01'	657-662
K86-01-07	26245	11-II-86	33°42', 151°59'	819-889
K86-01-08	26000	12-II-86	33°32', 152°10'	951-1015
K86-01-09	26001	12-II-86	33°28', 152°13'	1116-1207
K86-10-07	26453	22-IV-86	33°02', 152°33'	439-512
K86-10-14	26756	23-IV-86	33°00', 152°36'	457-503
K87-02-01	26981	19-II-87	32°22', 153°01'	896-960
K87-14-02	26998	5-VIII-87	34°18', 151°30'	636-781
K87-16-02	27647	27-VIII-87	32°23', 153°03'	878-951
K87-23-02	27609	3-XII-87	34°53', 151°11'	503-658
K87-24-01	29600	7-XII-87	33°52', 151°51'	783-978
K87-24-02	30737	8-XII-87	32°56', 152°40'	832-997
K87-24-03	28189	8-XII-87	32°53', 152°46'	863-960
K87-24-04	29805	8-XII-87	32°39', 152°54'	887-951
K87-24-05	29738	9-XII-87	31°54', 153°12'	479-922
K87-25-06	29741	16-XII-87	35°28', 150°52'	933-960
K88-04-06	28475	23-III-88	34°55', 151°15'	1116-1152
K88-04-08	27717	24-III-88	33°33', 152°08'	1024-1143
K88-04-09	28071	24-III-88	33°29', 152°11'	905-969
K88-05-01	27718	29-III-88	35°30', 150°54'	1134-1189
K88-08-04	27720	4-V-88	32°04', 153°08'	1024-1079
K88-08-05	28372	4-V-88	32°06', 153°09'	1070-1106
K88-08-06	28100	4-V-88	32°08', 153°09'	1024-1079
K88-08-07	27721	5-V-88	32°56', 152°44'	1006-1079
K88-08-08	29601	5-V-88	33°05', 152°34'	896-951
K88-08-09	27722	5-V-88	33°00', 152°38'	704-750
K88-10-02	28712	17-V-88	32°50', 152°48'	1024-1061
K88-10-04	28717	17-V-88	32°52', 152°48'	1079-1097
K88-11-01	27638	14-VI-88	33°43', 152°07'	1024-1042
K88-12-02	27643	21-VI-88	32°02', 153°10'	990-1020
K88-12-03	29591	21-VI-88	31°46', 153°18'	1005-1042
K88-14-04	27637	4-VIII-88	35°30', 150°53'	988-1024
K88-16-04	29340	17-VIII-88	32°56', 152°45'	1042-1061
K88-17-03	28749	31-VIII-88	33°28', 152°14'	1143-1198

Station	AMS Reg. No.	Date	Location	Depth (m)
K88-17-06	28900	1-IX-88	33°29', 152°12'	1033-1070
K88-20-01	29809	8-XI-88	32°54', 152°47'	1070-1097
K88-20-02	29297	8-XI-88	32°50', 152°48'	1024-1097
K88-20-03	29298	8-XI-88	32°50', 152°48'	988-1033
K88-21-02	29747	3-XII-88	32°48', 152°47'	841-933
K88-21-03	29746	3-XII-88	32°40', 152°50'	713-750
K89-03-15	29385	27-II-89	38°06', 149°42'	152-159
K89-06-02	29799	11-IV-89	32°56', 152°47'	1042-1061
K89-06-04	29808	11-IV-89	32°51', 152°48'	1090-1134
K89-06-05	29813	12-IV-89	33°12', 152°23'	722-768
K89-07-01	29803	18-IV-89	35°05', 151°07'	695-768
K89-07-04	32431	19-IV-89	35°42', 150°43'	887-960
K89-07-05	29807	19-IV-89	35°41', 150°43'	1015-1042
K89-08-01	29811	9-V-89	33°43', 151°59'	805-869
K89-08-02	29801	10-V-89	33°28', 152°13'	1134-1189
K89-09-01	29804	16-V-89	33°04', 152°36'	896-960
K89-09-03	28988	16-V-89	32°51', 152°49'	1024-1061
K89-09-06	29806	17-V-89	33°30', 152°07'	732-796
K89-09-07	29605	18-V-89	33°39', 152°05'	1024-1088
K89-09-09	29825	18-V-89	33°27', 152°10'	741-768
K89-11-02	28070	8-VI-89	32°51', 152°49'	1006-1052
K89-12-02	30738	14-VI-89	32°51', 152°48'	1079-1143
K89-12-03	29762	14-VI-89	32°43', 152°49'	713-796
K89-12-04	29798	15-VI-89	32°06', 153°10'	1033-1079
K89-12-05	29797	15-VI-89	32°03', 153°09'	914-997
K89-13-01	29823	29-VI-89	32°33', 152°59'	896-969
K89-13-02	28477	30-VI-89	33°44', 152°03'	1116-1170
K89-15-01	29827	3-VIII-89	32°56', 152°45'	1024-1061
K89-15-02	29812	3-VIII-89	32°51', 152°49'	1061-1097
K89-15-03	29757	3-VIII-89	32°51', 152°48'	933-988
K89-15-04	29756	4-VIII-89	33°39', 151°59'	677-750
K89-16-02	30394	10-VIII-89	34°47', 151°18'	1134-1225
K89-17-02	29749	15-VIII-89	32°39', 152°52'	814-850
K89-17-03	29754	15-VIII-89	32°30', 153°00'	1006-1052
K89-17-04	29750	16-VIII-89	31°47', 153°18'	1024-1052
K89-17-06	29753	16-VIII-89	31°52', 153°16'	878-933
K89-17-07	29742	17-VIII-89	32°07', 153°09'	1079-1143
K89-17-08	29752	17-VIII-89	32°06', 153°09'	1024-1061
K89-17-09	30304	17-VIII-89	32°12', 153°06'	823-860
K89-18-02	29745	22-VIII-89	34°56', 151°15'	1090-1143
K89-18-04	39052	22-VIII-89	34°45', 151°16'	950-990
K89-19-01	29737	31-VIII-89	35°29', 150°55'	1116-1134
K89-19-02	29761	31-VIII-89	35°29', 150°53'	1024-1061
K89-20-01	29743	7-IX-89	33°41', 152°00'	805-869
K97-01-21	39957	29-IV-97	37°43', 150°10'	219-227
K97-01-22	39958	30-IV-97	37°39', 150°17'	543-567
K97-02-01	38576	27-V-97	35°33', 150°46'	505-549

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