

# AUSTRALIAN MUSEUM SCIENTIFIC PUBLICATIONS

Collette, Bruce B., 1974. The garfishes (Hemiramphidae) of Australia and New Zealand. *Records of the Australian Museum* 29(2): 11–105. [12 March 1974].

doi:10.3853/j.0067-1975.29.1974.231

ISSN 0067-1975

Published by the Australian Museum, Sydney

nature culture **discover**

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# THE GARFISHES (HEMIRAMPHIDAE) OF AUSTRALIA AND NEW ZEALAND

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Figures 1-23

Manuscript received, 21st June, 1972

## SUMMARY

Twenty species and subspecies of garfishes are recognized from Australian and New Zealand waters: *Arrhamphus s. sclerolepis*, *A. s. krefftii*, *Euleptorhamphus viridis*, *Hemiramphus far*, *He. robustus*, *Hyporhamphus r. regularis*, *Hy. r. ardelio*, *Hy. neglectus*, *Hy. australis*, *Hy. melanochir*, *Hy. ihi*, *Hy. quoyi*, *Hy. affinis*, *Hy. dussumieri*, *Rhynchorhamphus georgii*, *Zenarchopterus buffonis*, *Z. caudovittatus*, *Z. dispar*, *Z. gilli*, and *Z. rasori*. *Reporhamphus* is considered a synonym of *Hyporhamphus*; *Farhians* and *Ardeapiscis* are considered synonyms of *Hemiramphus*; and *Loligorhamphus* a synonym of *Rhynchorhamphus*. *Hemiramphus welsbyi* is a synonym of *He. robustus*. The eastern river garfish (*Hyporhamphus ardelio*) is reduced to a subspecies of the western river garfish (*Hy. regularis*). The New South Wales-southern Queensland population of the snub-nosed garfish (*Arrhamphus sclerolepis*) is considered a subspecies (*A. s. krefftii*) of the northern *A. s. sclerolepis*. Eight species and subspecies are endemic to Australia and the single New Zealand species of garfish is endemic there. Australian populations of wide-spread species are compared with extra-limital populations. Geographic variation was found in *Hy. quoyi* and *Hy. dussumieri*. Tables of meristic and morphometric characters, drawings of 11 species of garfishes, synonymies, distribution maps, summaries of biology and parasites, catch statistics and a key are included.

Rec. Aust. Mus., 29, page 11.

## INTRODUCTION

The larger garfishes are important food fishes; over 1.5 million lbs were landed in Australia in 1970-71 (Anon., 1972a). Many of the species of garfishes are very similar to each other so literature records and catch statistics frequently have been based on mis-identified specimens. The purposes of this paper are to determine which species of garfishes occur in Australian and New Zealand waters, what their correct scientific names are, how they may be identified, how they vary geographically, and how Australian populations of widespread species compare with extra-limital populations of the same species. This paper is the eleventh in a series on the systematics of the Synentognathi. The work was begun and the first draft of the manuscript was completed while I was stationed at the Australian Museum in 1969-70.

## MATERIALS AND METHODS

The most important sources of Australia-New Zealand garfishes, based on the number of taxa (species and subspecies), collections, and specimens are the Australian Museum (16 taxa, 25.5% of the collections, 16.2% of the specimens), the U.S. National Museum (17 taxa, 19.4% of collections, 34.4% of specimens) and C.S.I.R.O. at Cronulla (17 taxa, 19.8% of collections, 16.8% of specimens). A total of 2,310 specimens from 509 collections of the 20 taxa of Australian-New Zealand garfishes have been examined from the following 22 institutions:

AMNH	American Museum of Natural History, New York.
AMS	Australian Museum, Sydney.
ANSP	Academy of Natural Sciences, Philadelphia.
BMNH	British Museum (Natural History), London.
CSIRO	C.S.I.R.O., Division of Fisheries and Oceanography, Cronulla.
DM	Dominion Museum, Wellington.
FBQ	Fisheries Branch, Department of Primary Industries, Brisbane.
IRSNB	Institut Royal des Sciences, Naturelles de Belgique, Bruxelles.
MCZ	Museum of Comparative Zoology, Harvard University, Cambridge.
MNHN	Muséum National d'Histoire Naturelle, Paris.
NHNV	Naturhistorisches Museum, Vienna.
QM	Queensland Museum, Brisbane.
SAM	South Australian Museum, Adelaide.
SIO	Scripps Institution of Oceanography, La Jolla.
SMF	Senckenberg Museum, Frankfurt.
SMN	Staatliches Museum für Naturkunde, Stuttgart.
SU	Stanford University, specimens now at California Academy of Sciences, San Francisco.
USNM	U.S. National Museum, Washington.
VMM	Vanderbilt Marine Museum, Centerport, New York.
WAM	Western Australian Museum, Perth.
ZMH	Zoologisches Institut und Zoologisches Museum, Hamburg.
ZMUC	Zoological Museum, University of Copenhagen.

Much extra-limital material has been examined from these and many other institutions. Locality data is given here only for Australian and New Zealand specimens and for types. Meristic and morphometric data for the extra-limital material has been drawn upon for discussions, diagnoses, tables and graphs. Locality data for this material will be included in subsequent papers.

The following abbreviations are used (all measurements in mm) for the characters used in this study:

SL	Standard length, from tip of upper jaw to caudal base.
D	Dorsal fin rays. All elements counted.
A	Anal fin rays. All elements counted.
Vert	Vertebrae, counted as precaudal plus caudal equals total. Includes hypural as last vertebra.
P <sub>1</sub>	Pectoral fin rays. All elements counted.
RGR <sub>1</sub>	Gill rakers on first arch (total on right side).
RGR <sub>2</sub>	Gill rakers on second arch (total on right side).
LJL	Lower jaw length, distance from tip of upper jaw to tip of lower jaw.
Hd L	Head length, distance from tip of upper jaw to posterior end of opercular membranes.
P <sub>1</sub> L	Pectoral fin length, distance from base of uppermost pectoral ray to tip of longest ray.
P <sub>1</sub> -P <sub>2</sub>	Distance from base of uppermost pectoral ray to base of anteriormost pelvic ray.
P <sub>2</sub> -C	Distance from base of anteriormost pelvic ray to caudal base. Also expressed as P <sub>2</sub> -C extension, which is this distance extended anteriorly from base of anteriormost pelvic ray.
D base	Length of dorsal fin base from origin of fin to last ray.
A base	Length of anal fin base.
UJL	Upper jaw length, from where upper jaw bends to tip of upper jaw.
UJW	Upper jaw width, measured where upper jaw bends.

The methods of study are essentially the same as in my earlier study of eastern Atlantic Hemiramphidae (Collette, 1965). Meristic characters were analyzed by comparing frequency distributions of the various counts for different geographic regions. Where no intraspecific differences were apparent, the frequency distributions for the Australian populations of a species were combined and compared with its most closely related Australian species. Tables included in this paper either show geographic variation within a species or compare closely related species.

Several measurements were used to insure the correct identity of specimens and populations of garfishes. The initial use of this information was to see if the upper jaw was longer or shorter than wide, the dorsal fin base longer or shorter than the anal fin base, how far forward the pelvic to caudal base distance extends, etc. Because there was geographic variation in some meristic characters, the morphometric data was also analyzed geographically. Allometry seems to be relatively unimportant except for lower jaw length which undergoes several distinct growth stanzas in some species. Regressions on standard length were run, population by population, on most characters measured.

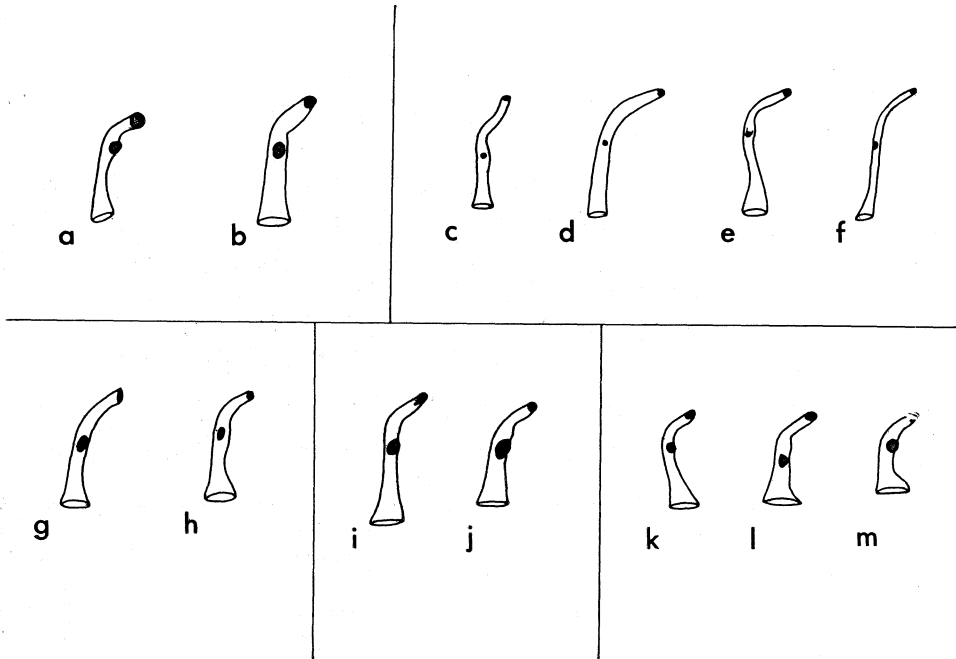


Figure 1. Preorbital canals (right side) of five species of Australian Hemiramphidae that lack a posterior branch to the canal. Not drawn to scale. a-b, *Arrhamphus sclerolepis*: a-lectotype of *A. sclerolepis*, BMNH 1862.11.15.127; b-holotype of *Hemiramphus kreffii*, "Port Jackson," N.S.W., NHMV uncat. c-f, *Rhynchorhamphus georgii*: c-holotype of *Hemiramphus georgii*, Bombay, MNHN B.1062; d-holotype of *Loligorhamphus normani*, Townsville, Qld., AMS IA.2319; e-Magnetic Is., Qld., FBQ 39; f-Cairns, Qld., FBQ 3608. g-h, *Hyporhamphus regularis ardelio*: g-lectotype of *Reporhamphus ardelio*, Clarence R., N.S.W., AMS I.12744; h-out of type series of *Hemiramphus gaimardi*, Port Jackson, N.S.W., MNHN 4590. i-j, *Hy. r. regularis*: i-lectotype of *Hemiramphus regularis*, W.A., BMNH pre-reg.; j-Swan R., W.A., AMS I.13252. k-m, *Hy. neglectus*: k-lectotype of *Hemiramphus neglectus*, E. Indies, BMNH 1866.5.2.18; l-Townsville, Qld., AMS IA.2315; m-Napier Broome Bay, W.A., CSIRO C.1751.

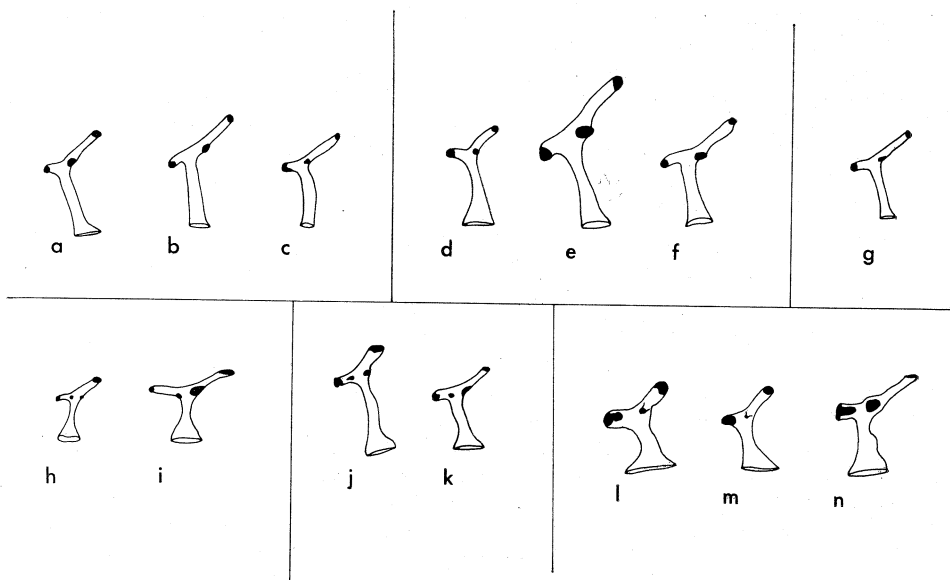


Figure 2. Preorbital canals (right side) of six species of Australian-New Zealand *Hyporhamphus*. Not drawn to scale. a-c, *Hy. australis*: a-holotype of *Hemiramphus australis*, Port Jackson, N.S.W., NHMV 5560; b-Lord Howe Is., AMS I.5568; c-Norfolk Is., AMS I.5407. d-f, *Hy. melanochir*: d-lectotype of *He. melanochir*, Adelaide, S.A., MNHN B.1066; e-Melbourne, Victoria, MCZ 8772; f-Swan R., W.A., AMS I.4199. g-*Hy. ihi*, New Zealand, DM 4865. h-i: *Hy. affinis*: h-lectotype of *He. affinis*, "South Seas," BMNH pre-reg; i-Joseph Bonaparte Gulf, N.T., CSIRO, C.1727. j-k, *Hy. dussumieri*: j-holotype of *He. dussumieri*, Seychelles, MNHN B.1063; k-One Tree Is., Great Barrier Reef, USNM 206575. l-n, *Hy. quoyi*: l-holotype of *He. quoyi*, New Guinea, MNHN B.1068; m-paralectotype of *He. gaimardi*, New Guinea, MNHN B. 1058; n-holotype of *Reporhamphus caudalis*, Cape York, Qld., AMS I.444.

Tests of differences of slopes and heights (intercepts) of pairs of regression lines were performed by analysis of covariance (Snedecor, 1956: 394-399). An unusually high value of F was selected to minimize concluding that populations were different. Only F values greater than those for  $P = 0.999$  (table from Beyer, 1968) were considered significant and these are marked \*\* in the tables. If the difference between the slopes of two regression lines is significant, the difference in heights cannot be tested with this procedure. This method was used previously in studying the Belonidae of the eastern Atlantic (Collette and Parin, 1970). For some species, adjacent populations which were not significantly different were combined and retested against other populations.

The structure of the preorbital canal is an important character in the classification of the Hemiramphidae. There are generic and specific differences in this character. Within the large and complex genus *Hyporhamphus*, it is particularly useful to sort species into groups based on the presence or absence of a posterior branch to the canal (compare Fig. 1 with Fig. 2).

Six genera are recognized for the 20 taxa discussed in this paper based on my published (1965, 1966) and unpublished research and the literature: *Arrhamphus* Günther, 1866 (one species with two subspecies); *Euleptorhamphus* Gill, 1859 (one species); *Hemiramphus* Cuvier, 1829 (two species, includes *Farhians* Whitley, 1930 and *Ardeapiscis* Whitley, 1931 as synonyms); *Hyporhamphus* Gill, 1859 (nine species and subspecies, includes *Reporhamphus* Whitley, 1931 as a synonym); *Rhynchorhamphus* Fowler, 1928 (one species, includes *Loligorhamphus* Whitley, 1931 as a synonym); and *Zenarchopterus* Gill, 1863 (five species). Presentation of generic diagnoses and synonymies must await completion of further research, now in progress.

## GENERAL REMARKS

### *Commercial Value*

Garfishes have long been considered as valuable food and bait fishes in Australia and New Zealand. About 1,555,000 lbs were landed in Australia in 1970-71 (Anon., 1972a).

Data on individual species landings are not available in Queensland but a total of 128,000 lbs of garfishes was landed in 1970-71 (Anon., 1972a). This catch was probably composed largely of *Arrhamphus sclerolepis krefftii*, *Hemiramphus far*, *He. robustus*, and *Hyporhamphus quoyi*, all of which have been reported as food fishes in the State (Ogilby, 1916; Anon., 1945; Ogilby, 1954; Marshall *et al.*, 1959; Marshall, 1964; Grant, 1965). *He. far* is also important as a bait fish, especially for *Scomberomorus* (Coates, 1950).

Three species are important in New South Wales: *Arrhamphus s. krefftii*, *Hyporhamphus regularis ardelio*, and *Hy. australis* (Castelnau, 1879; Tenison-Woods, 1882; Ramsay, 1883a, 1883b; Ogilby, 1887, 1893; Cohen, 1892; Stead, 1906, 1908, 1910, 1911; Roughley, 1916, 1951, 1954; Whitley, 1962; Marshall, 1964). For *A. s. krefftii*, the catch per year has ranged from 11,581 to 116,984 lbs from 1961 to 1970; 25,414 lbs in 1970-71 (Anon., 1972b). For *Hy. r. ardelio* from 1961 to 1970, the catch has ranged from 121,164 to 192,443 lbs per year; 207,269 lbs were landed in 1970-71 (Anon., 1972b). For *Hy. australis*, the catch per year has varied from 54,070 to 119,933 lbs from 1961 to 1970; 94,731 lbs were landed in 1970-71 (Anon., 1972b). *Hy. australis* is also a sport fish (McIntyre, 1971).

The only species of garfish commonly found in the three southern most states is *Hy. melanochir* and it has long been considered an important food fish in these States—Victoria (Castelnaud, 1872; Lynch, 1966); Tasmania (Johnston, 1883, 1891; Lakin, 1968–72); South Australia (Waite, 1921, 1923; Ling, 1958; Scott, 1962). In South Australia, it is one of the three most important species of inshore fishes in terms of pounds landed (Ling, 1958). The catch per year in Tasmania has varied from 13,000 lbs (1966–67) to 138,000 lbs (1962–63) over the last decade (Lakin, 1968, 1969, 1970, 1971, 1972). In 1970–71, 572,000 lbs were landed in South Australia; 427,000 lbs in Victoria; and 60,000 lbs in Tasmania (Anon., 1972a). *Hy. melanochir* and *He. robustus* are probably the most important species of garfishes in Western Australia.

*Hy. ihi* has been long considered a popular food fish in New Zealand (Hector, 1872; Sherrin, 1886; Phillipps, 1918, 1921, 1927b; Powell, 1947; Graham, 1953, 1956). In 1970, 261 cwt were landed with a value of \$4,199 (Anon., 1971).

### Biology

Little has been published on the biology of most species of Australian garfishes other than casual observations on ecology and habits. A summary of the available information about food habits, reproduction, and predators is presented here.

All the species studied appear to be largely herbivores (but none of the small estuarine species of *Zenarchopterus* has yet been examined). The sea grass *Zostera* was found in more than 80% of the gut contents of specimens of *Hyporhamphus regularis ardelio* from Lake Macquarie, N.S.W., with less than 20% containing filamentous algae or diatoms (Thomson, 1959b). In Lake Macquarie, *Hy. australis* feeds primarily on *Zostera* and crustaceans, both categories present in over 80% of specimens examined by Thomson (1959b). Thomson (1957a) also studied the food habits of *Hy. melanochir*. Of 301 specimens taken throughout the year from several Western Australia localities, 70% contained the sea grass *Zostera*; 36% filamentous green algae such as *Enteromorpha*, *Cladophora*, and *Chaetomorpha*; 25% diatoms, usually mixed with algal filaments; 6% chironomid larvae; and 4% polychaetes. No seasonal variation was found. Graham (1939a) concluded that the chief food of *Hy. ihi* in Otago Harbour, N.Z., was *Zostera marina* (eel-grass), *Ulva lactuca* (sea lettuce), and various other seaweeds and algae found on the mudflats. Although Thomson and Anderton (1921) and Thomson (1931) recorded worms (such as *Harmothoea*, *Amphitrite*, and *Eunice*) and small crustaceans in the diet, these may have been taken accidentally (Graham, 1939a, 1956). In addition, data is available on the food habits of two Australian species from India. Talwar (1962) found that 70% of the gut contents of *He. far* and *Hy. quoyi* contained sea grasses (*Cymodocea*) along with 10% green algae (such as *Cladophora* and *Chaetomorpha*), 5% diatoms, and 5% polychaetes (*Nereis* and *Perinereis*).

Information is available on reproduction of two species of sea garfishes, *Hy. melanochir* and *Hy. ihi*. For *Hy. melanochir*, the spawning period, as deduced from ripe ovaries, is in the spring and summer, October to February in Western Australia (Thomson, 1957b), October to March in South Australia (Ling, 1958). The minimum size at first maturity in Western Australia is 245 mm fork length for males, 246 mm for females (Thomson, 1957b). In South Australia, most spawners were at least two or three years old (Ling, 1958). Fecundity was calculated by Thomson (1957b) as 1,280–3,000 eggs with a diameter of 1.5 mm when ripe. *Hy. melanochir* eggs are large and clear and have filaments with which they become attached to aquatic vegetation. Based on otoliths, *Hy. melanochir* reaches an age of at least VIII in South Australia (Ling, 1958).



Ripe *Hy. ihi* appear in December (Thomson, 1932), January (Thomson and Anderton, 1921), and February and March (Benham, 1938). The eggs are 2.5–2.6 mm in diameter, have many small oil globules, and are covered with long transparent filaments that attach the eggs to the vegetation (Thomson and Anderton, 1921; Thomson, 1932; Graham, 1939b). In the laboratory, the eggs hatch in 36–45 days (Thomson, 1932; Graham, 1939b). Development of the larvae up to four days has been figured by Graham (1939b, 1956).

Predators of garfishes include a number of species of fishes, sea birds, and man. Up to 30% by volume of the stomach contents of the large black cormorant, *Phalacrocorax carbo novaehollandiae* in the Gippsland Lakes, Vict., consisted in some months, of *Hy. r. ardelio* (Mack, 1941). Known natural predators of *Hy. melanochir* include the ruff, *Arripis georgianus* and the red-tailed tropic-bird, *Phaethon rubicauda* (Thomson, 1957a; Tarbottom, 1968). Predators of *Hy. ihi* include red cod, *Physiculus bachus*; kahawai, *Arripis trutta*; and red gurnard, *Currupeiscis kumu* (Graham, 1939a, 1956; Baker, 1971).

### Parasites

While examining Australian garfishes, copepods and isopods were removed. Seven species of copepods were identified by Dr Roger F. Cressey (USNM): Ergasilidae—*Ergasilus semicoleus* Cressey, *Paraergasilus* sp.; Bomolochidae—*Nothobomolochus denticulatus* (Bassett-Smith), *Bomolochus bellones* Burmeister; Caligidae—*Pseudopetalus formicoides* (Redkar, Rangnekar, and Murti); Anthosomatidae—*Lernanthropus belones* Krøyer; and Lernaeidae—*Lernaeenicus sayori* Yamaguti. After completion of further studies on the Hemiramphidae Dr Cressey and I plan to treat the copepod fauna of the family as we recently did for the Belonidae (Cressey and Collette, 1970).

Cymothoid isopods have been given to Dr Thomas E. Bowman (USNM) for subsequent study. At least some of the isopods fit the description of *Irona melanosticta* Schiodte and Meinert but there are taxonomic problems at the generic as well as the specific levels according to Mr David M. Damkaer (pers. comm.) who made a preliminary study of the material.

Parasites known from Australian garfishes, both from the literature and from Dr Cressey's identification of material collected during this study are listed by host in the same order as the species of garfishes are treated in the main part of this paper.

*Arrhamphus s. sclerolepis*: *Lernaeenicus sayori* from Townsville, Qld (female attached near dorsal fin of CSIRO uncat.); *Ergasilus semicoleus* from Port Bradshaw, N.T. (three females from gill filaments of USNM 173776); *Paraergasilus* sp. from Port Hedland, W.A. (six females under opercles of AMNH 40003); Caligidae sp. from SE. Gulf of Carpentaria (juvenile attached to dorsal fin of AMS I.1552-006). *A. s. krefftii*: *Lernanthropus belones* from Gladstone, Qld. (female, male, and immature from gill filaments of USNM 294075) and *Lernanthropus* sp. from Moreton Bay, Qld. (4 males from CSIRO C.2982).

*Hemiramphus far*: *Lernanthropus* sp. from Groote Eylandt, N.T. (male from the gill filaments of USNM 173777). *He. robustus*: *Nothobomolochus denticulatus* from Townsville, Qld. (2 females under opercles of QM I.6593-4) and *Lernaeenicus* sp. from Townsville, Qld. (female imbedded in belly anterior to pelvic fins of QM I.6594).

*Hyporhamphus regularis ardelio*: *Bomolochus bellones* from Sydney (female under gill cover, SU 8318) and Sussex Inlet, N.S.W. (six females between opercle and gills of three specimens, USNM 206570; *Lernaenicus sayori* (one female imbedded in the side of USNM 176889). *Hy. neglectus*: *Lernaenicus sayori* from Port Essington, N.T. (female in pharyngeal cavity of CSIRO C.1747) and *Pseudopetalus formicoides* from Port Essington (female imbedded in left nasal fossa of CSIRO C.1747) and Port Bradshaw, N.T. (female from USNM 173792). *Hy. australis*: *Bomolochus bellones* from under the opercles of specimens from Jervis Bay, (female from CSIRO uncat.) and Port Stephens (four females from USNM 206581); *Lernanthropus belones* from the gill arches of five specimens from Port Stephens (five females and three males from USNM 206581); and *Lernanthropus* sp. from Sydney (male from SU 20981).

Two species of copepods were common on *Hy. melanochir*. *Lernaenicus sayori* from Mangles Bay, W.A. (USNM 206569); Bunbury, W.A. (WAM P-6129); Mandurah, W.A. (USNM 206587); Cockburn Sound, W.A. (AMNH 40004); and Adelaide, S.A. (USNM 206586); a total of 12 females imbedded in the sides, belly, caudal peduncle, under the pectoral girdle, behind the lower jaw, and in the nasal fossa of 12 specimens. *Bomolochus bellones*, 62 females and 3 males, from under the opercles of 27 fish from Rottne Is., W.A. (WAM P-13408-13); Fremantle, W.A. (WAM P-308); Whitford Beach, W.A. (WAM P-2575); Cockburn Sound, W.A. (AMNH 40004); Mandurah, W.A. (USNM 206587); Albany, W.A. (CSIRO C.2528); Adelaide, S.A. (ZMK P-341781-9); Kangaroo Is., S.A. (CSIRO uncat.); and Tamar R., Tas. (USNM 206557).

There are two literature reports of copepods from Australian garfishes, both from *Hy. melanochir*. Heegaard (1962: 185) reported a female *Lernaenicus hemiramphi* Kirtisinghe from the eye of a specimen from St Vincent Gulf, S.A. Kabata (1966: 568) reported 13 females and 2 males of the euryphorid *Gloiopotes huttoni* (Thomson) from Adelaide. *Gloiopotes* is restricted to hosts in the families Istiophoridae, Xiphiidae, and Scombridae and *G. huttoni* is known primarily from istiophorid hosts with one record from *Xiphius* (Cressey, 1967). Both Dr Cressey and I feel certain some sort of mix-up has occurred in the host data for Kabata's record.

Hale (1926, 1929) has reported the cymothoid isopod *Irona melanosticta* from under the gill covers of South Australian specimens from Port Victor, the Gulf of St Vincent, and Port Adelaide. Isopods were collected from a number of the specimens examined for this paper but their identity is still in question.

*Hyporhamphus ihi*. No copepods were collected from this species and none are reported in the literature. Numerous cymothoid isopods were removed from the *Hy. ihi* examined for this study but they have not been positively identified. Several different isopods have been reported from New Zealand garfishes. Thomson (1889) found a single specimen of *Ceratothoa lineata* Miers (= *Codonophilus lineatus*) from a garfish from Nelson. Powell (1947) listed *Livoneca novaezelandiae* (Filhol) as common in the mouths of *Hy. ihi*. Hurley (1961) considered *C. novaezelandiae* a synonym of *C. imbricatus* (Fabricius). Stephenson (1969) discussed a large sample (164 females, 54 males, 21 juveniles) of *Irona melanosticta* from the Bay of Islands and Hauraki Gulf. *Livoneca* does not occur on *Hy. ihi* according to Stephenson (1969 and pers. comm.). An acanthocephalan, *Micracanthocephalus hemirhamphi*, has been described from the stomach of *Hy. ihi* from Otago Bay by Baylis (1944: 469-471).

*Hyporhamphus quoyi*: *Lernanthropus belones* from the gills of a specimen from Groote Eylandt, N.T. (female and three males from USNM 173785); *Nothobomolochus denticulatus* from under the opercles of seven fish from six N.T. localities: Darwin (two females from CSIRO C.1724 and one female, USNM 173779), Port Bradshaw (six females, USNM 173787), Pellew Is. (female, ANSP 86430), Groote Eylandt (two females, USNM 173784), and Yirrkala (female, USNM 173786). *Hy. affinis*: *Lernaenicus sayori* female imbedded laterally anterior to the anal fin origin in a specimen from Joseph Bonaparte Gulf, N.T. (CSIRO C.1727). *Hy. dussumieri*: *Pseudopetalus formicoides* female attached under the gill cover of a specimen from Cairns, Qld. (AMS IA.2946).

*Zenarchopterus buffonis*: *Ergasilus semicoleus* from Darwin, N.T. (about 20 females from the gill filaments of USNM 173767). *Z. caudovittatus*: Ergasilidae from Arnhem Land, N.T. (female from gill filaments of USNM 173769).

### Zoogeography

Based on their distribution patterns in Australia, the 20 taxa of garfishes can be divided into four groups: tropical freshwater-estuarine (the five species of *Zenarchopterus*, none of which is endemic); southwest and southeast estuarine endemic (*Hyporhamphus r. regularis* and *Hy. r. ardelio*); temperate marine endemic (*Hy. melanochir*, *Hy. australis*, and *Hy. ihi*); and tropical marine (the remaining ten taxa, three of which are endemic). Whitley has published zoogeographic maps of the marine provinces of Australia and New Zealand (1932b) and of the freshwater "fluvifaunulae" of Australia (1959a) based on the work of a long series of previous investigators. Although the borders and definitions of some of these regions have been modified by subsequent workers, (for example, see George, 1969 and included references), it may be instructive to compare the distribution of Australian garfishes with Whitley's maps.

(1) The five species of the freshwater and estuarine genus *Zenarchopterus* are found in the tropical northern part of Australia and all have ranges which extend outside of the continent. Three species are widespread outside of Australia, to the East Indies and Philippines (*Z. buffonis*), New Guinea and New Caledonia (*Z. dispar*), Madagascar to Guam and Fiji (*Z. gilli*). Their distributional patterns within Australia can be compared with the freshwater fluvifaunulae of Whitley (1959a). Three species occupy the northern (Leichhardtian) and northeastern (Jardinean) fluvifaunulae. The other two species are restricted to the Leichhardtian Fluvifaunule in Australia but extend further north as well, to New Guinea (*Z. caudovittatus*) or the Celebes (*Z. rasori*).

(2) Southwest and southeast estuarine endemic (Fig. 12). *Hyporhamphus r. regularis* inhabits estuaries and rivers of the southwestern fluvifaunule (Vlaminghian) and is replaced in New South Wales and eastern Victoria (Lessonian) by *Hy. r. ardelio*.

(3) Temperate marine endemic (Fig. 18). Three closely related allopatric species: *Hy. melanochir* inhabits the cold temperate Flindersian (Perth, W.A. to Vict.) and Maugean (Tas.) provinces; *Hy. australis* replaces it in the Peronian (N.S.W. to southern Qld.) Province and also in the Phillipian Province (Lord Howe and Norfolk Is.); and *Hy. ihi* is found in three provinces of the Neozelanic Region (Cookian—North Is., Forsterian—South Is., and Moriorian—Chatham Is.). Whitley (1932b) included the Phillipian Province in the Neozelanic Region based on previous malacological work but the presence of *Hy. australis* and other evidence (J. C. Briggs, pers. comm.) indicates that the closest relationship of these islands is to eastern Australia, not New Zealand.

(4) Tropical marine. The distribution of the ten taxa of this group is centered in the northern tropical part of the continent, the Dampierian Province, and extends south along east and west coasts for varying distances depending on the species. The five most tropical species are restricted to the northern part of the Dampierian plus the Banksian and Solanderian provinces. The Australian range of *Hyporhamphus affinis* is restricted to the Dampierian Province from Shark Bay, W.A. to Joseph Bonaparte Gulf, Timor Sea. *Hemiramphus far* (Fig. 9) and *Hy. neglectus* (Fig. 12) extend south to Broome on the west coast and to Palm Is. and the Cumberland Is., respectively, on the east coast. However, *Hy. neglectus* is confined to the more turbid coastal waters of eastern Queensland (Whitley's Banksian Province) while *He. far* is mostly present around the Barrier Reef (Solanderian Province). *Hy. dussumieri* has been taken in a couple of Arnhem Land and Western Australia collections but is most abundant in the Solanderian Province. Only five Australian specimens of *Rhynchorhamphus georgii* have been taken, from eastern Queensland and the Northern Territory.

The remaining five taxa all extend further south. *Arrhamphus s. sclerolepis* (Fig. 6) and *Hy. quoyi* reach Shark Bay on the west coast, a more reasonable limit to the Dampierian fauna than Geraldton as mapped by Whitley (1932b). On the east coast, both inhabit the Banksian Province, south to Bowen and Lindeman Is. for *A. s. sclerolepis* and south to Yamba Bay, N.S.W. for *Hy. quoyi*. The pair of species extending the farthest south is *He. robustus* (Fig. 9) and *Euleptorhamphus viridis* (Fig. 6), reaching at least to Perth on the west coast and Sydney on the east coast. There are a few records even further south, of *E. viridis* to Albany, W.A. and *He. robustus* to Long Is. in the Hogan Group north of Tasmania. *A. sclerolepis krefftii* (Fig. 6) crosses the border between the tropical Banksian and the temperate Peronian provinces in extending from about Rockhampton, Qld., south to at least Laurieton, N.S.W.

#### KEY TO AUSTRALIAN AND NEW ZEALAND SPECIES OF GARFISHES

1. Nasal papilla elongate and pointed, extending well out of nasal fossa (Fig. 3 middle); caudal fin rounded or truncate; anal rays and sometimes dorsal rays of males specialized, sometimes greatly elongate ..... *Zenarchopterus* ..... 16
- Nasal papilla rounded or fan-shaped, mostly confined to the nasal fossa (Fig. 3 top); caudal fin moderately to deeply forked; fin rays of males not modified..... 2
2. Lower jaw very short, less than one-fifth head length; pelvic fins inserted far anteriorly, P<sub>2</sub>-C extension falls very far anterior, on upper or lower jaw ..... *Arrhamphus sclerolepis* ..... 3
- Lower jaw longer, no shorter than half head length; pelvic fins placed further posteriorly, P<sub>2</sub>-C extension falling no further forward than preorbital ..... 4
3. Gill-rakers on first arch 21-25, usually more than 22; total gill-rakers on first plus second arches 37-45; vertebrae 45-48; lower jaw longer in specimens over 100 mm SL (Fig. 4) ..... *A. sclerolepis sclerolepis*
- Gill-rakers on first arch 18-23, usually less than 22; total gill-rakers on first plus second arches 33-39, usually 38 or less; vertebrae 48-50; lower jaw shorter in specimens over 100 mm SL (Fig. 4) .. *A. sclerolepis krefftii*

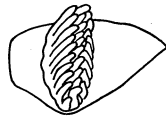
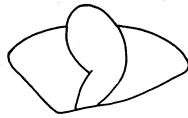


Figure 3. Diagrams of nasal papillae in (from top to bottom): *Hyporhamphus*, *Zenarchopterus*, and *Rhynchorhamphus*.

4. Pectoral fin very long, only 8-8½ rays; body strongly compressed and band-like; D 21-25; A 21-24 ..... *Euleptorhamphus viridis*  
 Pectoral fin much shorter, 10-14 rays; body rounded or only slightly compressed; D 12-18; A 10-20 ..... 5
5. Triangular part of upper jaw naked; preorbital ridge absent .. *Hemirhamphus* .. 6  
 Triangular part of upper jaw covered with small scales; preorbital ridge present ..... 7
6. Four-six dark blotches on sides of body; A 10 or 11 ..... *He. far*  
 One or no dark lateral blotches; A usually 12 or 13 ..... *He. robustus*
7. Upper jaw large and dome-shaped; nasal papilla fimbriate (Fig. 3 bottom); first arch gill-rakers 52-60 ..... *Rhynchorhamphus georgii*  
 Upper jaw flat or only slightly arched; nasal papilla rounded or fan-shaped, not fimbriate (Fig. 3 top); first arch gill-rakers 19-46 ..... *Hyporhamphus* ..... 8
8. Preorbital canal with posterior branch (Fig. 2) ..... 9  
 Preorbital canal without posterior branch (Fig. 1) ..... 14
9. Head length much greater than beak length in adults, slightly greater in juveniles ..... *Hy. quoyi*  
 Head length about equal to or less than beak length ..... 10
10. Preorbital canal narrow, usually slightly expanded at ventral pore; posterior branch of preorbital canal usually on a straight line with anterior branch (Fig. 2, a-g); A rays usually 18 or more ..... 11  
 Preorbital canal wider, greatly expanded at ventral pore; posterior branch forming an obtuse angle with anterior branch (Fig. 2, h-k); A usually 17 or less ..... 13
11. First arch gill-rakers usually 34 or more; second arch gill-rakers usually 27 or more ..... *Hy. australis*  
 First arch gill-rakers usually 33 or less; second arch gill-rakers usually 26 or less ..... 12
12. Pelvic fins placed further anteriorly, P<sub>2</sub>-C extension usually falls on pectoral base or opercle ..... *Hy. ihi*  
 Pelvic fins placed further posteriorly, P<sub>2</sub>-C extension usually falls on adpressed pectoral fins ..... *Hy. melanochir*
13. First arch gill-rakers usually 35 or less; second arch gill-rakers usually 24 or less; preorbital length much greater than upper jaw length ..... *Hy. affinis*  
 First arch gill-rakers usually 36 or more; second arch gill-rakers 26 or more; upper jaw longer than preorbital length ..... *Hy. dussumieri*
14. Second arch gill-rakers usually 23 or fewer; first arch gill-rakers 31 or fewer ..... *Hy. neglectus*  
 Second arch gill-rakers usually 23 or more; first arch gill-rakers 31 or more ..... *Hy. regularis* ..... 15

15. Lower jaw shorter (see Fig. 10); Western Australia ..... *Hy. r. regularis*  
 Lower jaw longer (see Fig. 10); S. Queensland to Victoria ..... *Hy. r. ardelio*
16. Upper jaw much longer than wide; width divided by length 0.6-0.7.  
 Pectoral fin nearly as long as head; head length divided by pectoral  
 length 0.9-1.0. Lower jaw shorter than head; head length divided  
 by lower jaw length 1.3-1.8 ..... *Zenarchopterus caudovittatus*  
 Upper jaw not as long; width divided by length 0.8-1.4. Pectoral fin  
 much shorter than head length; head length divided by pectoral  
 length 1.3-6.1. Lower jaw longer than head; head length divided by  
 lower jaw length 0.5-0.8 ..... 17
17. Upper jaw slightly longer than wide; width divided by length 0.8-0.9.  
 Anal rays 8 or 9 ..... *Z. rasori*  
 Upper jaw usually wider than long; width divided by length 0.9-1.4.  
 Anal rays 10-14 ..... 18
18. A dark brown line along midline of snout; dorsal and anal rays of male  
 modified but not reaching beyond caudal base ..... *Z. buffonis*  
 Snout unicolor brown; one or two dorsal rays of males thickened and  
 elongate; one or two anal rays of males greatly developed, reaching  
 past caudal base ..... 19
19. Sixth and seventh anal rays of males greatly elongated; two dorsal rays  
 (of 3rd, 4th, 5th) of males modified; D 11 or 12 ..... *Z. dispar*  
 Sixth anal ray of males greatly elongated; 4th and 5th dorsal rays of  
 males modified; D 10 or 11 ..... *Z. gilli*

## SPECIES ACCOUNTS

### *Arrhamphus sclerolepis* Günther

Snub-nosed Garfish

Figs 4-6, Tables 1-2

#### *Diagnosis*

*A. sclerolepis* differs from all other Australian garfishes in its very short lower jaw (Fig. 5) which extends only 1.5-11.0 mm beyond the upper jaw throughout the size range (17.9 to 277 mm SL). *Arrhamphus* shares this greatly reduced lower jaw with two other monotypic allopatric genera: *Melapedalion breve* (Seale) in the Philippines and *Chriodorus atherinoides* Goode and Bean in the western Atlantic. The lower jaw is even shorter in *Melapedalion* and it is essentially non-existent in adult *Chriodorus*. *M. breve* has been placed in *Arrhamphus* by some workers but it differs significantly in many characters: prominent posterior branch to preorbital canal; prominent black tips to upper and lower caudal lobes and to anterior dorsal and anal fin lobes; pelvic fins further posterior so that P<sub>2</sub>-C extension falls on orbit to preopercle; more gill-rakers; more vertebrae; etc. *Chriodorus* is similar to *Arrhamphus* in all these characters except that the pelvic fins are placed slightly further posteriorly, but not as far as in *Melapedalion*. The generic relationships of *Chriodorus* and *Arrhamphus* will be treated further in a subsequent paper.

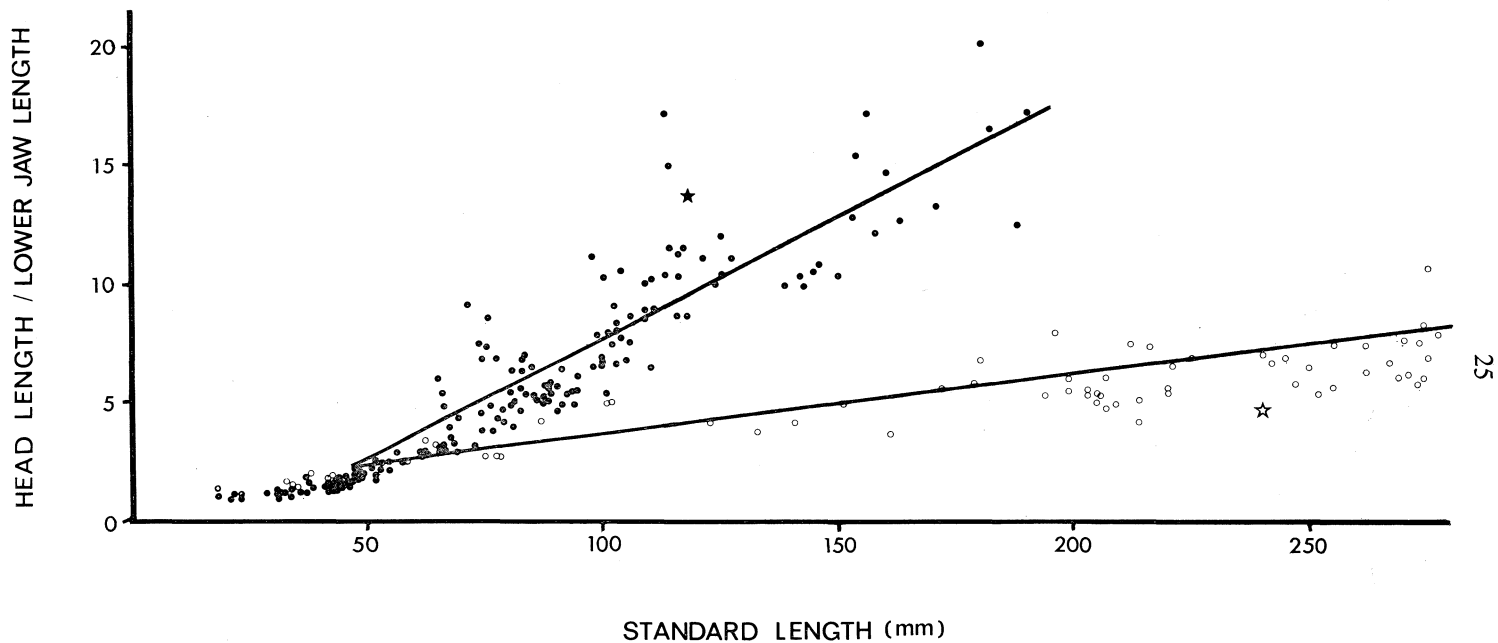


Figure 4. Change of ratio of head length divided by lower jaw length with size in the two subspecies of *Arrhamphus sclerolepis*. Open circles indicate the southeastern subspecies, *A. s. krefftii*; open star the holotype, NHMV uncat. Dots indicate the northern subspecies, *A. s. sclerolepis*; closed star the lectotype, BMNH 1862.11.15.127.



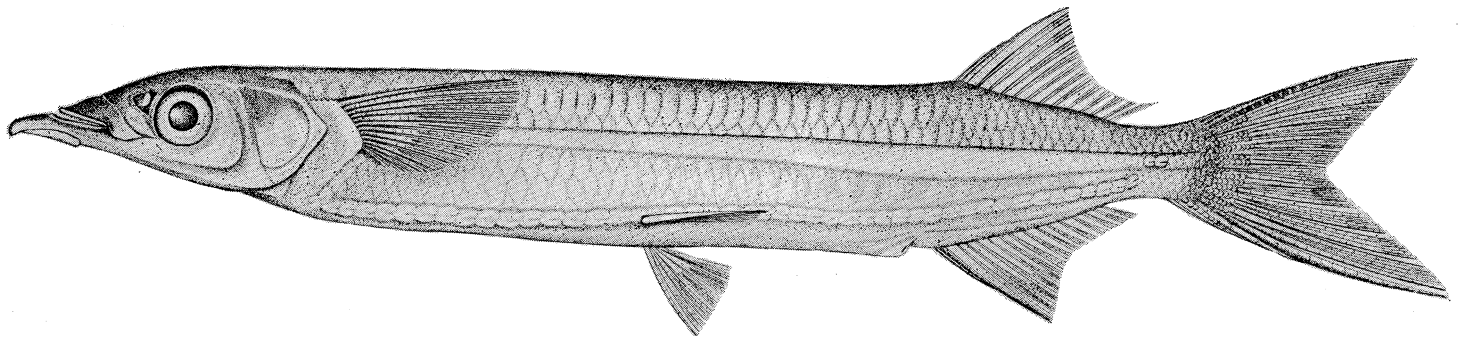


Figure 5. *Arrhamphus sclerolepis krefftii*, USNM 206571, 220 mm SL, Clarence River, N.S.W.

### Description

Preorbital canal a simple tube with a pore at each end and another in the middle (Fig. 1, a-b). Dorsal rays 13-16, usually 14-15; anal rays 14-17, usually 15-16; pectoral rays 12-14, usually 13. Vertebrae (28-32) + (17-19) = 45-50. Gill-rakers on first arch (5-8) + (14-18) = 18-25; on second arch (2-5) + (11-16) = 15-20. Lower jaw short, not increasing much with the growth of the fish. Head length divided by lower jaw length increases from 1.0-2.2 at small sizes (18-50 mm SL) to 5-20 at larger sizes (Fig. 4, and see geographic variation). Pelvic fins inserted very far anteriorly, much nearer pectoral fin origin than caudal base;  $P_2-C$  about twice  $P_1-P_2$ ;  $P_2-C$  extension falls on upper jaw to beyond tip of lower jaw. Dorsal and anal fin bases of about equal length, the dorsal fin base usually a little longer; dorsal base divided by anal base 0.93-1.18.

### Geographic Variation

Significant meristic and morphometric geographic variation exists in *Arrhamphus sclerolepis* (Tables 1-2). The meristic variation at first seemed to be clinal as it is in the number of gill-rakers in *Hyporhamphus quoyi*. However, dividing the specimens from the east coast of Australia into northern (MacKay to Cooktown, Qld.) and southern (Rockhampton south into New South Wales) populations clearly demonstrated that there are two groups of populations. The northern group extends across the top of Australia and down the coast of Western Australia.

The southeast population differs from the northern populations in having fewer gill-rakers on the first and second arches, more anal fin rays, and more vertebrae (Table 1). By adding the number of gill-rakers on the first and second arches, specimen by specimen, 94.4% of the southeast population can be separated from 96.8% of the northern populations. Correlated with the higher number of anal fin rays (modally 16 instead of 15), there are more vertebrae in the southeast population (48-50) than in those from the Gulf of Carpentaria, Northern Territory, and Western Australia (45-48). X-raying specimens was difficult in Australia so I have good data for only four populations. The number of dorsal and pectoral rays is relatively constant from population to population, usually 14 and 13, respectively.

Morphometrically each of the five populations differed from adjacent populations in some of the six characters analyzed (Table 2). Plotting the ratio of head length divided by lower jaw length against standard length shows two distinct groups of specimens at sizes over 100 mm SL (Fig. 4). The lower jaw remains proportionately longer in the southeast population (up to 10.9 times in head length) whereas the lower jaw becomes proportionately much shorter in all the northern populations (up to 20.2 times). In addition, the southeast population apparently reaches a greater length than the northern populations (277 vs. 218 mm SL).

The other morphometric differences are of less importance but do indicate that each population has diverged to some extent from adjacent populations. Each of the four northern populations differs significantly from the adjacent ones in the heights of regression of head length on standard length (Table 2). The N. Queensland population differs significantly from the Gulf of Carpentaria population in the slopes of regression of the length of the anal fin base. However, when N. and S. Queensland are combined and tested against the combined Gulf of Carpentaria, Darwin, and Western Australia group, neither slopes nor heights are significantly different ( $F = 2.69, 1.20$ ). The Western Australia population is significantly different from the Darwin population in the heights of regression of the  $P_1-P_2$  distance. However, when the populations to the east of Darwin are combined with Darwin and retested against the Western Australian population, again neither slopes nor heights are significantly different ( $F = 1.92, 0.78$ ).

**Table 1. Number of fin rays, gill-rakers, and vertebrae in populations of *Arrhamphus sclerolepis* (\* for New South Wales indicates count of holotype of *He. krefftii*, \* for types indicates lectotype of *A. sclerolepis*)**

Locality	Fin Rays														
	Dorsal						Anal						Pectoral		
	13	14	15	16	N	$\bar{x}$	14	15	16	17	N	$\bar{x}$	12	13	14
<i>A. s. krefftii</i>															
New South Wales ..	..	23	16*	2	41	14.49	..	3*	30	8	41	16.12	3*	31	7
SE. Queensland ..	2	14	5	..	21	14.14	..	4	14	3	21	15.95	1	8	4
<i>A. s. sclerolepis</i>															
NE. Queensland ..	..	42	12	..	54	14.22	1	34	18	1	54	15.35	7	15	..
Gulf of Carpentaria ..	4	21	15	..	40	14.28	6	30	4	..	40	14.95	2	17	1
Northern Territory ..	2	17	16	..	35	14.40	5	23	7	..	35	15.06	..	18	3
Western Australia ..	9	35	5	..	49	13.92	3	36	10	..	49	15.14	1	16	3
Types ..	..	2*	..	..	2	14.0	..	..	2*	..	2	16.0	..	2*	..
New Guinea ..	..	..	2	..	2	15.0	..	..	2	..	2	16.0	..	2	..

Table 1—continued

Locality	Gill-Rakers																							
	First Arch										Second Arch													
	18	19	20	21	22	23	24	25	N	$\bar{x}$	15	16	17	18	19	20	N	$\bar{x}$						
<i>A. s. krefftii</i>																								
New South Wales	2	11	12	16*	1	..	..	..	42	20.07	10	17*	14	1	..	..	42	16.14						
SE. Queensland	..	2	1	5	3	1	..	..	12	21.00	4	5	3	..	..	..	12	15.92						
<i>A. s. sclerolepis</i>																								
NE. Queensland	..	..	..	1	6	7	13	2	29	23.31	..	2	8	11	8	..	29	17.86						
Gulf of Carpentaria	..	..	..	2	5	12	16	5	40	23.43	..	..	4	15	16	5	40	18.55						
Northern Territory	..	..	..	1	1	9	12	2	25	23.52	..	..	3	10	10	2	25	18.44						
Western Australia	..	..	..	1	7	12	6	2	28	23.04	..	1	4	13	7	3	28	18.25						
Types	..	..	..	..	..	1	1*	..	2	23.5	..	..	..	1	1*	..	2	18.5						
New Guinea	..	..	..	1	..	..	1	..	2	22.5	..	1	1	..	..	..	2	16.5						
	Total Gill-Rakers on First and Second Arches										Total Vertebrae													
Locality	33	34	35	36	37	38	39	40	41	42	43	44	45	N	$\bar{x}$	45	46	47	48	49	50	N	$\bar{x}$	
<i>A. s. krefftii</i>																								
New South Wales	1	5	7	10	11*	7	1	..	..	..	..	..	..	42	36.19	..	..	..	2	14	3	19	49.05	
SE. Queensland	..	1	1	3	2	3	2	..	..	..	..	..	..	12	36.92	..	..	..	..	1	1	2	49.50	
<i>A. s. sclerolepis</i>																								
NE. Queensland	..	..	..	..	..	1	4	3	8	6	6	1	..	29	41.24	..	..	1	2	..	..	3	47.67	
Gulf of Carpentaria	..	..	..	..	..	1	2	4	8	10	9	4	2	40	41.93	..	2	26	6	..	..	34	47.12	
Northern Territory	..	..	..	..	..	..	1	3	5	6	8	1	1	25	41.96	..	2	20	4	..	..	26	47.08	
Western Australia	..	..	..	..	1	..	2	6	7	6	4	..	2	28	41.29	1	26	17	..	..	..	44	46.36	
Types	..	..	..	..	..	..	..	..	1	..	1*	..	..	2	42.0	..	..	1*	..	..	..	1	47.0	
New Guinea	..	..	..	..	..	1	..	1	..	..	..	..	..	2	39.0	..	..	..	1	..	..	1	48.0	

**Table 2. Comparison of regression equations and F values for slopes and heights of five morphometric characters and one ratio for five populations of *Arrhamphus sclerolepis* (\*\* = Significant at 99.9% level)**

Character	Regression equations Y =				
	New South Wales— S. Queensland	N. Queensland	Gulf of Carpentaria	Darwin	Western Australia
	Head length .. ..	0.2164X + 1.784	0.2198X + 1.932	0.2163X + 3.522	0.2150X + 2.440
P <sub>1</sub> -P <sub>2</sub> .. ..	0.2841X - 1.616	0.2748X - 1.425	0.2842X - 3.406	0.2592X - 0.262	0.2643X + 0.120
P <sub>2</sub> -C .. ..	0.5173X - 0.443	0.5410X - 2.034	0.5460X - 2.350	0.5331X - 1.470	0.5470X - 2.858
Base dorsal fin .. ..	0.1505X - 0.716	0.1623X - 1.116	0.1399X + 1.773	0.1508X + 0.398	0.1608X - 0.348
Base anal fin .. ..	0.1439X + 0.181	0.1484X - 0.575	0.1246X + 2.409	0.1354X + 0.871	0.1461X + 0.275
<u>Head length</u>					
Lower jaw length .. ..	0.0217X + 1.358	0.0959X - 2.429	0.1069X - 2.783	0.1155X - 3.876	0.0814X - 0.503

Character	F values							
	New South Wales— S. Queensland vs. N. Queensland		N. Queensland vs. Gulf of Carpentaria		Gulf of Carpentaria vs. Darwin		Darwin vs. Western Australia	
	Slopes	Heights	Slopes	Heights	Slopes	Heights	Slopes	Heights
Head length .. ..	0.221	1.08	0.185	20.72**	0.012	19.42**	5.36	17.14**
P <sub>1</sub> -P <sub>2</sub> .. ..	0.169	0.357	0.497	4.52	4.23	1.67	0.453	14.99**
P <sub>2</sub> -C .. ..	2.80	1.90	0.138	5.13	1.50	2.20	2.22	0.438
Base dorsal fin .. ..	2.29	3.72	10.26	1.31	2.52	0.965	3.91	0.849
Base anal fin .. ..	0.337	0.210	12.98**	0.780	1.84	2.48	4.90	5.66
Degrees of freedom .. ..	1, 66-68		1, 39-40		1, 38		1, 43	
<u>Head length</u>								
Lower jaw length .. ..	395**	(13.67)	1.25	3.62	0.360	0.542	7.59	3.34
Degrees of freedom .. ..	1, 123		1, 106		1, 76		1, 67	

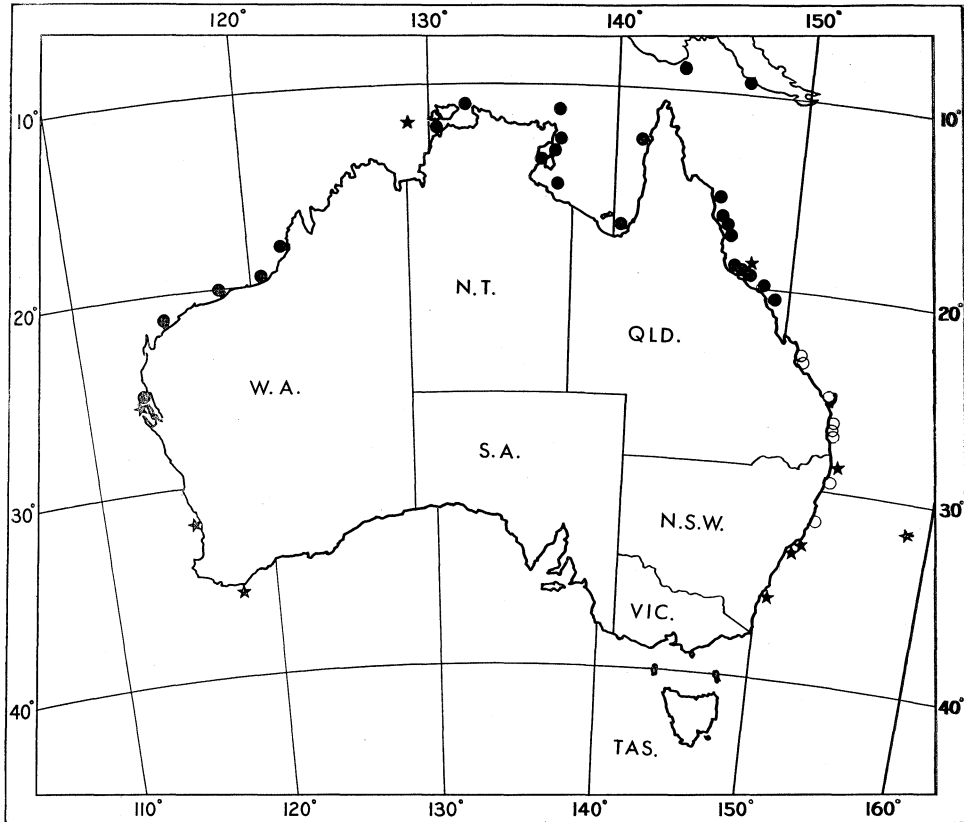


Figure 6. Distribution of *Arrhamphus s. sclerolepis* (dots), *A. s. kreftii* (open circles), and *Euleptorhamphus viridis* (stars) around Australia, based on specimens examined.

The sharp differences between the S. Queensland-New South Wales population on the one hand and the four northern populations on the other in numbers of vertebrae, anal fin rays, gill-rakers, and change in ratio of lower jaw length to head length convince me that there is differentiation on at least the subspecific level.

#### *Distribution*

Except for two records from southern New Guinea, *A. sclerolepis* is confined to the northern two-thirds of Australia (Fig. 6). The ranges of the two subspecies are given in the subspecies sections.

The types were originally recorded, as coming from “? New Zealand” by Günther (1866: 277). There is no locality data for either of the types in the original register books and no apparent reason for Günther to have indicated New Zealand as the type-locality. No subsequent specimens have been collected anywhere except Australia (and two individuals from southern New Guinea). Gill (1893: 113) noted that *A. sclerolepis* was wrongly credited to the New Zealand fauna and is a Queensland fish. In his checklist of New Zealand fishes, Whitley (1968a: 36) stated that *Arrhamphus sclerolepis* was Australian. The counts of gill-rakers (23 and 24 on the first arch; 18 and 19 on the second arch) and vertebrae (47) and the head length divided by lower jaw length (13.9 and 11.8) of the types indicate that they probably came from the Northern Territory or Western Australia so the northern population is the nominal subspecies *Arrhamphus sclerolepis sclerolepis* Günther and the southeast subspecies is *A. s. krefftii* (Steindachner).

#### *Material*

Listed under the subspecies accounts, 498 specimens (17.9–218 mm SL) from 45 collections of *A. s. sclerolepis* and 72 specimens (17.9–277) from 28 collections of *A. s. krefftii*.

### *Arrhamphus sclerolepis sclerolepis* Günther

#### Northern Snub-nosed Garfish

*Arrhamphus sclerolepis* Günther, 1866: 276–7 (original description of genus and species; “? New Zealand” [= Australia]). Hutton, 1872: 54 (description after Günther; doubtful New Zealand species). Macleay, 1878: 364 (Darwin). Klunzinger, 1880: 415 (Port Darwin [SMN 2603] and Port Denison [SMN 2274]; *He. krefftii* Steindachner a synonym of *A. sclerolepis*). Macleay, 1881: 248–9 (in part; Darwin). Sherrin, 1886: 305 (listed, New Zealand). Kent, 1889: 240 (Port Darwin district). Gill, 1893: 113 (*A. sclerolepis* a Qld. species). Rendahl, 1922: 175 (Roebuck Bay, W.A.). Paradise and Whitley, 1927: 80 (Pellew Is. [AMS IA.1486, 1686–7] and Darwin, N.T.). McCulloch, 1929: 104 (in part; N. Qld., N. Australia). Weed, 1933: 54 (description; status of genus). Anon., 1945: 8 (listed as Cairns, Qld. marketable fish). Whitley, 1945: 41 (NW. Australia). Whitley, 1948: 15 (North West Cape to 80 mile Beach and east, W.A.). Roughley, 1951: 23 (in part; W.A.). Fowler, 1957: 66 (Lady Musgrave Island [ANSP 93263], Qld.). Munro, 1957: 55 (in part; description; W.A., N.T., N. Qld.). Taylor, 1964: 103 (description; Arnhem Land [6 USNM collections], N.T.). Whitley, 1964b: 39 (listed). Marshall, 1964: 102–3 (in part; N. Qld., N.T.), colour pl. 6, fig. 112. Marshall, 1966: 112 (common Qld. food fish), colour pl. 6, fig. 112. Collette, 1966: 5 (vertebrae), 6 (pectoral rays), 7 (branchiostegal rays [USNM 173771]). Whitley, 1968a: 36 (*A. sclerolepis* an Australian not New Zealand species). Lake, 1971: 25 (in part).

### Diagnosis

Differs from *A. s. krefftii* in having fewer vertebrae and anal fin rays, more gill-rakers on both the first and second arches (Table 1), and in having a proportionately shorter lower jaw at larger sizes. The anal rays are modally 15 in *A. s. sclerolepis*, 16 in *A. s. krefftii*. The vertebrae number 45–48, usually 46 or 47, in *A. s. sclerolepis*; 48–50, usually 49, in *A. s. krefftii*. The gill-rakers on the first arch range from 21–25, usually 23 or 24, in *A. s. sclerolepis* compared to 18–23, usually 19–21, in *A. s. krefftii*. Similarly, the gill-rakers on the second arch range from 16–20, usually 18 or 19, in *A. s. sclerolepis*; 15–18 in *A. s. krefftii*. By adding the number of gill-rakers on the two arches, 96.8% of *A. s. sclerolepis* can be separated from 94.4% of *A. s. krefftii* on a dividing line between 38 and 39 gill-rakers. The lower jaw becomes proportionately much shorter with growth in *A. s. sclerolepis* than in *A. s. krefftii*. The ratio of head length divided by lower jaw length increases from 1.0–2.2 at small sizes (18–50 mm SL) in both subspecies to only 6.0–10.9 in *A. s. sclerolepis* over 270 mm SL compared to 10–20 in *A. s. krefftii* over 140 mm SL (Fig. 4).

### Description

Dorsal rays 13–15, usually 14 or 15; anal rays 14–17, usually 15 or 16. Vertebrae (28–31) + (16–19) = 45–48, usually 46 or 47. Gill-rakers on first arch (6–8) + (15–18) = 21–25, usually 23 or 24; on second arch (2–4) + (13–17) = 16–20, usually 18 or 19. Head length divided by lower jaw length increases from 1.0–2.2 at small sizes (18–50 mm SL) to 10–20 at sizes over 140 mm SL (Fig. 4, and see geographic variation).  $P_2-C$  divided by  $P_1-P_2$  1.75–2.40, means for the four populations 1.94–2.06. Dorsal base divided by anal base 1.05–1.18, means for the four populations 1.05–1.07.

### Maximum known size

218 mm SL (SMN 2274, Port Denison, Qld.).

### Types

*Arrhamphus sclerolepis* Günther. Lectotype; BMNH 1862.11.15.127; Royal College of Surgeons; “? New Zealand” here corrected to Australia (probably Northern Territory or Western Australia); female (118); herein selected because the other syntype is in bad condition. Lower jaw length 2.0 mm; head length 27.7 mm; head length divided by lower jaw 13.85;  $P_1-P_2$  31.1 mm;  $P_2-C$  64.0 mm;  $P_2-C$  extension falls well anterior to the tip of the lower jaw; D 14; A 16;  $P_1$  13–13; vertebrae 29 + 18 = 47;  $RGR_1$  7 + 17 = 24;  $RGR_2$  4 + 15 = 19. Preorbital canal without posterior branch (Fig. 1a). Paralectotype BMNH pre-reg.; “old collection;” 1 (191).

### Distribution

The northern *A. s. sclerolepis* occurs from Lindeman Island and Bowen, Qld. north to the tip of Queensland, across the top of Australia, and south along the coast of Western Australia to the Gascoyne River (Fig. 6). Two specimens have also been taken in southern New Guinea—Daru area, Dept Agr. Stock Fish. FO-808, 1 (199 mm) and Galley Reach, Manu-Manu, NW. of Port Moresby, DASF FO-2021, 1 (130 mm).

### Material

498 specimens (17.9–218 mm SL) from 45 collections arranged from south to north along the east coast of Queensland and then south and west from Cape York.



Queensland, 128 specimens (17.9–218) from 19 collections. AMS IA.6730; Lindeman Is., Cumberland Group; G. P. Whitley; 2 (182–186). SMN 2274; Port Denison; Müller; 3 (179–218). CSIRO; Ticklebelly Bay, Bowling Green Bay; Dec. 7, 1951; 3 (56.2–66.0). CSIRO; Cape Cleveland, Townsville; Dec. 6, 1951; 27 (32.2–64.5). AMS IA.2316–8; Townsville; W. E. J. Paradiçe; HMAS "Geranium"; Nov. 1924; 3 (139–160). BMNH 1927.2.10.18–20; Townsville; W.E.J. Paradiçe; HMAS "Geranium", Aug. 1924; 3 (130–155). CSIRO; Paluma Shoals, N of Bluewater Cr., Townsville; Nov. 24, 1941; 20 (34.8–62.6). CSIRO; Rollingstone Cr.; Dec. 11, 1951; 1 (54.5). CSIRO; Flying Fish Point, Innisfail; Feb. 14, 1951; 1 (41.2). AMS IB.1962–3; Cairns; R. le Rossignor; 2 (88.8–91.5). CSIRO; Cairns; Dec. 14, 1951; 35 (17.9–53.1). CSIRO; Port Douglas; Dec. 12, 1951; 2 (26.2–32.4). CSIRO; Port Douglas; Dec. 12, 1951; 15 (37.0–74.2). BMNH 1933.1.25.16; Low Is. off Port Douglas; 1 (154). AMS I.14504; Walkers Bay near Cooktown; A. R. McCulloch; Aug. 1918; 4 (100–106). WAM P-8104–5; Weipa, Gulf of Carpentaria; E. Gamberg; Nov. 1961; 2 (113–114). AMS I.15552–006; SE Gulf of Carpentaria off Norman R., 17° 30' N, 140° 45' W; CSIRO; Dec. 15, 1964; 1 (124). USNM 176891; "Great Barrier Reef"; J. Howard; April 8–May 29, 1952; 2 (168–188). ANSP 93263; "Lady Musgrave Is."; Geo. Vanderbilt; 1935; 1 (180).

Northern Territory, 95 specimens (32.0–190) from 17 collections. AMS IA.1486; Sir Edward Pellew Group, Gulf of Carpentaria; W. E. J. Paradiçe; HMAS "Geranium"; June 1923; 1 (190). AMS IA.1686–7; Sir Edward Pellew Group, Gulf of Carpentaria; W. E. J. Paradiçe; HMAS "Geranium"; Dec. 1923; 2 (116–163). USNM 173772; Little Lagoon, Umbakumba, Groote Eylandt, Gulf of Carpentaria; R. R. Miller 48–8; April 8–14, 1948; 1 (85.0). USNM 173773; Port Langdon, Groote Eylandt; R. R. Miller 48–10; May 1, 1948; 5 (65.2–105). USNM 173774; S. Bay, Bickerton Is., Gulf of Carpentaria; R. R. Miller 48–13; June 2, 1948; 1 (104). USNM 173776; Port Bradshaw S of Cape Arnhem; R. R. Miller 48–28; July 25, 1948; 23 (85.5–150); and AMS I.16153–002; 10. USNM 173775; Port Bradshaw S of Cape Arnhem; R. R. Miller 48–24; July 26, 1948; 11 (68.8–83.1). CSIRO; Marchinbar Is., Wessel Is.; Oct. 18, 1949; 2 (32.0–43.0). CSIRO C.1716; Port Essington, Cobourg Peninsula; 1 (103). USNM 173771; Nightcliff, 7 mi. N of Darwin; R. R. Miller 48–2; March 19, 1948; 26 (33.5–98.1). AMS I.5308–9; Darwin; Christie and Godfrey; 1902; 2 (153–158). AMS IA.3868; Darwin; L. Wilson; 1 (97.8). AMS IA.7778; Darwin; M. Ward; 1 (84.0). SMN 2603; Port Darwin; 1 (167). SIO 61–58–23A; Darwin; C. Russell and F. Stone; Oct. 17, 1960; 2 (106–110). SIO 61–701–23A; Darwin Bay; Naga Exped. 61–257; April 21, 1961; 2 (89.4–98.7). AMS IA.7804–6; "Northern Territory"; M. Ward; 3 (58.5–67.5).

Western Australia, 273 specimens (37.2–186) from 7 collections. WAM P-174; Broome; W. B. Alexander; 1914; 1 (186). AMNH 40002; Eighty Mile Beach 3 mi. N Wallal Homestead; D. E. Rosen, G. J. Nelson and W. H. Butler; DER 69–77; April 15, 1969; 14 (78.9–110). AMNH 40003; Pretty Pond, inlet outside Port Hedland; D. E. Rosen, G. J. Nelson, and W. H. Butler; DER 69–75; April 13, 1969; 184 (37.2–80.6); USNM 206748, 30; AMS I.16156, 20; and WAM P-20829–48, 20. AMS I.13253; Port Hedland; WA Fish Dept; Aug. 1914; 1 (171). WAM P-2836; Onslow; F. J. Rankin; Jan. 1945; 1 (180). WAM P-7592; Carnarvon Beach; R. M. Walker; Oct. 16, 1960; 1 (158). WAM P-7914; Gascoyne R. at Carnarvon; R. J. McKay; Aug. 28, 1960; 1 (38.8).

"New Zealand" = Australia. BMNH 1862.11.15.127; 1 (118); lectotype of *A. sclerolepis*. BMNH pre-reg.; 1 (191); paralectotype of *A. sclerolepis*.

### *Arrhamphus sclerolepis krefftii* (Steindachner)

#### Southeastern Snub-nosed Garfish

*Hemiramphus krefftii* Steindachner, 1867: 332–3 (original description; Port Jackson, N.S.W.; should be spelled *krefftii*), pl. 1, figs 1–2.

*Hemiramphus breviceps* Castelnau, 1878: 240 (original description; Brisbane).

*Hemiramphus argenteus*.—Castelnau, 1879: 353 (listed), 394 (*breviceps* a synonym of *argenteus*; common at Brisbane, seen only once at Sydney). Macleay, 1881: 246 (after Castelnau, 1879). Tenison-Woods, 1882: 22 (listed), 83 (after Castelnau, 1879). Ramsay, 1883b: 19 (rare in Sydney). Ogilby, 1887: 53 (after Castelnau, 1879; ?young of *He. intermedius*?). Kent, 1893: 298 (beak almost rudimentary), 370 (listed). McCulloch, 1921: 41 (after Castelnau). McCulloch and Whitley, 1925: 139 (after Castelnau). (Not *Hemiramphus argenteus* Bennett, 1840.)

*Arramphus sclerolepis* Günther, 1880: 33 (Mary R., Qld. [BMNH 1879.5.14.478-483]). Macleay, 1881: 248-9 (in part, Brisbane). Ogilby, 1887: 54 (E. Australia, Port Jackson; *He. Krefftii* Stdr. synonym of *A. sclerolepis*). Kent, 1893: 298 (Moreton Bay, Qld.), 370 (listed). Waite, 1904b: 20 (listed, N.S.W.). Stead, 1906: 68-9 (N.S.W. and Qld., most abundant in lower reaches of Clarence and Richmond R.; ascends into fresh water; reaches 15 inches and 9 oz.; valuable food fish), fig. 26. Stead, 1908: 38-9 (reaches 15 inches and 9 oz.). Ogilby, 1916: 6 (common, Moreton Bay and Brisbane R., Qld.), 49 (listed). Roughley, 1916: 31-2 (N.S.W. and Qld.; estuaries and coastal lakes; description; summer spawner; delicious food fish). McCulloch, 1921: 41 (Richmond and Clarence R. estuaries, N.S.W.), fig. 110a. McCulloch and Whitley, 1925: 138 (previous Qld. records). McCulloch, 1929: 104 (in part; N.S.W., S. Qld.). Roughley, 1951: 23 (in part; northern N.S.W., S. Qld.; moves far upstream; fine food fish). Ogilby, 1954: 9 (after Ogilby, 1916). Bleakly and Grant, 1954: 24 (S. Qld.; enters estuaries and fresh water; description). Munro, 1957: 55 (in part; description; S. Qld., N.S.W.), fig. 392 (after Steindachner, 1867). Marshall *et al.*, 1959: 26 (description, maximum size; Qld.), fig. Grant, 1965: 41 (in part; Qld.; description, habits), fig. Marshall, 1964: 102-3 (in part; description; S. Qld., N.S.W.; valuable food fish; reaches 15 inches), colour pl. 6. Marshall, 1966: 112 (common Qld. food fish), colour pl. 6. Lake, 1971: 25 (in part, southeast slopes, excellent food fish). Williams, 1971: 52 (listed; Brisbane R.). Grant, 1972: 67 (repeat of 1965 ed.).

*Hemirhamphus sclerolepis*.—Ogilby, 1893: 175-6 (description; northern N.S.W. rivers; New Zealand locality doubtful), pl. 44.

*Hemiramphus argenteus*.—McCulloch, 1929: 103 (listed, Qld., N.S.W.). Whitley, 1964b: 39 (listed, Australia).

*Arrhamphus brevis*.—Borodin, 1932: 73 (Brisbane, Qld. [VMM 900]). (Not *Oxyporhamphus brevis* Seale, 1909.)

### Diagnosis

*A. s. krefftii* (Table 1) has more anal fin rays (modally 16 instead of 15) and vertebrae (usually 49 vs. 46 or 47), fewer gill-rakers (usually 19-21 on the first arch compared to usually 23 or 24), and a proportionately longer lower jaw at larger sizes (Fig. 4) than *A. s. sclerolepis* as noted in the diagnosis of the nominal subspecies.

### Description

Dorsal rays 13-16, usually 14 or 15; anal rays 15-17, usually 16. Vertebrae (30-32) + (17-19) = 48-50 usually 49. Gill-rakers on first arch (5-6) + (13-16) = 18-23; on second arch (2-4) + (11-14) = 15-18, usually 16 or 17. Head length divided by lower jaw length increases from 1.0-2.2 at small sizes (18-50 mm SL) to 6.0-10.9 at sizes over 270 mm SL (Fig. 4, and see geographic variation).  $P_2-C$  divided by  $P_1-P_2$  1.62-3.22 ( $\bar{x}$  1.88). Dorsal base divided by anal base 0.93-1.10 ( $\bar{x}$  1.02).

### Maximum known size

277 mm SL (female, BMNH unreg., Clarence R., N.S.W.).

### Types

*Holotype: Hemirhamphus krefftii* Steindachner. NHMV 5559; Port Jackson, N.S.W.; 1 (240). Lower jaw length 10.8 mm; head length 51.3 mm; head length divided by lower jaw 4.75 (Fig. 4);  $P_1$ - $P_2$  67.9 mm;  $P_2$ -C 124 mm;  $P_2$ -C extension falls almost on tip of lower jaw; D 15; A 15;  $P_1$  12-12;  $RGR_1$  6 + 15 = 21;  $RGR_2$  3 + 13 = 16. Preorbital canal without posterior branch (Fig. 1b).

*Hemirhamphus breviceps* Castelnau. No types extant. Castelnau's description of *He. breviceps* could only be of either *Arrhamphus sclerolepis* or *Hyporhamphus quoyi* because of the very short lower jaw. His description fits comparable sized (120-130 mm SL) *Arrhamphus* much better than *Hy. quoyi*. Total head length in length without caudal: *He. breviceps*- $3\frac{1}{3}$ ; *Arrhamphus*-3.3-3.6; *Hy. quoyi*-2.4-2.9. Lower jaw extension in length without caudal: *He. breviceps*-12; *Arrhamphus* 11.2-40.9; *Hy. quoyi* 3.3-6.5. Interorbital distance compared to eye diameter: interorbital greater in *He. breviceps* and *Arrhamphus*; orbit greater in *Hy. quoyi*. Pectoral fin length compared to lower jaw length: pectoral longer in *He. breviceps* and *Arrhamphus*; lower jaw longer in *Hy. quoyi*. Pectoral fin compared to total head length: pectoral longer than half total head length in *He. breviceps* and *Arrhamphus*; half total head length greater in *Hy. quoyi*. The other characters given by Castelnau are either the same or similar in both *Arrhamphus* and *Hy. quoyi* or I am not sure enough how Castelnau measured them to be able to make comparisons.

### Distribution

*A. sclerolepis krefftii* occurs from at least Laurieton, N.S.W. (20 mi. S. of Port Macquarie) north to Rockhampton, Qld. (Fig. 6). There are several museum specimens labelled "Port Jackson" but they may have been purchased in the Sydney fish market and so may have been collected in the Clarence and Richmond rivers. There are catch records of "shortbeak garfish" south to Port Jackson, Botany Bay, and St Georges Basin.

### Material

72 specimens (17.9-277 mm SL) from 28 collections arranged from south to north.

New South Wales, 45 specimens (133-277) from 15 collections. USNM 206589; Laurieton, 20 mi. of S of Port Macquarie; Sydney mkt.; B. B. Collette and J. R. Paxton; BBC 1461; March 25, 1970; 9 (199-274). Clarence River, mostly purch. Sydney mkt.: USNM 47774; orig. AMS I.771; 1 (270). USNM 47797; "Port Jackson"; orig. AMS I.730; 1 (252). USNM 59865; D. G. Stead; 5 (133-275). AMS I.772; Aug. 1886; 1 (250). AMS I.7641-3; May 1906; 3 (199-206). AMS I.9519, 9521-3; "near Sydney"; 4 (179-221). AMS I.9855-6; March 1909; 2 (245-267). AMS I.13024-5; May 26, 1905; 2 (263-275). SU 20804; D. G. Stead; 1905; 2 (197-207). AMS I.15217-21; June 1920; 5 (225-269). AMS IA.6545-7; D. G. Stead; May 26, 1905; 3 (262-274). BMNH unreg.; D. G. Stead; April 2, 1912; 2 (243-277). USNM 206571; B. B. Collette and J. R. Paxton; BBC 1376; Dec. 6, 1969; 4 (203-220). NHMV 5559; "Port Jackson", Sydney; 1 (240); holotype of *He. krefftii* Steindachner.

Queensland, 27 specimens (17.9-229) from 13 collections: ANSP 95527; Bellevue Sta., 80 mi. up Brisbane R.; orig. QM I.3581, 3586; 2 (172-216). VMM 900; Brisbane; W. K. Vanderbilt, "Alva"; 1931-32; 1 (229). CSIRO C.2982; Moreton Bay; 1952; 1 (151). CSIRO; Bribie Is. Banks, Caloundra; May 1944; 1 (65.1). CSIRO; N. end Bribie Is.; Jan. 22, 1945; 2 (33.9-42.3). CSIRO; Caloundra; June 14, 1940; 3 (35.0-77.6). CSIRO; Tewantin, Noosa R.; Sept. 24, 1945; 2 (62.5-64.9). CSIRO; Noosa R. above Tewantin; Aug. 31, 1947; 3 (58.5-101). CSIRO; Lake Cooribah, Noosa R.; Aug. 7, 1944; 1 (68.3). BMNH 1879.5.14.478-483; Mary R.; "Challenger"; 2 (150-195). USNM 206558; Gladstone Harbour; B. B. Collette 1417; Dec. 11, 1969; 7 (17.9-123). AMS unreg.; Fitzroy R.; 1 (214). BMNH 1876.3.29.3; Rockhampton; Godeffroy Mus.; 1 (161).

**Euleptorhamphus viridis** (van Hasselt)

Fig. 6

*Esox maxilla superiore brevi; inferiore longissima, subulata; corpore lineare; squamis variis; cauda biloba.* "Kuddera. C" Russell, 1803: 62 (description; Vizagapatan, Coast of Coromandel, India), pl. 178.

*Hemiramphus viridis* van Hasselt, 1823: 131 (original description based on "Kuddera. C" Russell, 1803, pl. 178).

*Hemiramphus longirostris* Cuvier, 1829: 286 (original description based on "Kuddera. C" Russell, 1803, pl. 178).

*Hemiramphus macrorhynchus* Valenciennes in Cuvier and Valenciennes 1846: 55-56 (original description; Ellice Is., about 100 mi. E. of Nukufetau Is., formerly Peyster Is., at 180° 7' S.), fig. 556.

*Euleptorhamphus longirostris*.—Waite, 1903: 24 (Lord Howe Is. [AMS I.5335], new record). Waite, 1904a: 194 (Lord Howe Is.). Stead, 1907a: 4-6 (Bateman's Bay, N.S.W. [AMS I.15264], new N.S.W. record, description). Stead, 1908: 38 (after Stead, 1907). Waite, 1911: 28 (Kermadec Is., new record). Ogilby, 1916: 6 ("flight" in Wide Bay, Qld.). McCulloch, 1921: 41 (one N.S.W. record), pl. 10, fig. 109a. McCulloch and Whitley, 1925: 138 (Ogilby's 1916 record listed). McCulloch, 1929: 103 (Qld., N.S.W., Lord Howe Is., Kermadec Is.). Whitley, 1943: 177-8 (Bateman's Bay and Tuggerah Entrance, N.S.W. [AMS IB.615]; Albany district, W.A. [AMS I.11742]; Noosa R. specimen [AMS IA.7968] with no pelvic fins herein reidentified as *Hy. ardelio*). Whitley, 1948: 15 (W.A., listed). Roughley, 1951: 23-4 (Qld. to W.A., one N.S.W. record). Ogilby, 1954: 10 (after Ogilby, 1916). Munro, 1957: 55 (description; Qld., N.S.W., and W.A.), fig. 390. Whitley, 1964b: 39 (listed). Marshall, 1964: 102 (description; 2 Qld. records—N. of Gladstone and off Lady Elliott Is.), pl. 25, fig. 111. Marshall, 1966: 175, pl. 25, fig. 111. Whitley, 1968a: 36 (Kermadec Is. after Waite, 1911).

*Hemiramphus tweediei* Herre, 1936: 6-7 (original description; Singapore), pl. 2. Böhlke, 1953: 51 (holotype—SU 30979).

*Euleptorhamphus viridis*.—Parin, 1964 (description, taxonomy, distribution, geographic variation). Grant, 1972: 62 (col. pl.), 63 (description after Munro, 1957, 1967; known from 4 Qld. specimens that leapt aboard launches; N. of Gladstone, off Lady Elliott Is., and off Southport).

*Diagnosis*

*Euleptorhamphus viridis* differs strikingly from all other Australian garfishes in its ribbon-shaped, compressed body, very long pectoral fins, and very long lower jaw. The lower jaw may be as much as half of the standard length. It has more dorsal and anal rays than any other Australian species, 23-25 dorsal and 22-24 anal rays (as few as 21 dorsal and anal rays outside Australian waters) compared to a maximum of 18 dorsal rays (in *Hy. melanochir*) and 20 anal rays (in *Hy. melanochir* and *Hy. australis*). *E. viridis* has fewer pectoral rays than other Australian garfishes, only 8 or 9 compared to 10-14 (rarely 9 in some species of the estuarine genus *Zenarchopterus*). Gill-rakers on the first arch (5-9) + (18-23) = 25-33; gill-rakers on second arch reduced to small bumps that are difficult to count accurately. Vertebral number in *Euleptorhamphus* is much higher than in any other genus of garfishes (69-73 compared to 37-59, Collette, 1966).

*Maximum known size*

405 mm SL (WAM P-4732, Perth, W.A.).

*Types*

Both *Hemiramphus viridis* van Hasselt and *Hemiramphus longirostris* Cuvier are based on the figure of "Kuddera. C" in Russell (1803) and no type-specimens are extant.

*Hemiramphus macrorhynchus* Valenciennes. Type not found but figure in original description shows all the diagnostic characters of *E. viridis*.

*Hemiramphus tweediei* Herre. Holotype SU 30979; Selat Paoe, Malaya; April, 1923; A.W.C.T. Herre; 1 (180). Lower jaw length 86.0 mm; pectoral fin length 40.9 mm; D 22; A 21; P<sub>1</sub> 8-8; RGR<sub>1</sub> 8 + 21 = 29.

*Distribution*

An oceanic species found throughout tropical and sub-tropical waters in the Indo-Pacific (Parin, 1964) with only a few scattered Australian records (Fig. 6). It is basically a warm-water species but has been recorded as far south as Bateman's Bay, New South Wales and Albany, Western Australia.

*Australian Material*

16 specimens (86-405 mm SL) from 15 collections.

New South Wales: AMS I.15264; Bateman's Bay; Jan. 1907; 1 (312). AMS IB.615; ocean beach N of Tuggerah Entrance; P. Clifford; Jan. 1941; 1 (201). USNM 206852; off Newcastle; BBC 1465; April 6, 1970; 1 (250). AMS I.11088 and E. 1664; Byron Bay; "Endeavour"; June 26, 1910; 2 (272-300).

Lord Howe Island: AMS I.5335; F. Farnell; July 1902; 1 (338).

Queensland: AMS IB.5431; Townsville district; G. Coates; 1961; 1 (277).

Western Australia: CSIRO; 12° 02' S, 128° 59' E, Timor Sea; "Stanley Fowler"; Oct. 12, 1949; 1 (86.0). WAM P-304; Shark Bay; Fish. Inspector; 1 (365). CSIRO C.2578; Laurieion, Abrolhos Is.; May 1955; 1 (320). WAM P-4732; 2 mi. W. Marmion Beach, N of Perth; P. Richards; Feb. 7, 1960; 1 (405). WAM P-13780; Safety Bay, S of Perth; J. Munro; Dec. 20, 1962; 1 (345). WAM P-5505; Shoalwater Bay S of Perth; Jan. 7, 1963; 1 (390). AMS I.11742; Albany District; A. Abjornsson; June 1911; 1 (288). AMS IB.1959; W. Australia; A. J. Fraser; 1 (360). WAM P-1733; ?W. Australia?; 1 (332).

**Hemiramphus far** (Forsskål)

## Black Barred Garfish

Figs 7, 9

*Esox far* Forsskål, 1775: 67 (original description; Jidda, Red Sea).

*Esox gladius* Lacépède, 1803: 295 (original description; Indian Ocean), 308 (pl. 7, fig. 3).

*Hemiramphus commersonii* Cuvier, 1829: 286 (original description; based on Lacépède, 1803, pl. 7, fig. 3). Alleyne and Macleay, 1877: 349-50 (abundant about Cape York, Qld.).

- Hemiramphus commersoni*(i).—Günther, 1880: 50 (Somerset, Cape York, Qld.). Macleay, 1881: 247 (description; Port Jackson, N.S.W. to Cape York, Qld.). Tenison-Woods, 1882: 22 (listed), 83–4 (description; rare in Sydney). Ramsay, 1883a: 29 (rare in N.S.W.). Ramsay, 1883b: 19 (rare in N.S.W.). Munro, 1957: 56 (description; N.S.W., Qld., N.T., and W.A.), fig. 403. Grant, 1965: 40 (description after Munro, 1957; to 20 inches in N. Qld.), fig. Grant, 1972: 66 (description after Munro, 1967; text after Grant, 1965).
- Hemiramphus mocquardianus* Thomillot, 1886: 165–6 (original description; Cambodia).
- Hemiramphus far*.—Ogilby, 1887: 54 (range; Port Jackson; reaches 15 inches). Kent, 1893: 298–9 (large species; abundant Thursday Is. and Cooktown, Qld.). Waite, 1904b: 20 (N.S.W.). Stead, 1906: 68 (occasional in N.S.W., fairly common in Qld.). Stead, 1908: 37–8 (fairly common in northern N.S.W.). Cockerell, 1913: 51–2 (description of scales; Qld.). McCulloch, 1921: 41 (northern species common at times in N.S.W.). McCulloch and Whitley, 1925: 139 (previous Qld. records). Paradise and Whitley, 1927: 80 (Darwin and Pellew Is. [AMS IA.1436 and QM I.3968–70]; commonest and largest garfish).
- Hemiramphus far*.—Weber, 1895: 273 (Thursday Is., Qld.). McCulloch, 1929: 102 (N. Australia, Qld., N.S.W.). Roughley, 1951: 23 (northern N.S.W. to N. Qld.; baitfish). Ogilby, 1954: 10 (N. Qld.), fig. 11. Marshall *et al.*, 1959: 30 (description; Qld.), fig. (from Coates, 1950). Taylor, 1964: 104 (description, in part; Arnhem Land, N.T. [USNM 173777]). Marshall, 1964: 99–100 (description; common on Qld. coast; good food-fish; grows to 20 inches), colour pl. 6, fig. 108. Marshall, 1966: 174 (Qld.), colour pl. 6, fig. 108.
- Farhians commersonii*.—Whitley, 1930: 250–1 (*Farhians* new genus for *He. commersonii*; *He. far* (Forsskål) rejected as vernacular). Whitley, 1932a: 276 (synonymy; Low Isles off Port Douglas, Qld. [AMS IA.1676 and BMNH 1933.1.25.15]; description). Whitley, 1948: 15 (listed W.A.). Whitley, 1964b: 39 (listed).
- Hemiramphus fer* (sic).—Anon., 1945: 8 (listed among Cairns, Qld. marketable fishes). Coates, 1950: 47 (largest of N. Qld. garfishes; prized as baitfish; legal size 9 inches), fig.

### Diagnosis

A species of *Hemiramphus* distinguished by its four to six prominent vertical bars on the body (Fig. 7); most other species of the genus lack bars as adults although the other Australian species, *He. robustus*, has the remnants of one bar under the anterior part of the dorsal fin (Fig. 8). Australian specimens of *He. far* differ from most *He. robustus* in having 10 or 11 anal rays instead of 12–14, but a few *He. robustus* have 11 rays and non-Australian specimens of *He. far* sometimes have 12 rays.

### Description

Dorsal rays 12–14, usually 13; anal rays 10–11, rarely 12 in Australia; pectoral rays 12–13. Vertebrae (36–37) + 15 = 51–52 in three Australian specimens; (36–38) + (15–16) = 52–54 in a large series of specimens from Port Moresby, New Guinea. Gill-rakers on first arch (6–9) + (19–26) = 25–34, usually 29–31; on second arch (4–7) + (16–21) = 21–27, usually 22–25. Pectoral fin moderate in length; when extended forward, reaches anterior margin of nasal fossa to anterior margin of eye, usually on nasal fossa.

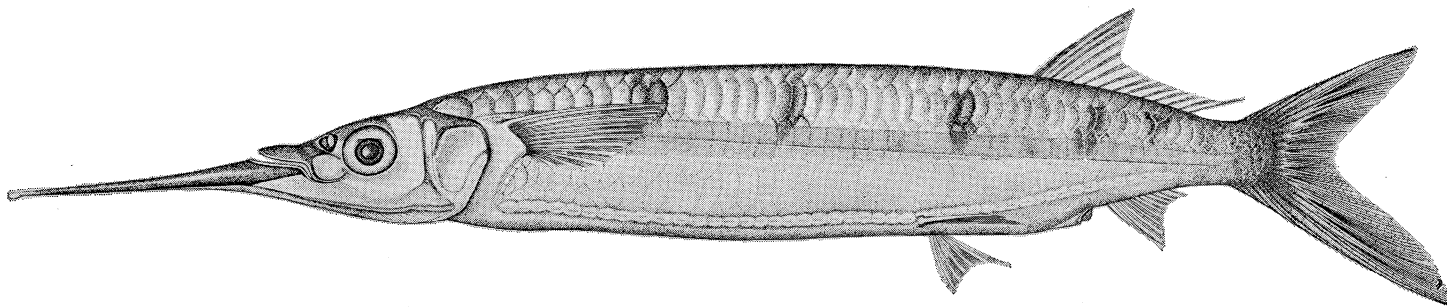


Figure 7. *Hemiramphus far*, USNM 137530, 263 mm SL, Philippine Is.

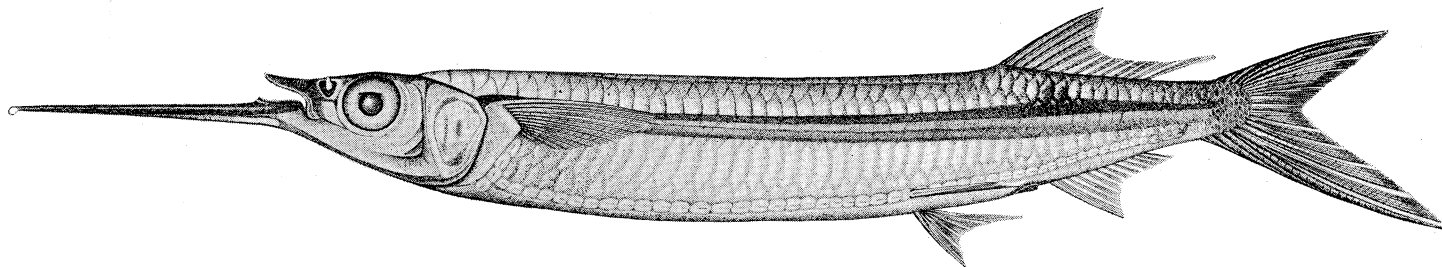


Figure 8. *Hemiramphus robustus*, USNM 206582, 265 mm SL, Perth, W.A.

*Maximum known size*

270 mm SL in Australia (MNHN A.7639, "Australie"), 317 mm elsewhere.

*Types*

*Esox far*, Forsskål, 1775. Type no longer extant according to Klauswitz and Nielsen (1965: 12).

*Esox gladius* Lacépède, 1803 and *Hemiramphus commersoni* Cuvier, 1829. No types, original description based on the figure in Lacépède (1803, pl. 7, fig. 3) which clearly shows four blotches on the sides of the body.

*Hemiramphus mocquardianus* Thominot, 1886. Holotype MNHN 86-2; Cambodia; 1 (140). D 12; A 11; P<sub>1</sub> 13-12; RGR<sub>1</sub> 9 + 23 = 32; RGR<sub>2</sub> 6 + 20 = 26; four prominent body bars.

*Discussion*

No significant meristic or morphometric differences were found between the Australian population and a large series from Port Moresby, New Guinea. Morphometric characters tested included lower jaw length, pectoral fin length, and body depth.

*Distribution*

Wide-spread in tropical Indo-West Pacific seas from East Africa and the Red Sea through the Indian Ocean to Australia, the East Indies, and the Philippine Islands. *He. far* has also traversed the Suez Canal to become established in the eastern Mediterranean Sea (Collette, 1965). In Australia, *He. far* is primarily a tropical species known from the Northern Territory and the northern parts of Western Australia and Queensland (Fig. 9). It is more common in the clear waters of the Barrier Reef than in the more turbid coastal waters of eastern Queensland where it is replaced by *He. robustus*. Several authors, starting with Macleay (1881), include New South Wales in the range of *He. far* but I have not seen any specimens south of the Palm Islands and suspect that most southern reports actually refer to *He. robustus*.

*Australian Material*

29 specimens (33.0-270 mm SL) from 18 collections arranged from south to north and then east to west.

Queensland: QM I.6437-8; Pencil Bay, Palm Is.; 2 (238-251). QM I.6643; Palm Is.; 1 (253). AMS IA.2237-8; Barnard Group, Great Barrier Reef, 17° 40' S; W. E. J. Paradise, HMAS "Geranium"; Nov. 1924; 2 (228-245). QM I.4077; Barnard Group, Great Barrier Reef, 17° 40' S; W. E. J. Paradise, HMAS "Geranium"; 1 (212); and ANSP 82296; same data; 1 (216). AMS IA.1676; Low Is., off Port Douglas; W. E. J. Paradise, HMAS "Geranium"; Dec. 1923; 1 (252). BMNH 1933.1.25.15; Low Is.; W. E. J. Paradise; HMAS "Geranium"; Dec. 1923; orig. AMS IA.4480; 1 (238). USNM 176888; Great Barrier Reef; J. Howard; May 29, 1953; 3 (160-187). USNM 176834; Great Barrier Reef; J. Howard May 1953; 1 (241). QM I.1223; Darnley Is., Torres Strait; 1 (248).

Northern Territory: AMS IA.1436; Sir Edward Pellew Group, Gulf of Carpentaria; W. E. J. Paradise, HMAS "Geranium"; June 1923; 1 (204). QM I.3968-70; Sir Edward Pellew Group, Gulf of Carpentaria; W. E. J. Paradise, HMAS "Geranium"; 3 (188-232). USNM 173777; Thompson Bay, Port Langdon, Groote Eylandt, Gulf of Carpentaria; R. R. Miller 48-10; May 1, 1948; 1 (205). AMS IA.7764; Croker Is.; M. Ward; 1 (226). CSIRO; off Black Point, Port Essington, Cobourg Peninsula; Oct. 3, 1949; 1 (33.0). SAM 1140; Palmerston; 1 (195).

Western Australia: WAM P-19108-11; Osborne Is., SE side Admiralty Gulf; R. W. George; Sept. 25, 1967; 4 (151-170). AMS IB.2650; Roebuck Bay; CSIRO; 1 (187).

Australia: MNHN A.7639; Castelnau; 1877-658, 659; 2 (206-270).



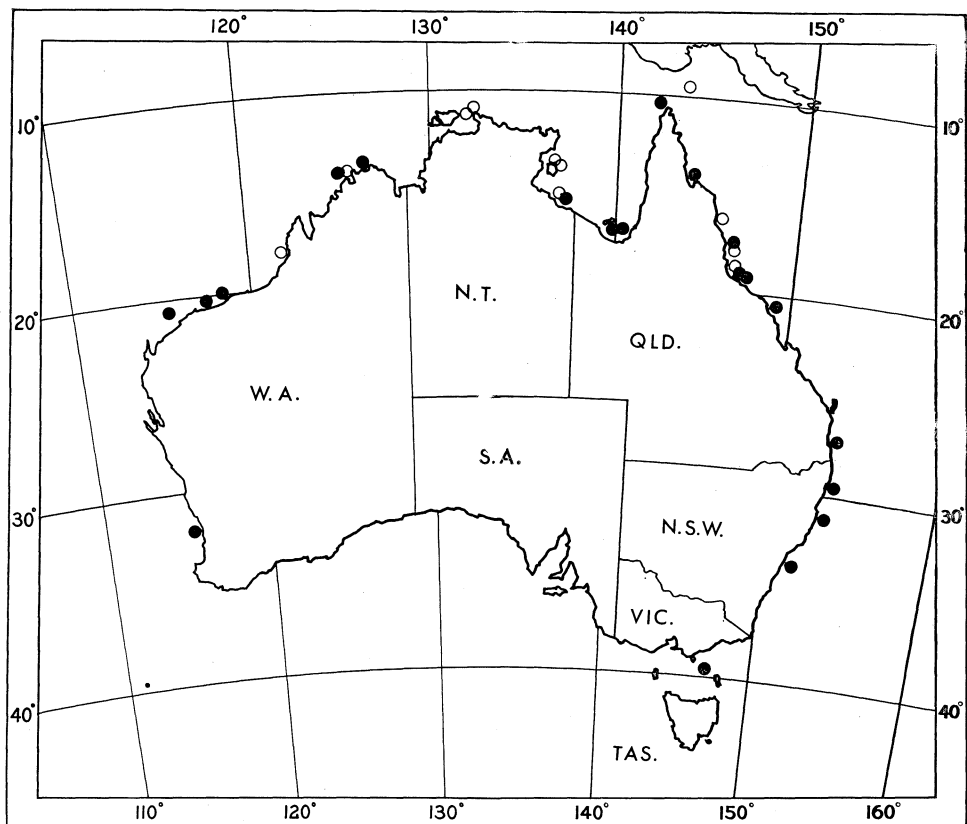


Figure 9. Distribution of two species of *Hemiramphus* (closed circles *He. robustus*, open circles *He. far*) around Australia, based on specimens examined.

**Hemiramphus robustus** Günther

Three-by-two Garfish

Figs 8-9

*Hemiramphus robustus* Günther, 1866: 270-1 (original description; Long Island, Tas.). Munro, 1957: 56 (description after Günther, 1866; "not noticed since original discovery").

*Hemiramphus welsbyi* Ogilby, 1908: 91-2 (original description; Moreton Bay, Qld.). McCulloch and Whitley, 1925: 139 (previous Qld. records). Paradice and Whitley, 1927: 80 (Pellew Is. [AMS IA.1678], N.T. and Thursday Is. [AMS IA.1677 and QM I.3974], Qld.; previously known only from types), pl. 11, fig. 2. Böhlke, 1953: 51 (paratypes—SU 20191). Munro, 1957: 56 (description; N.T., Qld., and W.A.), fig. 404 (from Paradice and Whitley, 1927). Grant, 1965: 39 (description after Munro, 1957; well-known in Brisbane markets, most popular garfish for filleting), fig. (from Marshall *et al.*, 1959). Grant, 1972: 65 (repeat of 1965 ed.).

*Hemiramphus welsbyi*.—McCulloch, 1929: 102 (listed; Qld., N. Australia). Anon., 1945: 8 (listed among Cairns, Qld. marketable fishes). Ogilby, 1954: 9-10 (all along Qld. coast; reaches 16 inches; excellent food-fish; extends further south than *He. far*). Marshall *et al.*, 1959: 31 (description; Qld. coast N. to Torres Strait and N.T.; well-known food-fish), fig. Marshall, 1964: 100 (description; popular food-fish), colour pl. 6, fig. 109. Marshall, 1966: 174 (Qld.), colour pl. 6, fig. 109.

*Hemiramphus robustus*.—McCulloch, 1929: 103 (listed; Tas.). Whitley, 1964b: 39 (listed).

*Ardeapiscis welsbyi*.—Whitley, 1931a: 314 (*Ardeapiscis* n. gen. for *He. welsbyi*). Weed, 1933: 56 (characters of genus). Whitley, 1947: 148 (Port Hedland [AMS I.13238] and Fremantle [AMS I.13237, 9], W.A., new state records). Whitley, 1964b: 39 (listed). Whitley, 1968b: 34 (Yamba [AMS IB.7112], N.S.W., new state record).

*Ardeapiscis* (sic) *welsbyi*.—Whitley, 1948: 15 (W.A. range, listed).

*Misidentifications:*

*Hemiramphus marginatus*.—Alleyne and Macleay, 1877: 349 (Palm Is.). Anon., 1945: 8 (listed among Cairns, Qld. marketable fishes). Marshall, 1964: 101 (N. Qld.).

*Hemiramphus cantori*.—Borodin, 1932: 73 (Brisbane [VMM 898], Qld.).

*Farhians commersonii*.—Whitley, 1945: 41 (Whitford Beach, Perth [WAM P.2572-3], W.A.).

*Hemiramphus far*.—Taylor, 1964: 104 (Paradice and Whitley's 1927 records from the Pellew Is. [AMS IA.1677 and QM I.3974], N.T.).

*Diagnosis*

An endemic Australian species of *Hemiramphus* which differs from *He. far* primarily in having only one dark blotch below the dorsal fin (Fig. 8) instead of 4-6 prominent dark bars on the sides (Fig. 7) and in usually having 12 or 13 anal rays instead of 10 or 11.

*Description*

Dorsal rays 13–15, usually 13 or 14; anal rays 11–14, usually 12 or 13; pectoral rays 12 or 13, usually 12. Vertebrae (35–37) + (17–19) = 52–55, usually 53 or 54. Gill-rakers on first arch (7–9) + (20–24) = 27–33, usually 29–31; on second arch (3–6) + (16–20) = 20–25, usually 22–25. Pectoral fin moderate in length, extending forward from the middle of the nasal fossa to anterior to the fossa, usually on the anterior margin of the fossa or anterior to the fossa. *He. robustus* does not differ significantly from *He. far* in the length of the pectoral fin or in body depth.

*Maximum known size*

315 mm SL (WAM P-2572, Perth).

*Types*

*Hemirhamphus robustus* Günther, 1866. Holotype BMNH pre-reg; Long Is., Hogan Group, Van Dieman's Land (= Tasmania); J. B. Jukes; female (198). D 14; A 12; P<sub>1</sub> 12–12; RGR<sub>1</sub> 9 + 22 = 31; RGR<sub>2</sub> 5 + 19 = 24; predorsal scales about 34; pectoral fin extended forward reaches to anterior third of nasal fossa; faint trace of blotch on body under first dorsal fin.

*Hemirhamphus welsbyi* Ogilby, 1908. Holotype QM I.1542; Moreton Bay, Qld; 1 (220). D 13; A 13; P<sub>1</sub> 12; RGR<sub>1</sub> 8 + 23 = 31; RGR<sub>2</sub> 4 + 19 = 23; predorsal scales about 35; pectoral fin extended forward reaches anterior margin of nasal fossa; faint blotch on body under dorsal fin. Paratypes AMS I.12539 (1,213) and SU 20191 (2, 234–252); Moreton Bay.

*Discussion*

The name *robustus* has apparently not been applied to any specimens following its original use by Günther in 1866. In his Handbook of Australian Fishes, Munro (1957) took its description from Günther. Examination of the types of *robustus* and *welsbyi* leaves no doubt that the two nominal species are conspecific; therefore, the more widely used junior synonym *welsbyi* is replaced by the senior synonym *robustus*.

Australian records of *He. marginatus* are either based on misidentified specimens of *He. robustus* (Alleyne and Macleay, 1877; Anon., 1945; Marshall, 1964) or accounts of *He. marginatus* have been copied from publications on extra-Australian specimens (Munro, 1957).

*Distribution*

Confined to Australia. Occurs along the northern coast of Australia with *He. far* but extends much farther south, at least to Sydney on the east coast (the type was described from Long Island, Tasmania) and to Perth, Western Australia (Fig. 9). Along the eastern coast of Queensland, *He. robustus* is mostly found in the more inshore turbid waters replacing *He. far* which is more common on the Barrier Reef.

*Material*

57 specimens (19.3–315 mm SL) from 30 collections.

Tasmania: BMNH pre-reg.; Long Is., Hogan Group, Van Dieman's Land; J. B. Jukes; 1 (198); holotype of *He. robustus*.

New South Wales: AMS I.9670; Port Jackson, Sydney; Macleay Mus.; Dec. 1908; 1 (248). AMS I.15223; Manning R.; D. G. Stead; May 3, 1906; 1 (229). BMNH 1914.8.20.91; Manning R.; D. G. Stead; 1 (200). AMS IB.7112; off Yamba; J. A. Garven; May 1963; 1 (223).

Queensland: QM I.1542; Moreton Bay; 1 (220); holotype of *He. welsbyi*. AMS I.12539; Moreton Bay; 1 (213); paratype of *He. welsbyi*. SU 20191; Moreton Bay; 2 (234-252); paratypes of *He. welsbyi*. QM I.7102; Moreton Bay; Brisbane mkt.; 1 (241). VMM 898; Brisbane; W. K. Vanderbilt, "Alva"; 1931-32; 1 (224). AMS IA.6729; Lindeman Is., Cumberland Group; G. P. Whitley; 1 (163) plus head of another specimen. QM I.5740; Townsville; 1 (182). QM I.6593-4; Townsville; 2 (196-199). QM I.7333; Rattlesnake Is., N. of Townsville; G. Coates; 1 (234). AMS IA.2239-40; Barnard Group, Great Barrier Reef, 17° 40' S.; W. E. J. Paradice, HMAS "Geranium"; Nov. 1924; 2 (205-210). CSIRO; Little N. Marret R., Princess Charlotte Sound; Sept. 27, 1948; 4 (19.3-29.8). AMS IA.1677; Thursday Is., Torres Strait; W. E. J. Paradice, HMAS "Geranium"; Dec. 1923; 1 (210). QM I.3974; Thursday Is., Torres Strait; W. E. J. Paradice, HMAS "Geranium"; 1 (175). AMS I.15557-048; S.E. Gulf of Carpentaria; 17° 20' S., 140° 12' E.; Nov. 23, 1964; CSIRO; "Rama" sta. 1567; 1 (172). AMS IB.6887; Inscription Point, Sweets Is., S. Welsley Is., Gulf of Carpentaria; D. McMichael and J. Yaldwyn; Dec. 9, 1963; 1 (181).

Northern Territory: AMS IA.1678; Sir Edward Pellew Group, Gulf of Carpentaria; W. E. J. Paradice, HMAS "Geranium"; Dec. 1923; 1 (187).

Western Australia: CSIRO out of C.1751; Mission Bay, Napier Broome Bay; 1 (110). WAM P-19112; Osborne Is., Admiralty Gulf; R. W. George; Sept. 25, 1967; 1 (149). AMS I.13238; Port Hedland; W.A. Fish. Dept; Aug. 1914; 1 (196). AMS IB.2641; Depuch Is.; CSIRO; 1 (190). WAM uncat.; Barrow Is., N. of Onslow; WAM-USNM Exped.; Aug. 25, 1966; 1 (170). WAM P-2572-3; Whitford Beach, Perth; Dec. 1943; 2 (267-315). USNM 206582; Whitford Beach, Perth; purch. Perth mkt.; B. B. Collette, J. R. Paxton, R. J. McKay; BBC-1448; Feb. 13, 1970; 14 (250-295); BMNH 1970.7.28.4-5, 2; AMS unreg., 4. AMS I.13237; Fremantle; W.A. Fish. Dept; Aug. 1914; 1 (260). AMS I.13239; Fremantle; W.A. Fish. Dept; Aug. 1914; 1 (267).

## **Hyporhamphus regularis** (Günther)

### River Garfish

Figs 10-13, Tables 3-4

#### *Diagnosis*

The river garfish *Hy. regularis* and *Hy. neglectus* are similar to the type-species of *Hyporhamphus*, *Hy. unifasciatus* (Ranzani) and other Atlantic and eastern Pacific species of the genus in having an emarginate caudal fin, lacking a distinct posterior branch to the preorbital canal, and in having the upper jaw distinctly wider than long. All the other Australian species of *Hyporhamphus* have a more deeply forked tail and a distinct posterior branch to the preorbital canal. Among Australian garfishes, *Hy. regularis* is most similar to *Hy. neglectus* but is a larger species (maximum size of 280 vs. 149 mm standard length). *Hy. regularis* has more gill-rakers (Table 3), usually 23 or more on the second arch (compared to usually 23 or less), and usually 31 or more on the first arch (usually 31 or less). The pelvic fins are placed relatively further posteriorly in *Hy. regularis* so that the P<sub>2</sub>-C extension usually reaches the orbit instead of anterior to it as in *Hy. neglectus* (Table 3). *Hy. regularis* usually has more vertebrae (Table 3) than *Hy. neglectus* (52 or more vs. 51 or less) except in eastern Queensland where both *Hy. r. ardelio* and *Hy. neglectus* have the same range (51-53) and mean (52.00).

**Table 3. Number of fin rays, gill-rakers, and vertebrae, and position of pelvic fins in populations of *Hyporhamphus regularis ardelio*, *Hy. neglectus*, and *Hy. r. regularis* (\* indicate types)**

Species and Population	Fin Rays														
	Dorsal							Anal							
	13	14	15	16	17	N	$\bar{x}$	14	15	16	17	18	19	N	$\bar{x}$
<i>Hy. r. ardelio</i>															
Victoria .. ..	..	1	5	2	..	8	15.13	..	..	3	5	..	..	8	16.63
New South Wales .. ..	..	18	62*	5	1	86	14.87	..	..	34	49*	3	..	86	16.65
E. Queensland .. ..	..	12	21	2	..	35	14.71	..	1	20	14	..	..	35	16.37
<i>Hy. neglectus</i>															
E. Queensland .. ..	..	4	18	7	..	29	15.10	..	..	14	15	..	..	29	16.52
Gulf of Carpentaria .. ..	..	6	10	2	..	18	14.78	..	2	9	7	..	..	18	16.28
N. Territory .. ..	9	20	11	2	..	42	14.14	9	5	13	14	..	..	41	15.78
W. Australia .. ..	..	..	11	2	..	13	15.15	..	..	4	9	..	..	13	16.69
East Indies .. ..	..	3	1*	..	..	4	14.25	..	3	1*	..	..	..	4	15.25
<i>Hy. r. regularis</i> .. ..	..	6	31*	11	..	48	15.10	..	..	7	38*	2	1	48	16.94
	First Arch Gill-rakers														
	25	26	27	28	29	30	31	32	33	34	35	36	N	$\bar{x}$	
<i>Hy. r. ardelio</i>															
Victoria .. ..	..	..	..	..	..	1	1	1	3	1	..	..	7	32.29	
New South Wales .. ..	..	..	..	..	..	6	14	22	17	11*	4	1	75	32.39	
E. Queensland .. ..	..	..	..	..	..	2	3	5	5	2	..	..	17	32.12	
<i>Hy. neglectus</i>															
E. Queensland .. ..	..	..	1	1	1	3	4	3	5	..	..	..	18	31.06	
Gulf of Carpentaria .. ..	..	..	..	..	1	1	4	3	1	..	..	..	10	31.20	
N. Territory .. ..	1	6	5	2	4	4	4	..	..	..	..	..	26	28.15	
W. Australia .. ..	..	..	..	..	..	2	2	1	2	..	..	..	7	31.43	
East Indies .. ..	1	1	2*	..	..	..	..	..	..	..	..	..	4	26.25	
<i>Hy. r. regularis</i> .. ..	..	..	..	..	..	1	7	10*	5	2	..	..	25	32.00	

Table 3—continued

Species and Population	Second Arch Gill-rakers												N	$\bar{x}$						
	18	19	20	21	22	23	24	25	26	27										
<i>Hy. r. ardelio</i>																				
Victoria .. .. .	..	..	..	..	..	..	..	..	..	..	..	1	3	3	7	26.29				
New South Wales ..	..	..	..	..	..	1	5	22	22*	21	3	74	24.89							
E. Queensland .. ..	..	..	..	..	..	..	4	5	6	2	..	17	24.35							
<i>Hy. neglectus</i>																				
E. Queensland .. ..	..	2	..	3	6	7	..	..	..	..	..	18	21.89							
Gulf of Carpentaria ..	..	..	..	2	3	3	3	..	..	..	..	11	22.64							
N. Territory .. .. .	3	8	9	1	3	1	1	..	..	..	..	26	20.00							
W. Australia .. .. .	..	..	..	2	3	2	..	..	..	..	..	7	22.00							
East Indies .. .. .	..	..	1	1	2*	..	..	..	..	..	..	4	21.25							
<i>Hy. r. regularis</i> .. ..	..	..	..	1	1	8	11*	4	..	..	..	25	23.64							
	Gill-rakers on First plus Second Arch																			
	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	N	$\bar{x}$
<i>Hy. r. ardelio</i> .. .. .	..	..	..	..	..	..	..	..	..	2	7	8	13	9	19	11*	6	3	78	57.17
<i>Hy. neglectus</i>																				
E. Queensland .. ..	..	..	1	..	1	1	..	2	1	2	4	2	4	..	..	..	..	..	18	52.04
Gulf of Carpentaria ..	..	..	..	..	..	..	1	..	1	1	2	..	2	1	..	..	..	..	8	54.00
N. Territory .. .. .	4	2	3	5	1	2	3	1	1	2	2	..	..	..	..	..	..	..	26	48.15
W. Australia .. .. .	..	..	..	..	..	..	..	1	1	..	4	1	..	..	..	..	..	..	7	53.43
East Indies .. .. .	..	1	..	1	..	2*	..	..	..	..	..	..	..	..	..	..	..	..	4	47.50
<i>Hy. r. regularis</i> .. ..	..	..	..	..	..	..	..	..	1	1	5	5	5*	3	3	2	..	..	25	55.72

Table 3—continued

Species and Population	P <sub>2</sub> -C Extension <sup>1</sup>								Total Vertebrae															
	1	2	3	4	5	6	N	$\bar{x}$	47	48	49	50	51	52	53	54	55	56	57	58	N	$\bar{x}$		
<i>Hy. r. ardelio</i>																								
Victoria . . . . .	..	..	2	3	2	..	7	3.0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	7	55.57
New South Wales ..	..	..	2	3	30	24*	9	68	4.5	..	..	..	..	1	9	24*	15	4	1	..	..	54	53.28	
E. Queensland ..	..	..	1	5	5	4	5	20	4.4	..	..	..	..	3	5	3	..	..	..	..	..	4	52.00	
<i>Hy. neglectus</i>																								
E. Queensland ..	3	8	3	2	..	..	16	2.3	..	..	..	..	1	5	1	..	..	..	..	..	..	7	52.00	
Gulf of Carpentaria ..	1	8	3	6	1	..	19	2.9	..	..	..	5	10	..	1	..	..	..	..	..	..	16	50.81	
N. Territory ..	2	17	4	2	..	..	25	2.2	5	8	3	5	3	..	..	..	..	..	..	..	..	24	48.71	
W. Australia ..	3	6	1	..	..	..	18	1.8	..	..	1	2	1	..	2	..	..	..	..	..	..	6	51.00	
East Indies ..	..	1*	2	1	..	..	4	3.0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
<i>Hy. r. regularis</i>	..	..	6	10*	9	3	1	29	3.4	..	..	..	..	1	5	12	3	..	..	..	1	22	54.00	

<sup>1</sup> P<sub>2</sub>-C extension coded as follows: 1 = upper jaw; 2 = preorbital; 3 = orbit anterior to pupil; 4 = pupil; 5 = orbit posterior to pupil; 6 = preopercle.

**Table 4. Comparison of regression equations and F values for slopes and heights of eight morphometric characters for three Australian taxa of *Hyporhamphus* (\*\* = Significant at 99.9% level)**

Character	Regression Equations Y =			F values					
	<i>Hy. r. regularis</i>	<i>Hy. r. ardelio</i>	<i>Hy. neglectus</i>	<i>Hy. r. ardelio</i> vs. <i>Hy. r. regularis</i>		<i>Hy. r. ardelio</i> vs. <i>Hy. neglectus</i>		<i>Hy. r. regularis</i> vs. <i>Hy. neglectus</i>	
Lower jaw length ..	0.2002X + 2.608	0.1642X + 6.945	0.0774X + 13.099	<i>Slopes</i> 9.25	<i>Heights</i> 0.502	<i>Slopes</i> 18.99**	<i>Heights</i> 8.51	<i>Slopes</i> 43.43**	<i>Heights</i> 4.33
Head length ..	0.1285X + 6.985	0.2134X + 0.505	0.2317X - 1.663	90.95**	(65.27)	3.17	1.35	60.82**	11.75
P <sub>1</sub> -P <sub>2</sub> .. ..	0.3459X - 2.299	0.3398X - 0.772	0.3115X + 0.404	0.466	3.67	6.84	22.55**	5.83	3.78
P <sub>1</sub> -C .. ..	0.4600X - 0.646	0.4597X - 1.154	0.4812X - 0.961	-0.029	1.31	1.98	24.76**	2.72	22.71**
Base dorsal fin ..	0.1504X - 0.226	0.1478X + 0.347	0.1504X + 0.640	0.257	1.10	0.144	6.13	-0.005	18.68**
Base anal fin ..	0.1430X + 0.565	0.1384X + 0.590	0.1398X + 1.270	0.576	4.81	0.033	8.83	0.134	1.92
Upper jaw length ..	0.0351X - 0.124	0.0346X - 0.282	0.0411X - 0.832	0.044	5.02	2.55	1.23	2.33	0.670
Upper jaw width ..	0.0558X - 0.861	0.0547X - 0.529	0.0493X - 0.281	0.153	2.07	0.932	4.94	3.03	1.31
Degrees of freedom ..				1, 74-79		1, 68-83		1, 46-56	



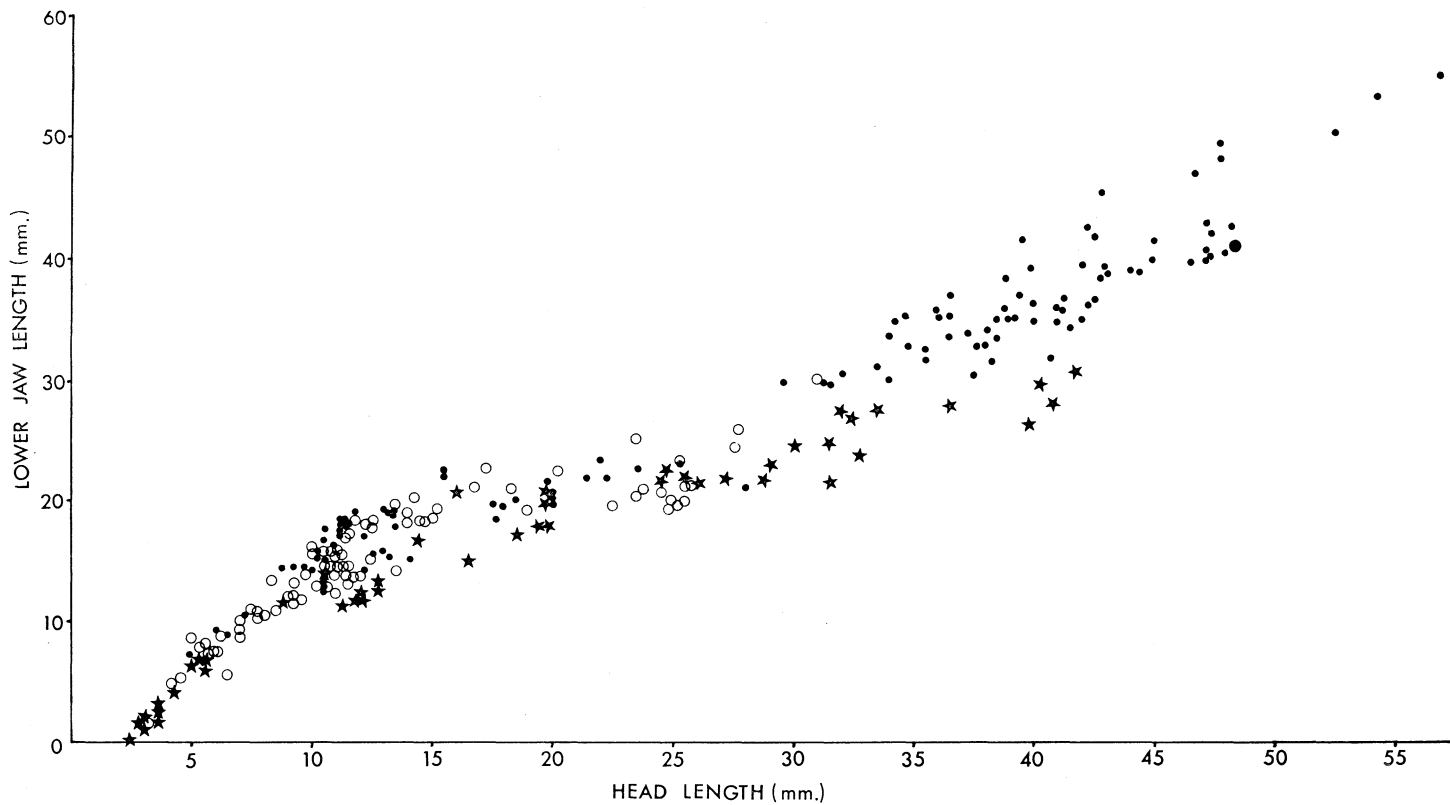


Figure 10. Relationship of lower jaw length to head length in two Australian species of *Hyporhamphus* (stars = *Hy. r. regularis*; dots = *Hy. r. ardelio*, large dot = lectotype; open circles = *Hy. neglectus*).

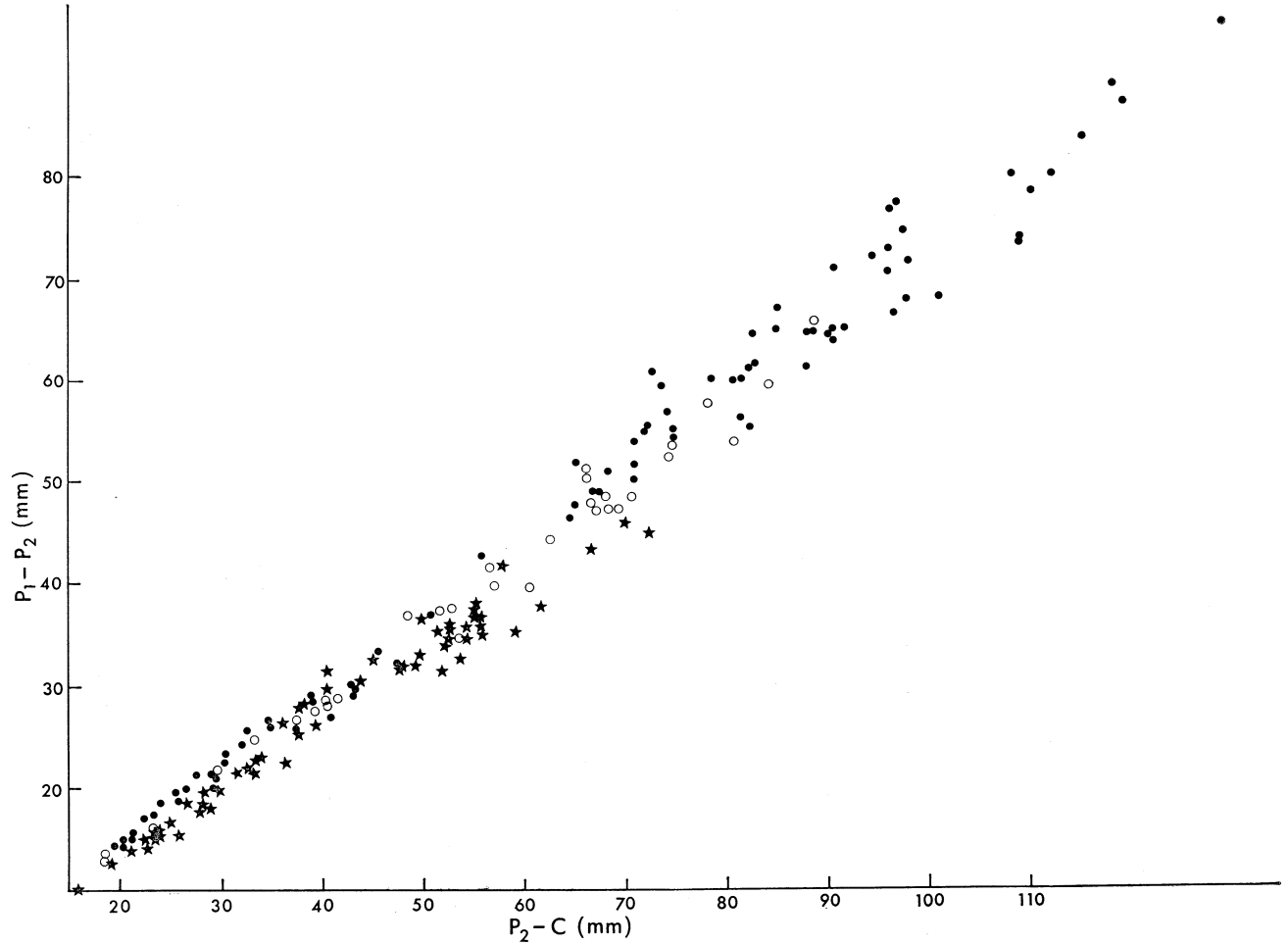


Figure 11. Relationship of pectoral to pelvic distance ( $P_1 - P_2$ ) with pelvic to caudal base distance ( $P_2 - C$ ) in two Australian species of *Hyporhamphus*. Open circles = *Hy. r. regularis*; dots = *Hy. r. ardelio*; and stars = *Hv. neglectus*.

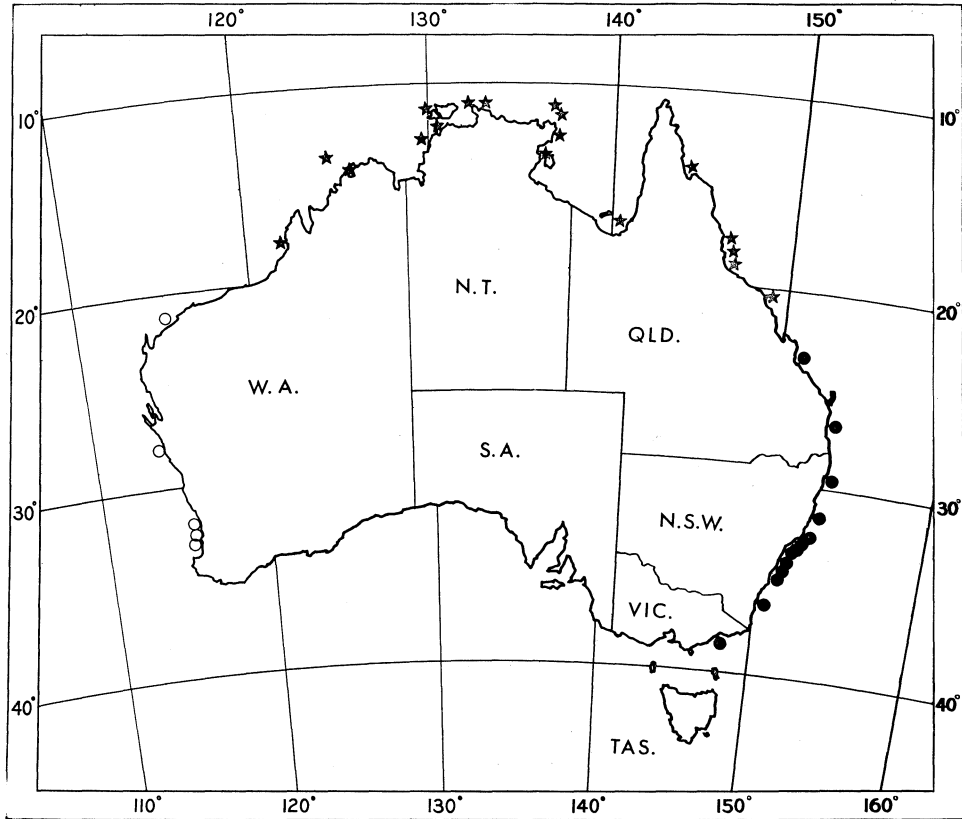


Figure 12. Distribution of two species of *Hyporhamphus* (open circles = *Hy. r. regularis*; dots = *Hy. r. ardelio*; stars = *Hy. neglectus*) around Australia, based on specimens examined.

### Description

Posterior branch of preorbital canal absent (Fig. 1, g-j). Lower jaw length moderate, usually shorter than head length (Fig. 10); head length divided by lower jaw length 0.67-1.29. Pelvic fins inserted far forward;  $P_2-C$  much greater than  $P_1-P_2$  (Fig. 11);  $P_2-C$  divided by  $P_1-P_2$  1.2-1.5,  $\bar{x}$  1.4;  $P_2-C$  extension falls on pre-orbital to preopercle, usually on orbit (Table 3). Dorsal rays 14-17, usually 15; anal rays 15-19, usually 16 or 17; pectoral rays 11 or 12. Vertebrae (33-38) + (18-20) = 51-58. Gill-rakers on first arch (9-12) + (20-25) = 30-36, usually 31-34; on second arch (3-6) + (17-22) = 21-27. Total gill-rakers on first plus second arches 52-61, usually 54-59. Upper jaw broadly rounded, much shorter than wide; width divided by length 1.1-1.9. Bases of dorsal and anal fins about equal in length; dorsal base divided by anal base 0.95-1.15. Maximum body depth much greater than width.

### Discussion

The eastern and western populations of *Hy. regularis* have been considered as species since Whitley (1931a) described *Hy. ardelio*. However, the populations show little meristic differences (Table 3) and the regression of head length on standard length was the only one of eight morphometric characters tested where *Hy. r. regularis* was significantly different from *Hy. r. ardelio* (Table 4). Thus, the populations are plainly not different species but I have decided to recognize them as subspecies because the populations are isolated at present and have been considered different in the recent literature.

### Distribution

*Hy. regularis* is divided into two populations, one on the southeast coast of Australia and one on the southwest coast (Fig. 12).

### Material

Listed under the subspecies accounts, 78 specimens (12.8-195 mm SL) from 11 collections of *Hy. r. regularis* and 193 specimens (18.1-280 mm SL) from 54 collections of *Hy. r. ardelio*.

### *Hyporhamphus regularis regularis* (Günther)

#### Western River Garfish

Figs 10-12, Tables 3-4

*Hemirhamphus regularis* Günther, 1866: 261-2 (original description; Australia and West Australia). Stead, 1906: 67-8 (in part, W.A.; description). Roughley, 1916: 29-31 (in part, W.A.). Munro, 1957: 56 (W.A., description).

*Hyporhamphus regularis*.—McCulloch, 1929: 102 (listed, in part, W.A.). Roughley, 1951: 21-2 (description, in part, W.A.).

*Reporhamphus regularis*.—Whitley, 1931a: 314 (*He. regularis* Günther restricted to W.A.; N.S.W. population described as *R. ardelio* new species; both species placed in *Reporhamphus* new genus). Weed, 1933: 59 (in discussion of *Reporhamphus*).

Tortonese, 1939: 256-7 (discussion of validity of *Reporhamphus*). Whitley, 1948: 15 (listed, W.A.). Fraser, 1953: 9 (included in list of estuarine fisheries of minor importance, W.A.). Whitley, 1957: 21 (comparison with *R. ardelio*; reaches 16¼ inches and about 1 lb., W.A.). Whitley, 1960: 45 (W.A., related to *R. ardelio*). Whitley, 1964b: 38 (listed).

### Diagnosis

*Hy. r. regularis* is a smaller subspecies (maximum length 195 mm SL versus 280 mm) and differs from *Hy. r. ardelio* in having a relatively shorter lower jaw compared to head length, especially at larger sizes (Fig. 10).

### Description

Head length divided by lower jaw length 0.67-1.19,  $\bar{x}$  0.85. Anal rays 16-19, usually 17. Vertebrae (34-38) + (18-20) = 52-58, usually 53 or 54. Gill-rakers on first arch (9-10) + (21-24) = 30-34, usually 31-33, on second arch (4-6) + (17-21) = 21-25, usually 23 or 24; total gill-rakers on first plus second arches 52-59, usually 54-56. Upper jaw broadly rounded, much shorter than wide; width divided by length 1.11-1.69,  $\bar{x}$  1.44.

### Maximum known size:

Female, 195 mm SL (AMS I.13252, Swan R., Perth, W.A.).

### Lectotype

BMNH 1843.5.19.91, male, 151 mm SL, essentially selected by Whitley (1931a: 314) who restricted *Hy. regularis* to Western Australia because Günther gave only "Australia" for the other specimens in the type-series. D 15; A 17; P<sub>1</sub> 11-11; RGR<sub>1</sub> 10 + 22 = 32; RGR<sub>2</sub> 5 + 19 = 24; P<sub>1</sub>-P<sub>2</sub> 49.0 mm; P<sub>2</sub>-C 70.0 mm; P<sub>2</sub>-C extension falls on orbit anterior to pupil; preorbital canal without posterior branch (Fig. 11). Paralectotypes BMNH 1847.7.21.77-81, Australia, 8 (133-180).

### Distribution

A Western Australian endemic, found from the mouth of the Murchison River south to Leschanault Estuary, Bunbury (Fig. 12). There is one questionable record (AMS IB.1586) from much further north—Onslow. Most specimens are from around Perth, particularly in the Swan and Canning rivers.

### Material

78 specimens (12.8-195 mm SL) from 11 collections arranged from north to south along the coast of Western Australia. ?AMS IB.1586; Onslow; CSIRO; 1 (142). WAM P-19107; Murchison R. mouth; I. Elliott; April 1965; 1 (146). WAM P-16731-2; Tutula Well, Murchison R.; R. J. McKay; Jan. 23, 1969; 2 (125-129). USNM 206561; Canning R., Perth; B. B. Collette, J. R. Paxton, R. J. McKay; BBC 1449; Feb. 13, 1970; 1 (158). AMS I.13247-52; Swan R., Perth; W.A. Fish. Dept; Aug. 1914; 6 (139-195). CSIRO; Swan R., Perth; April 12, 1941; 3 (85.8-88.8). WAM P-146; Swan R., Perth; W.A. Fish Inspector; 2 (174-180). WAM P-8937-42; Canning R., Rossmoyne, Perth; R. J. McKay; Dec. 7, 1964; 6 (109-143). WAM P-6121-28; Murray R., south of Perth; M. Graham; March 10, 1963; 8 (47.0-147). USNM 206568; Leschanault Estuary at Koombana Caravan Park, Bunbury; B. B. and S. E. Collette and J. R. Paxton; BBC 1437; Feb. 13, 1970; 47 (12.8-100). BMNH 1843.5.19.91; W. Australia; 1 (151); lectotype of *He. regularis*; purch. from Turner.

*Hyporhamphus regularis ardelio* (Whitley)

## Eastern River Garfish

## Figs 10–13, Tables 3–4

- Hemiramphus Gaimardi* Valenciennes in Cuvier and Valenciennes, 1846: 36–7 (in part, two syntypes from Sydney [MNHN 4590–1], other syntypes are *Hy. quoyi*). Kner, 1887: 323 (in part, specimens [NHMV uncat.] from Sydney).
- Hemiramphus regularis* Günther, 1866: 261–2 (original description, in part, specimens from “Australia”). Castelnau, 1879: 355, 360, 394 (common garfish of Sydney market [MNHN A.4068]; description). Macleay, 1881: 245–6 (description; Port Jackson). Tenison-Woods, 1882: 22 (listed), 83–4 (description; favorite breakfast food in Sydney), plate 37 (lower fig.). Ramsay, 1883a: 28–9 (N.S.W.; food value). Ramsay, 1883b: 4, 19 (N.S.W.; river garfish; food value), 26 (canned), 45 (listed). Ogilby, 1887: 53 (common, Port Jackson; good table fish). Cohen, 1892: 17 (comparison with sea garfish; spawning habits). Kent, 1893: 370 (Qld., listed). Ogilby, 1893: 174–5 (long description; colour; spawning habits; food value; abundant N.S.W. south to Illawarra). Waite, 1904b: 20 (N.S.W., listed). Stead, 1906: 67–8 (in part, N.S.W., S. Qld., and Vict. coastal lakes and estuaries; 5,000 70–80 lb. baskets per year landed in N.S.W.). Stead, 1907b: 33–4, fig. 9 (eggs). Stead, 1908: 37 (one of principle N.S.W. market fishes), pl. 11 (photo). Stead, 1910: pl. 2, no. 4 (photo of river garfish—common N.S.W. food fish). Roughley, 1916: 29–31 (in part, N.S.W. and S. Qld.; description; food fish), colour pl. 5. McCulloch, 1921: 41 (abounds in N.S.W. coastal lakes, harbours, and estuaries; a prime market species; reaches 14 inches). McCulloch and Whitley, 1925: 138 (previous Qld. records). Lewis and Ellway, 1971: 62 (Tallebudgera Cr., S. Qld.).
- Hemiramphus regularis*.—McCoy, 1887: 134 (Gippsland Lakes, Vict.; compared with sea garfish). Marshall *et al.*, 1959: 29 (description; Qld.), fig. (after Stead). Marshall, 1964: 100 (common in S. Qld. but not as abundant as in N.S.W.).
- Hyporhamphus regularis*.—McCulloch, 1929: 102 (in part, N.S.W. and Qld.). Fowler, 1940: 757 (Sydney [USNM 83047], Wilkes Exped. 1838–42). Mack, 1941: 104 (Gippsland Lakes, Vict.; catch rate 0 to 300,000 lbs per year, 1911–1937; 0–30% by volume, of food of large black comorant). Roughley, 1951: 21–2 (in part; most abundant in N.S.W.; important constituent of fishery, 200,000 lbs landed in 1948–9), colour pl. 4. Fowler, 1953: 12–13 (description; behaviour; Wilkes Exped. specimens—see Fowler, 1940).
- Reporhamphus ardelio* Whitley, 1931a: 314 (original description, Clarence R., N.S.W.; considered specifically distinct from the W.A. river garfish *He. regularis* Günther; placed in new genus *Reporhamphus* Whitley). Weed, 1933: 59 (in discussion of *Reporhamphus*). Tortonese, 1939: 256–7 (in discussion of *Reporhamphus*). Whitley, 1956: 40 (listed as freshwater species). Whitley, 1957: 20–1 (Qld., N.S.W., Vict.; enters freshwater; description; comparison with *R. regularis*), fig. Whitley, 1959b: 310, 314 (lectotype AMS I.12744), fig. of lectotype. Whitley, 1960: 44–5 (description; habits; Qld., N.S.W., and Vict.). Whitley, 1964b: 38 (listed).
- Hemiramphus ardelio*.—Munro, 1957: 56 (description; Qld. and N.S.W.), fig. 398 (after Stead). Thomson, 1959a: 356 (important part of catch in some years in Lake Macquarie, N.S.W.), 357 (fig. 3, catch composition 1941–56), 359 (fig. 5, catch curve—200–500 lbs per man), 360 (fig. 6, catch curve 3,000 to 19,000 lbs

per year). Thomson, 1959b: 366 (Lake Macquarie, N.S.W.), 369 (herbivore, *Zosteria* in 80% of stomachs). Lake, 1959: 3 (saltwater fish occasionally entering freshwater, N.S.W.). Grant, 1965: 36 (description after Munro, 1957; panfish and baitfish; Qld.), fig. Grant, 1972: 60 (repeat of 1965 ed.).

#### Misidentifications:

*Euleptorhamphus longirostris*.—Whitley, 1943: 177-8 (Noosa R., Qld. specimen [AMS IA.7968] with no pelvic fins). Whitley, 1961: 299 (same specimen as in Whitley, 1943).

*Reporhamphus australis*.—Whitley, 1961: 301 (Port Stephens, N.S.W. specimen [AMS IB.779] with 3-pronged beak; Port Macquarie, N.S.W. specimen [AMS IB.780] with deformed mouth), 300 (photo of first specimen).

#### Diagnosis

A subspecies of *Hyporhamphus regularis* similar to but larger than the Western Australian *Hy. r. regularis*. Differs from *Hy. r. regularis* in having a slightly longer lower jaw, particularly at larger sizes (Fig. 10).

#### Description

Head length divided by lower jaw length 0.63-1.29,  $\bar{x}$  0.99. Anal rays 15-18, usually 16 or 17. Vertebrae (33-36) + (18-20) = 51-56, usually 52-54. Gill-rakers on first gill arch (9-12) + (20-25) = 30-36, usually 31-34; on second arch (3-6) + (18-22) = 22-27, usually 24-26. Upper jaw broadly rounded, wider than long; width divided by length 1.2-1.9,  $\bar{x}$  1.56.

#### Maximum known size

Female, 280 mm SL (USNM 206577, Eden, N.S.W.).

#### Types

Lectotype AMS I.12744, Iluka near mouth of Clarence River, N.S.W.; purch. Sydney mkt.; March 1913; female, 217 mm SL; selected and figured by Whitley (1959b: 310). Lower jaw length 41.8 mm; head length 48.4 mm;  $P_1$ - $P_2$  77.5 mm;  $P_2$ -C 96.6 mm;  $P_2$ -C extension falls on posterior part of eye; D 15; A 17;  $P_1$  11-12;  $RGR_1$  10 + 24 = 34;  $RGR_2$  5 + 20 = 25; vertebrae 35 + 18 = 53; no posterior branch on preorbital canal (Fig. 1g). Paralectotypes AMS I.12745-6; same data as lectotype; 2 females (140-192).

#### Distribution

An east Australian endemic, found from Gladstone, Qld. south in coastal rivers and estuaries to Lakes Entrance, Vic. (Fig. 12).

#### Material

193 specimens (18.1-280 mm SL) from 54 collections arranged from north to south along the coast.

Queensland: 35 specimens (29.0-171) from 9 collections. USNM 206545; Gladstone Harbour; B. B. Collette 1417; Dec. 11, 1969; 4 (29.0-103). CSIRO; The Bluff, S. Fraser I.; Aug. 24, 1950; 18 (43.9-69.8). CSIRO; Rocky Point, Mary R.; Sept. 2, 1950; 1 (88.3). CSIRO; Noosa R.; Feb. 21, 1947; 1 (46.7). AM IA.7986; Noosa R.; T. Iredale; 1 (51.5). CSIRO; Caloundra; Nov. 12, 1944; 5 (75.1-90.2). CSIRO; Caloundra; June 14, 1940; 1 (88.3). AMS A.12490-1; "Queensland"; Spalding; 1882; 2 (150-168). SU 20561; Brisbane R.; J. D. Ogilby; 2 (169-171).

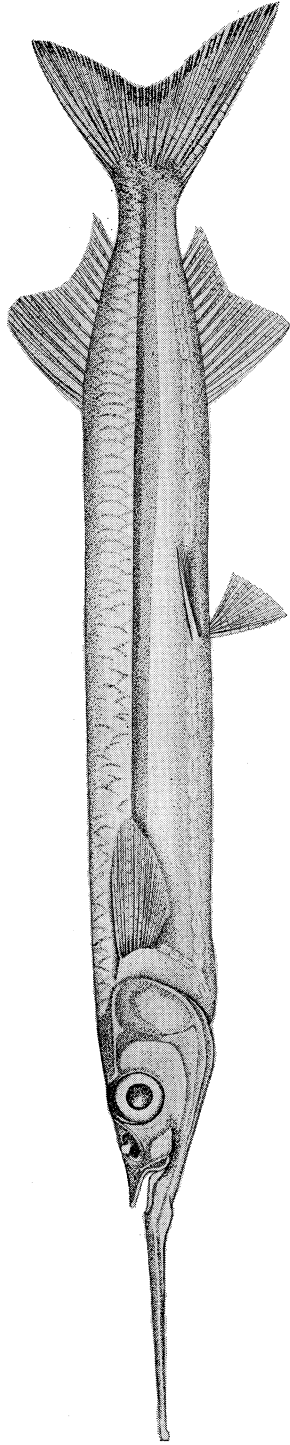


Figure 13. *Hyporhamphus regularis ardeio*, USNM 206573, 186 mm SL, Laurieton, N.S.W.



New South Wales: 150 specimens (18.1–280) from 43 collections. USNM 176983; New South Wales; J. Howard; Feb. 2–March 11, 1953; 8 (189–216). AMS I.12744 (lectotype), 12745–6 (paralectotypes); Iluka, Clarence R.; Sydney mkt.; March 1913; 3 (140–217). CSIRO; Yamba Bay, Clarence R.; May 20, 1946; 1 (44.6). CSIRO; Clarence R. between Maclean and Harwood Is.; April 19, 1948; 1 (18.1). AMS IB.780; Port Macquarie; 1 (200). USNM 206573; Laurieton; Sydney mkt.; B. B. Collette and J. R. Paxton; BBC 1461; March 25, 1970; 13 (158–215). AMS I.14943–5; outside Port Stephens Heads; D. G. Stead; 3 (148–162). AMS IB.779; Port Stephens; 1 (115). USNM 148614; off Newcastle; H. J. Brown; 1909; 1 (131). USNM 206578; Mannering Park, Lake Macquarie; Sydney mkt.; B. B. Collette and J. R. Paxton; BBC 1376; Nov. 6, 1969; 3 (177–228). CSIRO C.3123; North Creek, Lake Macquarie; Sept. 12, 1956; 7 (127–145). CSIRO; Marks Point, Lake Macquarie; Sept. 25, 1956; 8 (43.8–59.6). CSIRO; The Islands, Lake Macquarie; Aug. 15, 1956; 1 (49.7). CSIRO A.2081–2; Lake Macquarie; 1953; 2 (40.9–48.1). USNM 59912; Tuggerah Lake; D. G. Stead; 5 (156–224). SU 20780; Tuggerah Lake; D. G. Stead; 1906; 3 (157–167). CSIRO; Tuggerah Lake; Jan. 3, 1940; 1 (60.0). AMS IB.1412; Toukley, near Wyong on Tuggerah Lake; W. Barnes; March 1945; 1 (47.2). USNM 206572; Tuggerah and Macquarie Lakes; Sydney mkt.; B. B. Collette and J. R. Paxton; BBC 1455; March 5, 1970; 8 (169–195). USNM 206563; Jerusalem Bay on Broken Bay; R. B. Talbot; BBC 1423; Jan. 1, 1970; 2 (25.0–33.3). MNHN 4590–1; Port Jackson; Sydney; Quoy and Gaimard, Urville Exped.; 2 (177–179). SU 8318; Sydney; D. H. Campbell; 1 (154). MNHN A.4068; Sydney; Castelnau; 1879; 2 (168–178). NHMV 5571; Port Jackson; Steindachner; 1884; 2 (155–172). NHMV; Sydney; “Novara” Exped.; 1857–9; 3 (150–167). BMNH 1890.9.23.242–3; Port Jackson; Imperial Institute; 2 (168–172). USNM 83047; Sydney; Wilkes Exped.; 2 (91–185). IRSNB 1228B; Port Jackson; exchange from Sydney Mus., 1882; 5 (152–165). AMS I.7637, 7639–40; Port Jackson; N.S.W. Fish. Comm.; May 1906; 3 (143–226). USNM 47792; Port Jackson; orig. AMS A.9914; 3 (162–169). ZMH 1771; Watson’s Bay, Sydney; P. Timm; April 20–May 17, 1914; 2 (174–181). AMS I.9527–29, 9531; near Sydney; N.S.W. Fish. Dept; Sept. 1908; 4 (152–163). AMS I.4448; Sydney mkt.; July 1900; 1 (220). AMS old coll.; no data—prob. near Sydney; 2 (162–211). USNM 206576; N. and S. of Sydney; Sydney mkt.; B. B. Collette and J. R. Paxton; BBC 1370; Sept. 18, 1969; 12 (170–200). CSIRO C.2126–9; Lake Illawarra; 1953; 4 (163–165). BMNH 1914.8.20.85–90; Lake Illawarra; July 11, 1911; D. G. Stead; 6 (160–165). AMS I.15222; Lake Illawarra; D. G. Stead; June 21, 1909; 1 (260). USNM 206574; Nowra; Sydney mkt.; B. B. Collette and J. R. Paxton; BBC 1463; April 3, 1970; 6 (179–200). USNM 206570; Sussex Inlet; W. Ivantsoff; Jan. 25, 1970; 4 (64.4–168). CSIRO; Lake Conjola; July 11, 1948; 3 (87.3–94.0). CSIRO; Narooma; Aug. 21, 1941; 4 (102–125). USNM 206577; Eden; Sydney mkt.; B. B. Collette 1472; May 1, 1970; 3 (184–280).

Victoria: USNM 206588; Lakes Entrance; Sydney mkt.; B. B. Collette 1469; April 17, 1970; 7 (194–271). CSIRO; North Arm, Lakes Entrance; Dec. 1, 1939; 1 (32.6).

### **Hyporhamphus neglectus** (Bleeker)

Figs 10–12, 14, Tables 3–4

*Hemirhamphus neglectus* Bleeker, 1866: 157–8 (original description; Indonesia).

*Hyporhamphus gaimardi*.—Taylor, 1964: 104–5 (Arnhem Land, N.T. [4 USNM coll.]; description). (Not *Hemirhamphus gaimardi* Valenciennes, 1846.)

#### *Diagnosis*

A small (maximum size in Australia 149 mm SL) northern species of *Hyporhamphus* distinguished from *Hy. regularis* by the lower number of gill-rakers, usually 23 or fewer on the second arch and 31 or fewer on the first arch (compared to 24 or more and more than 31). Pelvic fins placed relatively further anterior so that the P<sub>2</sub>–C extension usually falls anterior to the orbit instead of on it as in *Hy. regularis*. *Hy. neglectus* has fewer vertebrae (usually 51 or less) than *Hy. regularis* (usually 52 or more) except in eastern Queensland where both *Hy. r. ardelio* and *Hy. neglectus* have the same range (51–53) and mean (52.00).

### Description

Posterior branch of preorbital canal absent (Fig. 1, k-m). Lower jaw length moderate, slightly shorter than head length in adults, longer in juveniles (Fig. 10); head length divided by lower jaw length 0.63-1.26,  $\bar{x}$  0.95. Pelvic fins inserted far forward;  $P_2$ -C much greater than  $P_1$ - $P_2$  (Fig. 11);  $P_2$ -C divided by  $P_1$ - $P_2$  1.35-1.68,  $\bar{x}$  1.49;  $P_2$ -C extension falls on base of upper jaw to orbit, usually on orbit. Dorsal rays 13-16, usually 14 or 15 (Table 3); anal rays 14-17, usually 16 or 17; pectoral rays 10-12, usually 11. Vertebrae (31-35) + (16-19) = 47-53. Gill-rakers on first arch (7-11) + (17-24) = 25-33, usually 31 or less; on second arch (2-5) + (15-19) = 18-24, usually 19-23; total of gill-rakers on first plus second arches 44-57, usually 54 or less. Dorsal fin base length equal to or greater than length of anal fin base (dorsal base divided by anal 0.92-1.17,  $\bar{x}$  1.03). Upper jaw wider than long (width divided by length 1.15-1.67,  $\bar{x}$  1.43). Maximum body depth much greater than maximum body width.

### Maximum known size

Female, 149 mm SL (AMS IA.2315, Townsville, Qld.). Males mature, with well-developed testes at 104-137 mm SL; females with large eggs at 102-149 mm SL.

### Types

Lectotype BMNH 1866.5.2.18; East Indies; Bleeker; female (152), herein selected because it has dorsal and anal ray counts agreeing with the original description and because it is the syntype in best condition. Lower jaw length 28.6 mm;  $P_1$ - $P_2$  46.1 mm;  $P_2$ -C 70.0 mm;  $P_2$ -C extension falls on border of preorbital and orbit; D 15; A 16;  $P_1$  12-12;  $RGR_1$  7 + 20 = 27;  $RGR_2$  5 + 17 = 22; no posterior branch on preorbital canal (Fig. 1 k). Paralectotypes Rijksmus. Nat. Hist. Leiden 6951, 3 (129-134).

### Discussion

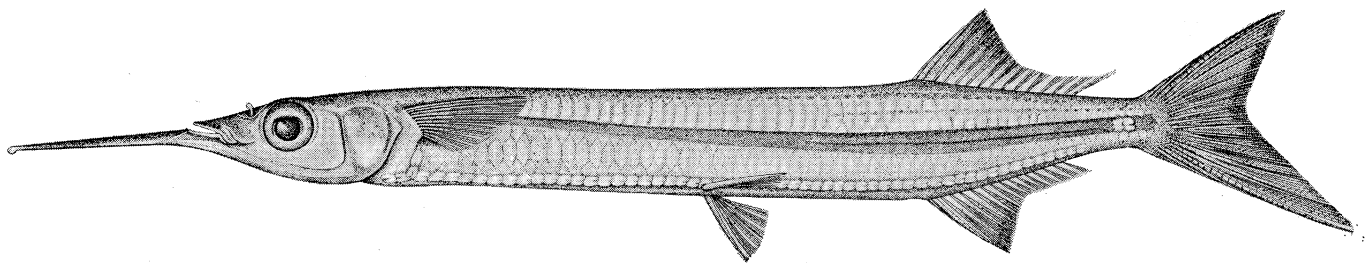
The species of *Hyporhamphus* with an emarginate caudal fin (instead of deeply forked) and without a posterior branch to the preorbital canal are difficult to distinguish. *Hy. regularis* and *Hy. neglectus* are members of this species group along with species such as *Hy. limbatus* (Valenciennes) and the western Atlantic *Hy. unifasciatus* (Ranzani). The name *neglectus* Bleeker is used only tentatively for this Australian species because Bleeker's specimens from the East Indies, and a few small specimens from New Guinea are the only non-Australian specimens that I have examined. It is possible that additional material will show that the Australian species is specifically distinct from *Hy. neglectus*.

### Distribution

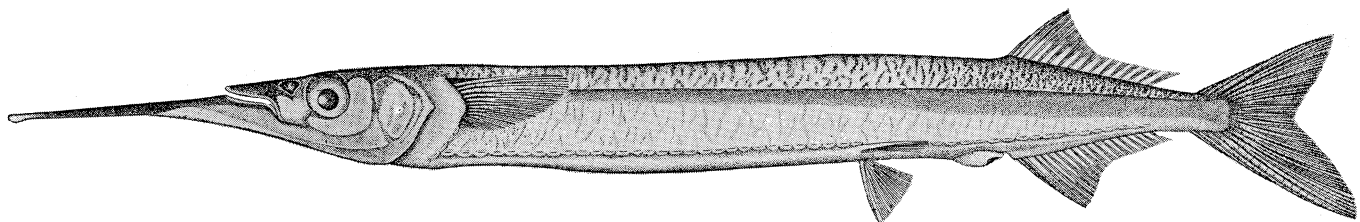
Known from the middle of the eastern coast of Queensland, Arnhem Land, Northern Territory, and the northern part of Western Australia (Fig. 12). Several records from offshore islands. *Hy. neglectus* does not appear to be an estuarine species like *Hy. regularis*. The types are from Indonesia.

### Material

111 specimens (15.3-149 mm SL) from 32 collections arranged from south to north and then east to west.



Above.—Figure 14. *Hyporhamphus neglectus*, USNM 173791, 117 mm SL, Groote Eylandt, N.T. Below.—Figure 15. *Hyporhamphus australis*, USNM 206581, 262 mm SL, Port Stephens, N.S.W.



Queensland: 38 specimens (29.2-149 mm SL) from 11 collections. AMS IA.6297; Lindeman I., Cumberland Is.; M. Ward; 1 (49.8). AMS IA.2312-15; Townsville; W. E. J. Paradise, HMAS "Geranium"; 4 (98.9-149). CSIRO; Paluma Shoals N. of Bluewater Cr., Townsville; Nov. 24, 1941; 1 (52.4). CSIRO; Missionary Bay near Cape Richards, Hinchinbrook I.; Sept. 22, 1951; 1 (71.2). CSIRO; Goold I. N. of Hinchinbrook I.; Sept. 22, 1951; 3 (40.1-59.0). CSIRO; Flying Fish Point, Innisfail; Feb. 14, 1951; 8 (36.9-63.4). CSIRO; Flying Fish Point, Innisfail; Dec. 14, 1951; 10 (29.2-43.2). CSIRO; Little N. Marrett R., Princess Charlotte Bay; Sept. 27, 1948; 1 (32.7). AMS IB.3159/2762; Karumba, Gulf of Carpentaria; 1 (91.7). AMS IB.3195; Karumba, Gulf of Carpentaria; 1 (90.6). FBQ 2762; Karumba, Gulf of Carpentaria; 7 (81.3-103).

Northern Territory: 59 specimens (20.2-126 mm SL) from 18 collections. USNM 173791; S. end Winchelsea I.; N. Coast Groote Eylandt, Gulf of Carpentaria; R. R. Miller 48-13a; June 6, 1948; 3 (47.4-117). USNM 173792; 2 mi. in from mouth of Port Bradshaw, near Cape Arnhem; R. R. Miller 48-24; July 26, 1948; 11 (45.5-117). USNM 173793; Port Bradshaw near Cape Arnhem; R. R. Miller 48-25; July 23, 1948; 2 (106-117). CSIRO; Truant I., English Company's Is.; July 27, 1949; 1 (80.1). CSIRO 1746; Jensens Bay, Wessel Is.; 1 (112). CSIRO; Jensens Bay, Wessel Is.; July 28, 1949; 6 (47.5-72.2). CSIRO; Mullet Bay, N. Goulburn I.; July 30, 1949; 5 (60.5-82.2). CSIRO C.1747; Port Essington, Cobourg Peninsula; 6 (102-126). CSIRO C.1713; Black Port, Port Essington, Cobourg Peninsula; 1 (110). CSIRO; Port Essington, Cobourg Peninsula; Aug. 1, 1949; 1 (25.4). CSIRO; 15 mi. N.N.W. Cape Don, Cobourg Peninsula; Sept. 17, 1949; 2 (14.0-27.2). CSIRO; off Cape Don, Cobourg Peninsula; Oct. 16, 1949; 1 (20.2). CSIRO; Gordon Bay, Bathurst I.; Aug. 25, 1949; 1 (26.6). CSIRO; Bathurst I.; Aug. 26, 1949; 1 (20.2). CSIRO C.1739; Gordon Bay, Bathurst I.; 4 (83.1-115). USNM 173790; Nightcliff, 2 mi. N. of Darwin; R. R. Miller 48-2; March 19, 1948; 11 (39.2-64.9). CSIRO C.1719; Peron I., Anson Bay; 1 (117). CSIRO; 1.5 mi. N.E. Peron I., Anson Bay; Oct. 11, 1949; 1 (49.5).

Western Australia: 14 specimens (15.3-116 mm SL) from 3 collections. CSIRO C.1751; Mission Bay, Napier Broome Bay; Aug. 11, 1949; 5 (104-116). CSIRO; Broome; Sept. 25, 1949; 7 (25.8-51.8). CSIRO; Broome; Sept. 27, 1949; 2 (15.3-26.5).

### **Hyporhamphus australis** (Steindachner)

#### Eastern Sea Garfish

Figs 15-18, Tables 5-6

*Hemiramphus australis* Steindachner, 1866: 471-2 (original description; Port Jackson, Sydney, N.S.W.). Ogilby, 1916: 10, fig. 10. Marshall, 1964: 101 (in part, N.S.W. and S. Qld.).

*Hemiramphus melanochir*.—Castelnau, 1875: 46-7 (small specimen, Qld.). Castelnau, 1879: 394 (in part, Brisbane and Sydney; description probably based on *Hy. melanochir*). (Not *Hemiramphus melanochir* Valenciennes, 1846.)

*Hemiramphus intermedius*.—Macleay, 1881: 245 (in part, Port Jackson and Brisbane; description). Tenison-Woods, 1882: 22 (listed), 83-84 (description), pl. 37 (upper fig.). Ramsay, 1883a: 28-9 (N.S.W.; comes in immense schools; favorite breakfast food). Ramsay, 1883b: 4, 19 (after Ramsay 1883a), 45 (listed among 180 N.S.W. food fishes). Ogilby, 1887: 53 (in part, Port Jackson; common garfish of Sydney market; grows to 18 in; excellent table fish). Ogilby, 1889: 71 (Lord Howe Is. [AMS I.1544, 1548], new record). Cohen, 1892: 17 (in part, E. Australia; delicious fish; habits). Ogilby, 1893: 172-3 (synonymy in part; long description; delicious fish; habits), pl. 42. Stead, 1906: 66-7 (in part; description; methods of capture; excellent food fish), fig. 25. Stead, 1907b: 33-4, fig. 9 (eggs). Stead, 1908: 35-6 (one of most valuable N.S.W. food fishes; capture and description after Stead, 1906). Stead, 1911: pl. 2 (huge catch of sea garfish near Sydney). Roughley, 1916: 27-9 (in part;

description, range, habits, food value), colour pl. 4. McCulloch, 1921: 41 (brief description; valuable food fish), pl. 9, fig. 108a. Stead, 1927: 28 (spawns on *Zostera*, Nov.-Feb., Mosman, N.S.W.). (Not *Hemirhamphus intermedius* Cantor, 1842.)

*Hyporhamphus* sp. Waite, 1901: 37 (Lord Howe Is. [AMS I.4617-8], differs from *Hy. intermedius* and *Hy. regularis* of mainland). Waite, 1904a: 187 (Lord Howe Is., same record as Waite, 1901).

*Hyporhamphus intermedius*.—Waite, 1904a: 194 (Lord Howe Is., synonymy in part). Waite, 1904b: 20 (listed, N.S.W.). Stead, 1907a: 4 (*E. longirostris* captured while seining for *Hy. intermedius*, Bateman's Bay, N.S.W.). Waite, 1909: 381 (Norfolk Is. [AMS I.5407, I.5999], new record, 382 (*Hyporhamphus* listed, Norfolk and Lord Howe Is.). McCulloch and Whitley, 1925: 138 (previous Qld. records). McCulloch, 1929: 102 (in part, N.S.W.). Phillipps, 1932: 230 (in part, mixed with *Hy. melanochir* and compared with *Hy. ihi* Phillipps). Blackburn and Tubb, 1950: 34 (abundance of schools, N.S.W.), 35 (table 19a, percentage of positive weekly reports for 8 N.S.W. localities, analysis of reports; table 19c, seasonal maximum occurrence, Feb.-March). Roughley, 1951: 22-3 (in part; description; reaches 18 in.; N.S.W. catch 1948-9 81,000 lbs), colour pl. 5 (from Roughley, 1916).

*Hemirhamphus australis*.—McCulloch, 1921: 41 (after Steindachner, 1866; not recognized since first described). Munro, 1957: 56 (description; N.S.W., Qld., and possibly N. Vic.), fig. 400. Thomson, 1959a: 356 (small contribution to catch, Lake Macquarie, N.S.W. in some years). Thomson, 1959b: 366 (table 1, listed, Lake Macquarie, N.S.W.), 370 (table 3, list of omnivores, algae and crustaceans present in over 80% of stomachs). Grant, 1965: 38 (brief description, after Munro, 1957; N.S.W. and S. Qld.; important bait fish), fig. (*Hy. melanochir* after McCoy, 1887). Grant, 1972: 64 (repeat of 1965 ed.).

*Hyporhamphus australis*.—McCulloch, 1929: 102 (listed, N.S.W.).

*Reporhamphus australis*.—Whitley, 1931a: 314 (type-species of *Reporhamphus* Whitley; distinguished from *R. melanochir* and *R. ardelio*). Weed, 1933: 59-60 (validity of *Reporhamphus* Whitley). Whitley, 1935a: 300 (ocean beach zone fish, Sydney). Whitley, 1935b: 341 (Port Stephens, N.S.W. specimen [AMS IA.6102] with rubber band around body), fig. Whitley, 1941: 341 (Tuggerah Lakes, N.S.W. specimens [AMS IB.731-2] with rubber bands around body). Whitley, 1962: 54-5 (exquisite table-fish), fig. (after Stead). Whitley, 1964b: 38 (listed).

### Diagnosis

The three species of sea garfishes (*Hy. australis*, *melanochir*, and *ihi*) differ from the river garfishes (*Hy. r. regularis* and *Hy. r. ardelio*) in a number of characters. The sea garfishes have a posterior branch to the preorbital canal which is absent in the river garfishes (compare Fig. 2, a-g with Fig. 1, g-j). The posterior branch is on an almost straight line with the anterior branch, both posterior and ventral branches are narrow and the posterior and ventral pores are small compared to other Australian fork-tailed garfishes such as *Hy. quoyi* (Fig. 2, l-n). The upper jaw is pointed and about as long as wide in the sea garfishes, rounded and wider than long in the river garfishes (width divided by length 0.82-1.49, means 1.00, 1.16, and 0.94 for the sea garfishes vs. 1.11-1.92, means 1.56 and 1.69 for the river garfishes). The scales are deciduous and usually absent in market and museum sea garfishes contrasted to usually present, at least in market specimens, in river garfishes. These three species differ from *Hy. dussumieri* in having the maximum body depth distinctly greater than the width instead of about equal, width divided by depth 0.47-0.90.

**Table 5. Number of fin rays, gill-rakers and vertebrae in populations of *Hyporhamphus australis*, *Hy. melanochir*, and *Hy. ihi* (\* in New South Wales and S. Australia columns indicates holotype of *Hy. australis* and lectotype of *Hy. melanochir* respectively)**

Species and Population	Fin Rays														
	Dorsal					Anal							Pectoral		
	15	16	17	18	N	x	17	18	19	20	N	x	11	12	13
<i>Hy. australis</i>															
Norfolk I. .. .. .	..	1	1	..	2	16.50	..	..	2	..	2	19.00	..	2	..
Lord Howe I. .. .. .	..	3	6	..	9	16.67	..	5	4	..	9	18.44	4	2	1
New South Wales .. .. .	29*	68	10	..	107	15.82	12	63*	24	2	101	18.16	26	43	..
<i>Hy. melanochir</i>															
Victoria .. .. .	1	28	33	2	64	16.56	..	19	37	8	64	18.83	4	17	..
Tasmania .. .. .	1	12	19	1	33	16.61	..	13	17	2	32	18.66	3	19	..
S. Australia .. .. .	2	31	32*	..	65	16.46	2	25	38*	..	65	18.55	..	30*	..
W. Australia .. .. .	6	54	19	..	79	16.16	4	56	17	2	79	18.22	10	46	1
<i>Hy. ihi</i>															
New Zealand .. .. .	20	64	16	2	102	16.00	12	64	23	3	102	18.17	14	28	..
	First Arch Gill-rakers														
	27	28	29	30	31	32	33	34	35	36	37	38	39	N	x
<i>Hy. australis</i>															
Norfolk I. .. .. .	..	..	..	..	1	..	..	..	..	..	..	..	..	1	31
Lord Howe I. .. .. .	..	..	..	..	..	..	2	3	1	3	..	..	..	9	34.55
New South Wales .. .. .	..	..	..	..	3	6	9	16	23*	28	10	6	2	103	35.10
<i>Hy. melanochir</i>															
Victoria .. .. .	1	2	11	15	14	11	6	..	..	..	..	..	..	60	30.60
Tasmania .. .. .	..	1	4	7	11	6	4	..	..	..	..	..	..	33	30.88
S. Australia .. .. .	..	..	1	8	13	13*	2	3	1	..	..	..	..	41	31.49
W. Australia .. .. .	..	..	3	13	18	19	9	4	..	..	..	..	..	66	31.45
<i>Hy. ihi</i>															
New Zealand .. .. .	3	13	11	19	6	3	1	..	..	..	..	..	..	56	29.45

Table 5—continued

		Second Arch Gill-rakers													N	$\bar{x}$
		21	22	23	24	25	26	27	28	29	30	31	32	33		
<i>Hy. australis</i>																
Norfolk I.	.. ..	..	..	..	..	..	..	..	1	..	..	..	..	..	1	28
Lord Howe I.	.. ..	..	..	..	..	..	1	3	3	1	1	..	..	..	9	27.78
New South Wales	.. ..	..	..	1	..	7	6	10	16	16	19	17*	6	2	100	28.91
<i>Hy. melanochir</i>																
Victoria	.. ..	1	5	10	17	20	4	2	..	..	..	..	..	..	59	24.19
Tasmania	.. ..	..	..	2	8	11	8	..	1	..	..	..	..	..	30	24.97
S. Australia	.. ..	..	..	1	6*	13	11	3	3	..	..	..	..	..	37	25.49
W. Australia	.. ..	..	1	1	8	26	16	6	6	1	..	..	..	..	65	25.57
<i>Hy. ihi</i>																
New Zealand	.. ..	9	11	14	13	6	..	..	..	..	..	..	..	..	53	22.92
		Total Vertebrae										N	$\bar{x}$			
		55	56	57	58	59	60	61								
<i>Hy. australis</i>																
New South Wales	.. ..	..	7	33	10	..	..	..	..	..	50	57.06				
<i>Hy. melanochir</i>																
Victoria	.. ..	..	..	..	6	3	2	..	..	..	11	58.64				
Tasmania	.. ..	..	..	..	6	7	7	2	..	..	22	59.23				
S. Australia	.. ..	..	..	2	11	12	1	..	..	..	26	58.46				
W. Australia	.. ..	1	2	17	23	2	..	..	..	..	45	57.51				
<i>Hy. ihi</i>																
New Zealand	.. ..	7	35	12	3	..	..	..	..	..	57	56.19				

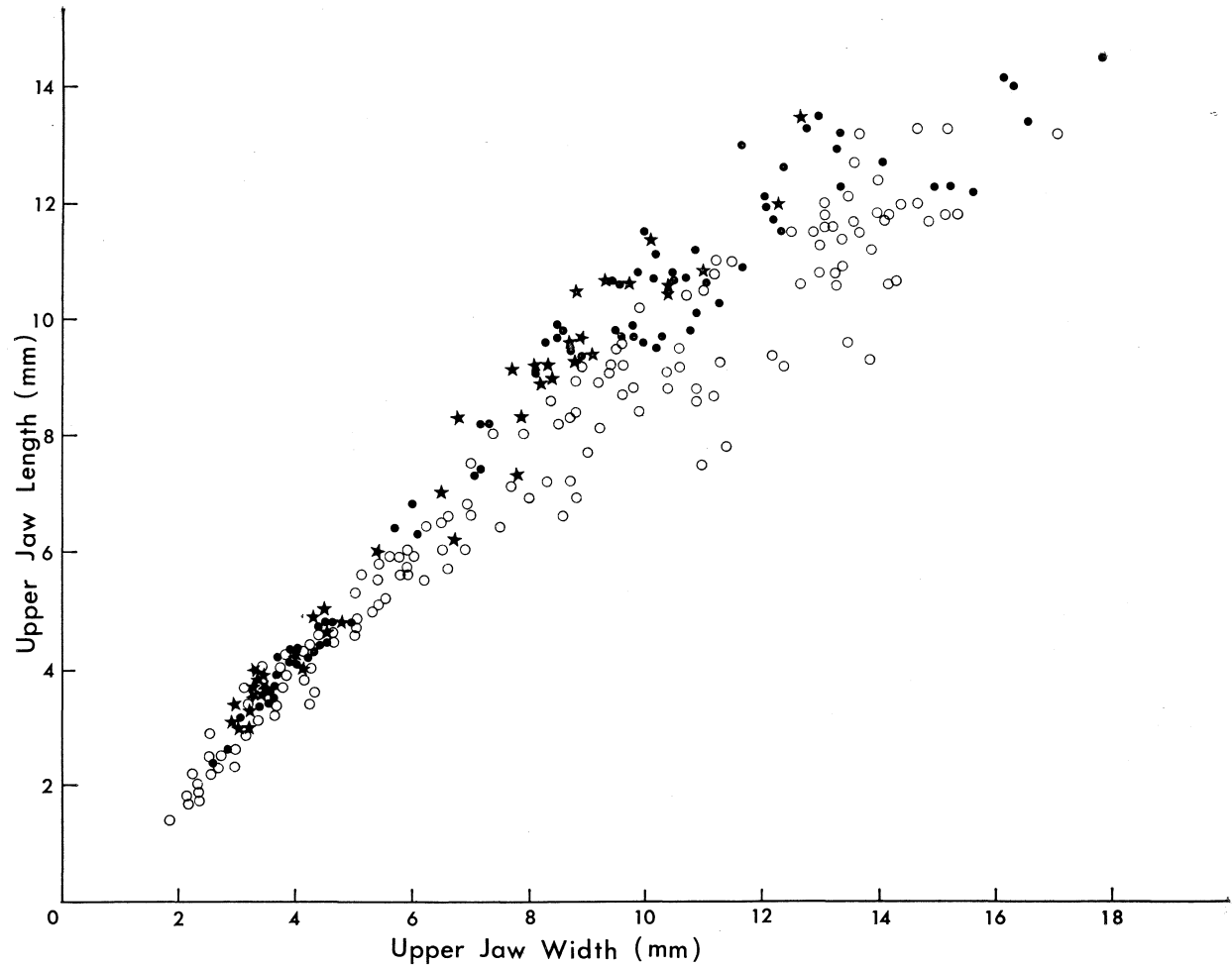


Figure 16. Relationship of upper jaw length to upper jaw width in three species of *Hyporhamphus*. Dots = *Hy. australis*; open circles = *Hy. melanochir*; and stars = *Hy. ihi*.



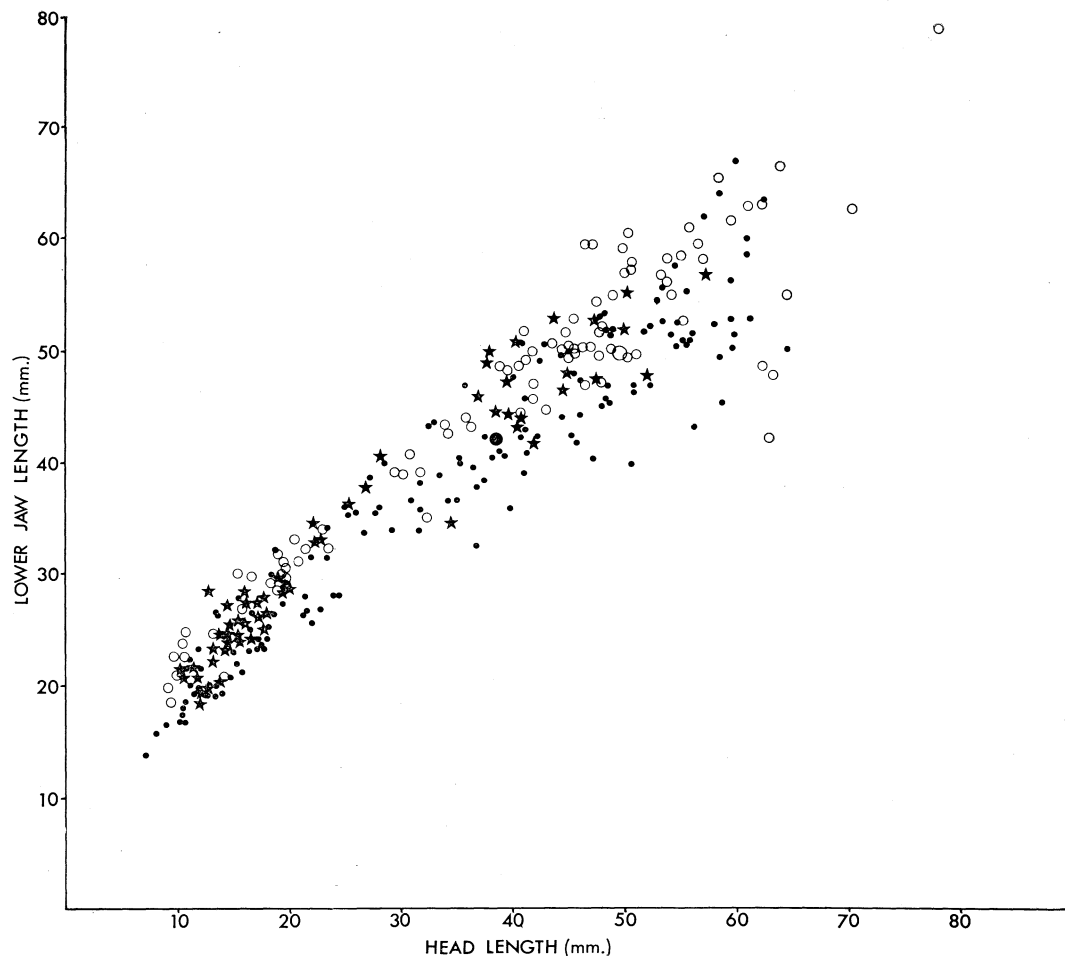


Figure 17. Relationship of lower jaw length to head length in three species of *Hyporhamphus* (dots = *Hy. melanochir*; open circles = *Hy. australis*; stars = *Hy. ihi*; large symbols = types).

*Hy. australis* differs from its two closest relatives, *Hy. melanochir* and *Hy. ihi*, primarily in having more gill-rakers (Table 5), usually 34 or more on the first arch (compared with usually 33 or less in both *Hy. melanochir* and *Hy. ihi*), and usually 27 or more on the second arch (usually 26 or less). Both *Hy. australis* and *Hy. ihi* have relatively longer upper (Fig. 16) and lower jaws (Fig. 17) than does *Hy. melanochir*, especially at larger sizes.

#### *Description*

Upper jaw long and pointed, longer than wide at small sizes, shorter than upper jaw width at larger sizes (Fig. 16); width divided by length 0.86–1.29,  $\bar{x}$  1.00. Lower jaw length moderate, usually slightly longer than head length (Fig. 17); head length divided by lower jaw length 0.62–1.32,  $\bar{x}$  0.89 over entire size range. Pelvic fins placed about midway between pectoral and caudal bases;  $P_2$ –C distance divided by  $P_1$ – $P_2$  0.81–1.04,  $\bar{x}$  0.93;  $P_2$ –C extension falls on opercle to mid-addressed pectoral fin, usually on the anterior third of the addressed pectoral. Dorsal rays 15–17, usually 16; anal rays 17–20, usually 18; pectoral rays 11 or 12, rarely 13 (Table 5). Vertebrae (37–39) + (18–20) = 56–58, usually 38 + 19 = 57. Gill-rakers on first arch (9–12) + (22–28) = 31–39, usually 34–37; on second arch (4–7) + (19–27) = 23–33, usually 27–31. Length of dorsal fin base greater or equal to length of anal fin base (dorsal base divided by anal base 0.97–1.13,  $\bar{x}$  1.04).

#### *Maximum known size*

398 mm SL (AMS IA.6543, Tuggerah Lake, N.S.W.).

#### *Holotype*

NHNV 5560, 236 mm SL, Port Jackson. D 15; A 18;  $P_1$  11–12;  $RGR_1$  10 + 25 = 35;  $RGR_2$  5 + 26 = 31; lower jaw length 49.8 mm; head length 49.7 mm;  $P_1$ – $P_2$  98.6 mm;  $P_2$ –C 88.3 mm;  $P_2$ –C extension falls on anterior third of addressed pectoral fin; preorbital canal shown in Fig. 2a.

#### *Discussion*

*Hy. australis* and *Hy. melanochir* are considered as species rather than subspecies because the diagnostic characters of the species do not show any trace of intergradation in the geographically closest large samples, Moruya, N.S.W. (*Hy. australis*) and Melbourne (*Hy. melanochir*). Two of four specimens from Eden appear to be *Hy. australis*, the third *Hy. melanochir*, and the fourth a hybrid between the two. This is discussed at greater length under the account of the latter species.

The populations of *Hy. australis* at Norfolk and Lord Howe islands do not appear to differ significantly from the mainland population but it would be worthwhile to have larger samples available for a more thorough comparison.

#### *Distribution*

An eastern Australian endemic found from Moreton Bay, Qld. to Eden, N.S.W. (Fig. 18) and also at Lord Howe and Norfolk islands. The southern distribution of *Hy. australis* meets the eastern range of *Hy. melanochir* at Eden.

#### *Material*

186 specimens (50.4–398 mm SL) from 45 collections, arranged from north to south.  
Queensland: QM I.7099; Moreton Bay; 1 (220).

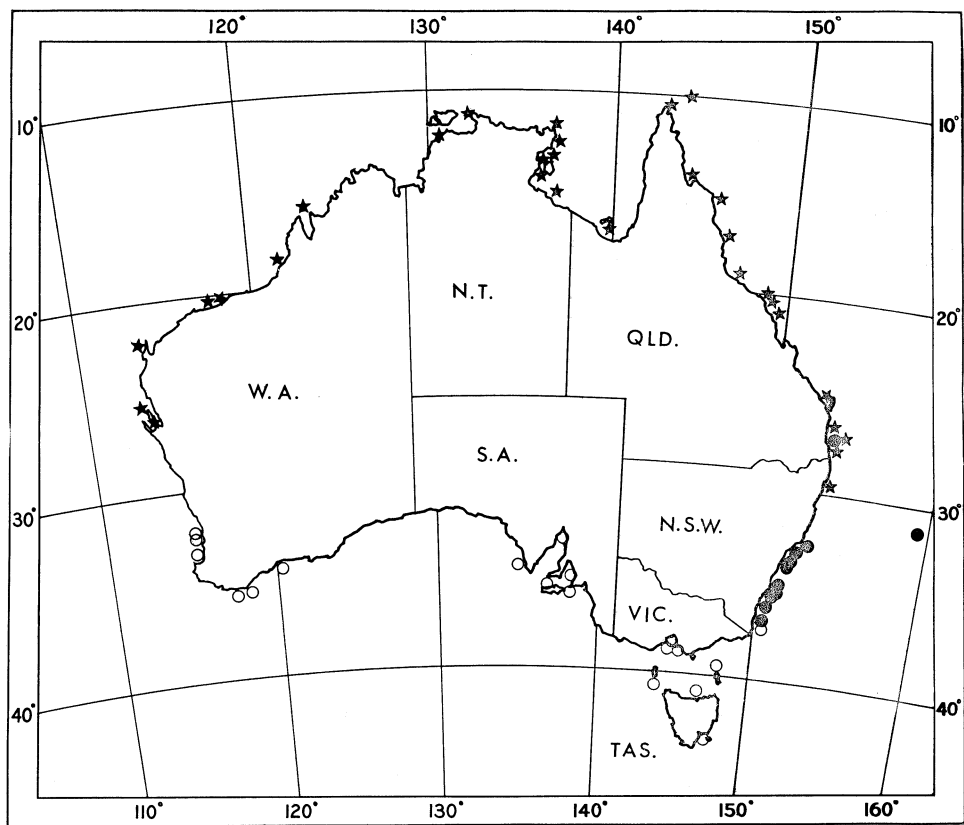


Figure 18. Distribution of three species of *Hyporhamphus* (dots = *Hy. australis*, open circles = *Hy. melanochir*, stars = *Hy. quoyi*) around Australia, based on specimens examined.

New South Wales: 174 specimens (50.4–398 mm) from 36 collections: BBC 1427; Port Stephens; Sydney mkt.; B. B. Collette and J. R. Paxton; Jan. 22, 1970; 63 (194–280); 5 spec. at SAM, 5 at WAM, 20 at AMS, 3 at BMNH 1970.7.28.11–13, 3 at MNHN, remainder USNM 206581. AMS I.9853–4; Port Stephens; R. Thorpe; March 1909; 2 (260–296). AMS IA.6102; North Head, Port Stephens; N.S.W. Fish. Dept; Aug. 1934; 1 (218). AMS IA.6543; Tuggerah Lake; D. G. Stead; 1 (398). AMS IB.731–2; Tuggerah Lake; T. C. Roughley; June 21, 1941; 2 (259–303). NHMV 5560; Port Jackson, Sydney; 1 (236); holotype of *He. australis*. USNM 47839; Port Jackson, Sydney; 3 (217–222). SU 20981; Port Jackson, Sydney; orig. AMS I.4616; 4 (152–293). ZMUC CN 5–6; Port Jackson; Th. Mortenson; March 3, 1915; 2 (145–147). MNHN 4079; Sydney; Castelnau; 1879; 2 (225–242). MNHN A.4068; Sydney; Castelnau; 1879; 1 (195). MNHN A.4077; Sydney; Castelnau; 2 (200–240). NHMV 5572; Sydney; Steindachner; 1874; 2 (207–215). IRSNB 1521; Port Jackson; exchange Sydney Mus., 1882; 2 (174–175). IRSNB 1228; same data; 1 (226). IRSNB 654; same data; 6 (200–250). AMS I.1142; Port Jackson, Sydney; Sydney mkt.; March 1887; 1 (248). BMNH 1890.9.23.195–8; Port Jackson; 5 (222–308). AMS I.4483; locality ?; Sydney mkt.; Aug. 1900; 1 (268). BMNH 1883.11.29.83; Sydney Mus.; 1 (268). AMS I.9525–6; near Sydney; N.S.W. Fish. Dept; 2 (234–240). AMS IB.1418; Dee Why, Sydney; G. P. Whitley; April 26, 1945; 1 (91.2). AMS IB.2681; Camp Cove, Sydney; D. G. Stead; 1 (71.1). ZMH 1771; Watson's Bay, Sydney; P. Timm; April 20–May 17, 1914; 5 (220–243). AMS I.9847; Maroubra Beach, Sydney; Fry and Kinghorn; Feb. 1909; 1 (95.0). AMS IB.7503; Coal Cliff; K. D. Williams; 1 (332). USNM 59961; Port Hacking; 1901; D. G. Stead; 1 (325). USNM 206580; Nowra, Shoalhaven R.; Sydney mkt.; B. B. Collette and J. R. Paxton; BBC 1377; Nov. 12, 1969; 4 (171–314). USNM 206585; Nowra; Sydney mkt.; B. B. Collette 1460; March 19, 1970; 8 (179–237). USNM 59977; Crookhaven R.; 1904; D. G. Stead; 3 (141–144). CSIRO; Crookhaven R. entrance; April 22, 1939; 10 (50.4–80.3). CSIRO; Crookhaven R. entrance; Dec. 25, 1939; 3 (110–118). CSIRO; Jervis Bay; March 5, 1954; 17 (78.2–158). USNM 206583; Ulladulla; Sydney mkt.; B. B. Collette 1460; March 19, 1970; 3 (215–224). USNM 206584; Moruya; Sydney mkt.; B. B. Collette and J. R. Paxton; BBC 1453; Feb. 26, 1970; 10 (166–195). ZMUC 307; "New South Wales"; Th. Steel; 1 (171).

Lord Howe Island: 9 specimens (64.1–301 mm) from 6 collections: AMS I.4089; E. R. Waite; 1898; 1 (262). AMS I.5567–8; Waite and McCulloch; Feb. 1903; 2 (290–301). SU 9217; orig. AMS I.5565; 1 (296). AMS I.1544, 48; R. Etheridge; Nov. 1887; 2 (216–260). AMS I.4617–8; F. Farnell; Sept. 1900; 2 (64.1–83.1). AMS IB.6387; J. Booth; 1 (71.1).

Norfolk Island: AMS I.5407; F. A. Allen and H. Quintal; Nov. 1902; 1 (296). AMS I.5999; G. E. Nobbs; April, 1903; 1 (302).

### **Hyporhamphus melanochir** (Valenciennes)

#### Southern Sea Garfish

Figs 16–18, Tables 5–7

*Hemiramphus* sp. Richardson, 1840: 30 (Port Arthur, Tas.). Richardson, 1842: 108 (Port Arthur, Tas.).

*Hemiramphus melanochir* Valenciennes in Cuvier and Valenciennes, 1846: 41–2 (original description; Port Western, New Holland = Adelaide, S. Australia; misspelled "malanochir" on p. 41, spelled correctly in table of contents). Castelnau, 1872: 179–80 (description; one of commonest food fishes in Melbourne markets at all seasons). Scott, 1962: 78 (description; one of most important S.A. food fishes), fig. Kabata, 1966: 568 (record of copepod *Gloioptotes hutoni* from Adelaide: doubtful—see parasites section). Lakin, 1968: 252; 1969: 268; 1970: 312; and 1971: 283, 287 (catch in Tas.).

*Hemiramphus intermedius*.—Günther, 1866: 260–1 (in part, specimens from Tas. [BMNH unreg.] and S.A.; *He. melanochir* placed in synonymy). Macleay, 1881: 245 (in part, specimens from Melbourne and W.A.; description). Johnston, 1883: 56–7 (market fish in Tas.), 91 (abundant in shallow estuaries in summer, highly esteemed in market), 132 (brief description). Johnston, 1891: 23 (abundant, Tas. markets), 27 (one of principle edible Tas. species), 36 (description), 42 (size limits—8 in.), 43 (10,229 doz. sold, Hobart market,

- 1888). Ogilby, 1893: 172-3 (in part; synonymy, range, habits). Waite, 1900: 210 (Swan R. near Perth [AMS I.4199], W.A.). Stead, 1906: 66-7 (in part, description). Zietz, 1909: 263 (in part; Vict., Tas., S.A., W.A.). Roughley, 1916: 27-9 (in part; description; food value; life history). Lord, 1923: 65 (listed, Tas.). Lord and Scott, 1924: 8 (listed), 42 (description; Tas.; valuable food fish). Phillipps, 1927a: 21 (range and synonymy in part). Jowett and Davies, 1938: 7 (Vict., suitable for conversion into meal), 13, 34 (table 11, chemical composition of 20 fillets), 35 (low fat content fish). (Not *Hemiramphus intermedius* Cantor, 1842.)
- Hemiramphus intermedius*.—Klunzinger, 1872: 42 (Hobsons Bay, [Melbourne, SMN 2190, 1578], Vict.). Klunzinger, 1880: 414 (Hobsons Bay, Vict.). McCoy, 1887: 113-4 (long description, Vict.), colour pl. 135, fig. 1. Lucas, 1890: 36 (listed, Vict.). Fowler, 1919: 7 (description; Vict.). Fowler, 1923: 43 (Melbourne market [ANSP 49307-9]). Lord, 1927: 13 (Tas., listed). Heegaard, 1962: 185 (copepod *Lernaeenicus hemiramphi* from St Vincent Gulf, S.A. specimen).
- Hemiramphus melanochir*.—Castelnau, 1873: 143 (Fremantle, W.A.; green vertebrae). Castelnau, 1879: 355 (listed), 394 (description; Swan R., W.A.; Melbourne [MNH A.4077, A.4079, A.4068]). Munro, 1957: 56 (description; Vic., S.A., Tas., and W.A.), fig. 401 (after McCoy, 1887). Lynch, 1966: 10 (taken by beach seines; Port Phillip Bay, Vict.), 11-12 (annual catch 1951-60 varied from 3,283 to 10,319 lbs; Port Phillip Bay).
- Hyporhamphus intermedius*.—Waite, 1921: 65 (S.A.; description; synonymy in part; breakfast fish), fig. 98. Waite, 1923: 89 (S.A.; description), fig. Hale, 1926: 222 (cymothoid isopod *Irona melanosticta* under gill covers of 18 S.A. specimens). Waite, 1928: 5 (S.A., listed). Hale, 1929: 263 (*Irona melanosticta* under gill covers). McCulloch, 1929: 102 (in part; S.A., Vict., Tas., and W.A.). Phillipps, 1932: 230 (in part, compared with *Hy. ihi*). Guest and Robertson, 1939: 179 (excellent edible fish), 181 (Sir Joseph Banks Is., Spencer Gulf, S.A.). Campbell *et al.*, 1946: 484 (used as food by aborigines in southeast S.A.). Roughley, 1951: 22-3 (in part).
- Reporhamphus melanochir*.—Whitley, 1931a: 314 (placed in new genus *Reporhamphus* Whitley; distinguished from *R. australis*). Weed, 1933: 59 (comments on genus *Reporhamphus*). Whitley, 1946: 27 (Esperance, W.A.). Whitley, 1948: 15 (listed, Esperance to Shark Bay, W.A.). Beck, 1956: 16 (14-17 ppm dry weight concentration of copper in livers of 2 spec. from Busselton, W.A.). Thomson, 1957a: 4-6 (stomach contents 301 W.A. specimens; 70% contained *Zostera*), 8 (in stomach of *Arripis georgianus*). Thomson, 1957b: 4-8 (299 W.A. specimens; gonad development; 1,280-3,000 eggs; males mature at 24.5 cm., females at 24.6 cm.). Ling, 1958: (S.A.; breeding; age determination; growth rate). Whitley, 1964b: 38 (listed).
- Hyporhamphus australis*.—Tortonese, 1939: 255-7 (Melbourne; discussion of validity of *Reporhamphus*; no mention of the name *Hy. melanochir*). (Not *Hemiramphus australis* Steindachner, 1866.).
- Hemiramphus australis*.—Marshall, *et al.*, 1959: 28 (fig. of *Hy. melanochir* after McCoy, 1887). Marshall, 1964: 101 (in part, valuable food fish in S. Australian states).
- Hemiramphus australis*.—Grant, 1965: 38 (fig. of *Hy. melanochir* after McCoy, 1887).

### Diagnosis

*Hy. melanochir* differs from *Hy. australis* and resembles *Hy. ihi* in having fewer gill-rakers (Table 5), usually 33 or less on the first arch (compared with usually 34 or more in *Hy. australis*) and usually 26 or less on the second arch (usually 27 or more). *Hy. melanochir* differs from both *Hy. australis* and *Hy. ihi* in having a relatively shorter upper and lower jaw, especially at larger sizes (shorter than upper jaw width and head length, respectively, Figs 16 and 17). The pelvic fins are further posterior in *Hy. melanochir*, the P<sub>2</sub>-C extension usually falling on the adpressed pectoral fins instead of on the opercle or pectoral fin base as in *Hy. ihi*.

### Description

Upper jaw long and pointed, as long as wide at smaller sizes, shorter than wide at larger sizes (Fig. 16); width divided by length 0.84-1.49, population means over entire size range 1.02-1.16. Lower jaw length moderate, usually slightly longer than head length until about 200 mm SL when it becomes about equal to head length (Fig. 17); head length divided by lower jaw length 0.49-1.29, population means over entire size range 0.73-0.96. Pelvic fins placed about midway between bases of pectoral and caudal fins; P<sub>2</sub>-C distance divided by P<sub>1</sub>-P<sub>2</sub> 0.78-1.11, population means 0.91-0.94; P<sub>2</sub>-C extension falls on opercle to mid-adpressed pectoral fin, usually on the anterior third of the adpressed pectoral fin. Dorsal rays 15-18, usually 16 or 17; anal rays 17-20; usually 18 or 19; pectoral rays 11-13, usually 12. Vertebrae (36-41) + (18-21) = 55-61, lower counts to the west. Gill-rakers on first arch (7-11) + (20-25) = 27-35, usually 30-32; on second arch (2-6) + (18-25) = 21-29, usually 23-26. Length of dorsal fin base equal to anal fin base, or slightly longer; dorsal base divided by anal 0.96-1.17, population means 1.03-1.06.

### Maximum known size

332 mm SL (BMNH 1896.6.17.80-84, Melbourne Market).

### Lectotype

MNHN B.1066, female, 184 mm SL, Port Western, New Holland (= Adelaide, S. Australia); Quoy and Gaimard; herein selected. This specimen is the largest of the three syntypes, is in the best condition, bears the original tag, and has a dorsal and anal ray count (17-19) that matches Valenciennes' original description. Gill-rakers on first arch 9 + 23 = 32; on second arch 4 + 20 = 24; lower jaw length 42.2 mm; head length 38.2 mm; P<sub>1</sub>-P<sub>2</sub> 76.0 mm; P<sub>2</sub>-C 69.7 mm; P<sub>2</sub>-C extension falls on anterior third of adpressed pectoral fin. Preorbital canal with posterior branch (Fig. 2d). Paralectotypes; MNHN B.2636; 2 (148-163); removed from B.1066.

### Geographic variation

Meristic data for populations of *Hy. melanochir* in the four southern states are presented in Table 5. There is a decreasing cline in vertebral number from Victoria west to W. Australia. The populations in Victoria and Tasmania are more similar to each other than to the populations in S. Australia and W. Australia in number of gill-rakers but there is some evidence of a clinal increase toward the west. Fin-ray counts are essentially the same throughout the range.

Morphometrically, there is also evidence of two groups of populations. Comparison of regressions of eight characters between adjacent states (Table 7) shows that the only significant differences were in lower jaw length and P<sub>2</sub>-C distance between Victoria and S. Australia.

**Table 6. Comparison of regression equations and F values for slopes and heights of eight morphometric characters for three species of *Hyporhamphus* (\*\* = Significant at 99.9% level)**

Character	Regression Equations Y =			F values					
	<i>Hy. australis</i>	<i>Hy. melanochir</i>	<i>Hy. ihi</i>	<i>Hy. australis</i> vs. <i>Hy. melanochir</i>		<i>Hy. australis</i> vs. <i>Hy. ihi</i>		<i>Hy. melanochir</i> vs. <i>Hy. ihi</i>	
Lower jaw length ..	0.1368X + 17.528	0.1555X + 12.334	0.1682X + 12.679	<i>Slopes</i> 3.74	<i>Heights</i> 2.74	<i>Slopes</i> 6.72	<i>Heights</i> 0.136	<i>Slopes</i> 1.52	<i>Heights</i> 10.41
Head length ..	0.0255X - 0.151	0.2126X - 1.014	0.2089X - 0.511	4.66	2.00	0.578	0.176	0.656	0.149
P <sub>1</sub> -P <sub>2</sub> ..	0.4271X - 2.103	0.4255X - 2.046	0.4188X - 2.460	0.241	-0.612	1.66	11.01	1.30	10.30
P <sub>2</sub> -C ..	0.3757X + 1.014	0.3638X + 2.166	0.3818X + 1.025	6.71	6.06	0.967	4.74	10.27	16.22**
Base dorsal fin ..	0.1380X + 0.718	0.1344X + 1.688	0.1416X + 1.170	2.60	2.70	0.770	10.53	7.51	9.12
Base anal fin ..	0.1277X + 1.468	0.1205X + 2.665	0.1320X + 1.788	8.28	0.018	1.99	17.75**	14.05**	(14.67)
Upper jaw length ..	0.0401X + 0.521	0.0439X - 0.331	0.0488X - 0.411	6.65	2.14	21.47**	6.11	7.08	26.94**
Upper jaw width ..	0.0478X - 0.596	0.0544X - 1.213	0.0458X - 0.401	19.27**	(15.48)	1.55	0.776	18.92**	10.66
Degrees of freedom ..				1, 143-171		1, 53-63		1, 151-174	

### Discussion

*Hy. melanochir* and *Hy. australis* are considered as species rather than as subspecies because their ranges meet at Eden, New South Wales and because the most important differentiating characters, numbers of gill-rakers and vertebrae, show no trace of intergradation in the geographically closest large samples, Moruya, New South Wales (*Hy. australis*) and Melbourne, Victoria (*Hy. melanochir*). In fact, the Melbourne population has even fewer gill-rakers (mean number on first arch 30.64, second arch 24.18) than other populations of *Hy. melanochir*. For the Adelaide population, the mean number of gill-rakers on the first arch is 31.62, second arch 26.00; for all specimens of *Hy. melanochir* (except the Melbourne population) the means are 31.38 and 25.33. Similarly, the Victoria population of *Hy. melanochir* has distinctly more vertebrae than does *Hy. australis* while the W. Australian population completely overlaps the range of *Hy. australis*.

This character displacement in number of gill-rakers and vertebrae indicates that the species are maintaining their identity as they approach each other geographically. Presumably, Tasmania was once connected to Victoria across Bass Strait thus dividing a continuous population of *Hyporhamphus* into an eastern population which differentiated into *Hy. australis*, and a western population which differentiated into *Hy. melanochir*. A similar split between eastern and western populations of the Australian "salmon", *Aripis trutta*, has been described by Malcolm (1959, 1960), but in this case the populations are only subspecifically distinct, mix somewhat out of the breeding season, and maintain their identity by migrating to separate breeding areas.

The presence of both species at Eden deserves special mention. Four specimens were selected, more or less at random, from several boxes of large sea garfish in the Sydney Fish Market on 8 April, 1970. The smallest of the four (266 mm SL) was quickly separated from the other three on the basis of low gill-raker counts. The three larger specimens had a more prominent ridge in the middle of the upper jaw than the smallest one. There was more yellow on the anterior edge of the anal fin in the smallest, a moderate amount in one specimen, and much less in the remaining two. Otoliths were extracted from the fresh specimens: two sets were of one species, one set (the smallest specimen) was of a second species, and the third set was intermediate. Two specimens have 57-58 total vertebrae, the smallest specimen has 60, and the fourth has 59. I conclude (Collette, 1973) that the smallest specimen is *Hy. melanochir*, two others are *Hy. australis*, and the fourth specimen is a hybrid between the two.

### Distribution

Known from Tasmania and from Melbourne, Victoria west along the Great Australian Bight into the Indian Ocean north as far as Perth, Western Australia (Fig. 18). One specimen of four from Eden, New South Wales appears to be *Hy. melanochir*, two others *Hy. australis*, and the fourth a hybrid between the two species (see above).

### Material

306 specimens (38.1-332 mm SL) from 63 collections arranged from north to south and then east to west.



New South Wales: USNM 207521; Eden; purch. Sydney mkt.; B. B. Collette and J. R. Paxton; BBC 1466; April 8, 1970; 1 (266).

Tasmania, 33 specimens (58.9-277 mm) from 8 collections: MCZ 697; Hobart; Robertson; 8 (126-144). CSIRO; West Sister Is., Furneaux Group; Oct. 8, 1952; 5 (60.7-88.8). CSIRO; Seal Bay, King Is.; Sept. 7, 1952; 1 (58.9). USNM 206557; Green's Beach at mouth Tamar R.; R. H. Green; Jan. 18, 1969; 5 (122-189). USNM 206556; same locality and collector; Jan. 1970; 7 (93.2-147). AMS B.5527, 5530; Tasmania; exch. Hobart Mus.; Dec. 1884; 2 (236-277). BMNH pre-reg.; Van Dieman's Land; Melville; 2 (183-193). BMNH 1875.10.12.18-20; Tasmania; M. Allport; 3 (212-220).

Victoria, 70 specimens (61.6-332 mm) from 14 collections: AMS I.7506-12; Queenscliffe, near Melbourne; E. R. Waite; Nov. 1905; 47 (61.1-227). MNHN 1177; Port Phillip, Melbourne; Müller; 2 (208-261). MNHN 1416; Port Phillip, Melbourne; Dec. 1862; 1 (297). MNHN 4249; Melbourne; Müller; 1 (216). SMN 2190 + 1578; Hobsons Bay, Port Phillip; Müller; 2 (218-251). MNHN 84-371; Melbourne Museum; 1884; 1 (257). NHMV 5600; Melbourne; McCoy; 1882; 1 (260). BMNH 1896.6.17.80-84; Melbourne mkt.; Degen; 5 (280-332). MCZ 8772; Melbourne; F. Müller; recd. April 1886; 1 (107). AMS I.7547; Melbourne mkt.; E. R. Waite; Nov. 1905; 2 (240-269). ANSP 49307-9; Melbourne mkt.; A. F. Kenyon; 1909; 3 (245-271). USNM 176998; Hastings, near Melbourne; J. K. Howard; March 15-17, 1953; 1 (200). CSIRO; Rye, near Melbourne; Aug. 21, 1941; 2 (94.3-97.4). MCZ 8776; "Victoria"; 1 (306).

South Australia, 84 specimens (37.0-307 mm) from 14 collections. MNHN B.1066, lectotype; and MNHN B.2636, paralectotypes of *He. melanochir*; Port Western (=Adelaide); Quoy and Gaimard; 3 (148-184). USNM 206586; Port Adelaide; purch. Adelaide mkt.; B. B. Collette and J. R. Paxton; BBC 1430; Feb. 3, 1970; 10 (231-279). AMS A.17619-21; Adelaide; G. Bealey; July 1883; 3 (216-282). ZMK P341781-9; off Adelaide; Galathea 567; Dec. 7, 1951; 9 (77.5-208). AMS IB.1046; W. River, Kangaroo Is.; CSIRO; Feb. 23, 1939; 6 (50.0-81.8). AMS IB.1057; same data as IB.1046; 8 (38.1-63.7). USNM 177167; around Kangaroo Is. and St Stephens Bay; J. K. Howard; March 25-April 18, 1953; 5 (148-233). CSIRO; Antechamber Bay, Kangaroo Is.; Feb. 28, 1939; 8 (49.3-138). CSIRO; Antechamber Bay, Kangaroo Is.; March 7, 1953; 4 (45.7-77.4). USNM 206566; Spencer Gulf at Port Augusta Caravan Park; B. B. Collette and J. R. Paxton; BBC 1431; Feb. 3, 1970; 2 (116). ZMH uncat.; Spencer Gulf; H. Nissen; 1901; 18 (37.0-79.2). AMS IA.7101-2; "South Australia"; G. Bourne; 2 (300-307). SAM 1141; "South Australia", perhaps St Vincent Gulf; 2 (211-235). CSIRO; Coffin Bay; April 28, 1949; 4 (58.8-95.9).

Western Australia, 112 specimens (57.7-294 mm) from 22 collections: CSIRO C.2648; Hopetoun; March 6, 1952; 1 (197). AMS IA.667-8; King George Sound, Albany; Troughton, Grant, and Wright; April 1922; 2 (210-230). NHMV 5601; Albany; 2 (227-228). CSIRO C. 2528-9; Albany Harbour; Oct. 10, 1954; 2 (211-240). AMNH 40005; N. edge Two Peoples Bay, near Albany; D. E. Rosen, G. J. Nelson, and W. H. Butler; DER 69-21; March 14, 1969; 2 (59.9-189). WAM P-7900; Denmark Estuary; J. Ride; Jan. 10, 1964; 1 (178). USNM 206565; Leschanault Estuary at Koombana Caravan Park, Bunbury; B. B. Collette and J. R. Paxton; BBC 1437; Feb. 7, 1970; 1 (81.2). WAM P-6129; Bunbury; W. H. Graham; March 2, 1963; 1 (79.3). USNM 206564; Bunbury Bay at Koombana Park, Bunbury; B. B. Collette and J. R. Paxton; BBC 1442; Feb. 8, 1970; 2 (86.4-90.8). BBC 1448; Mandurah; purch. Perth mkt.; B. B. Collette, J. R. Paxton, R. J. McKay; Feb. 13, 1970; 23 (213-294); 4 spec. to AMS; 3 to BMNH (1970.7.28.8-10); 3 to MNHN; remainder to USNM 206587. USNM 206567; Shoalwater Bay, near Point Peron; B. B. Collette and J. R. Paxton; BBC 1445; Feb. 11, 1970; 3 (66.0-106). AMNH 40004; Point Peron, Cockburn Sound; D. E. Rosen, G. J. Nelson, and W. H. Butler; DER 69-43; March 23, 1969; 45 (67.5-182). USNM 206569; Mangles Bay, Cockburn Sound; B. B. Collette and J. R. Paxton; BBC 1444; Feb. 9, 1970; 6 (65.0-115). WAM P-98; Garden Island; Jan. 1914; 1 (166). WAM P-13408-13; Rottnest Is. off Perth; M. Bartlett; March 7, 1963; 6 (214-291). AMS I.4199; Swan R., Perth; exch. Perth Mus.; May 1899; 1 (292). ZMH uncat.; Fremantle; W. Wölting; 1907; 1 (102). AMS I.13244-6; Fremantle; W.A. Fish. Dept; Aug. 1914; 3 (204-232). WAM P-308; Fremantle; Fish. Inspector; July 1915; 2 (248-290). WAM P-2574-5; Whitford Beach, Perth; W.A. Fish. Dept; 2 (225-253). WAM P-uncat.; N. of North Point, Rottnest Is., off Perth; Jan. 17, 1961; 2 (57.7-95.2). SMN 2623 + 2693; W.A.; Müller; 3 (215-270).

"Australia", 6 specimens (136-252 mm) from 4 collections: MCZ 46720; Müller; 2 (136-163). MNHN 1905; Müller; 1 (205). MNHN A.7635; Emeric; 1 (136). SMN 3367; Müller; 2 (234-252).

**Hyporhamphus ihi** Phillipps

New Zealand Garfish or Piper

Figs 16–17, Tables 5–6

*Hemirhamphus intermedius*.—Günther, 1866: 260–1 (description in part, New Zealand [BMNH 1855.9.19.1064]). Klunzinger, 1880: 414 (in part, New Zealand [SMN 3687]). Hutton, 1889: 283 (listed). Ogilby, 1893: 172–3 (in part). Gill, 1893: 103, 114 (listed, previous records). Hutton, 1904: 50 (listed). Stead, 1906: 66–7 (in part, N.Z. included in range). Phillipps, 1927a: 21 (previous N.Z. records). Phillipps, 1927b: 12 (food fish in N.Z.). Thomson, 1931: 31 (worms and small crustaceans in stomachs). Benham, 1938: 36 (cold July killed most garfish in outside ponds, Portobello, N.Z.), 37 (gravid females, Feb. and March). Graham, 1938: 404 (abundant on *Zostera* flats in Otago Harbour, N.Z.; 400–1,000 doz. per seine haul; reaches 26 in., mean 16 in.). Graham, 1939a: 424 (three species of predators, Otago Harbour, N.Z.), 435 (herbivores, feeding primarily on *Zostera* and *Ulva*). Graham, 1939b: 364 (eggs and development), pl. 42, figs 1–11 (development). Baylis, 1944: 469–471 (*Micracanthocephalus hemirhamphi*, a new species of acanthocephalan from garfish stomach; Otago Harbour). Powell, 1947: 66 (common in estuaries of N. and S. islands; excellent food fish; methods of capture), fig. 312. Graham, 1953: 157–161 (eggs and embryos), fig. of *Hy. australis* after Roughley, 160 (development figs after Graham, 1939b). (Not *Hemiramphus intermedius* Cantor, 1842.)

*Hemiramphus intermedius*.—Hector, 1872: 118 (common, N.Z.; highly appreciated food fish; methods of capture), pl. 9, fig. 86. Hutton, 1872: 53–4 (description; abundant at Wellington and Auckland; range in part). Sherrin, 1886: 33–5 (description; food value), 284 (size limit—9 in.), 305 (listed). Phillipps, 1921: 120 (abundant, northern N.Z.), 125 (sold in Wellington markets on 37 days, March–Aug., 1918). Phillipps and Hodgkinson, 1922: 94 (Auckland market, June and July only). Thomson, 1932: 26 (ripe in Nov. and Dec. at Portobello; hatching after 44 days; growth of lower jaw), figs. Fowler, 1940: 757 (N.Z. specimen [USNM 83332]; Wilkes Exped. 1838–1842). Morrow, 1952: 144 (favorite food of striped marlin; records interpreted by Baker, 1966 as being *Scomberesox saurus*), 145 (1 spec. in stomachs of 38 *Makaira mitsukurii*). Baker, 1966: 820 (Morrow's 1952 report of "piper" interpreted as *Scomberesox saurus*).

*Hyporhamphus intermedius*.—Waite, 1907: 15 (listed, N.Z.). Phillipps, 1918: 271 (large numbers caught yearly near Picton for shipment to Wellington). Thomson and Anderton, 1921: 72 (common spring and summer, Otago Harbour; ripe in Jan.; description of eggs).

*Hyporhamphus ihi* Phillipps, 1932: 230 (original description; Wellington, N.Z.; comparison with Australian *Hy. "intermedius"*—*Hy. australis* and *Hy. melanochir* combined).

*Reporhamphus ihi*.—Graham, 1956: 157–161 (description; development from Graham, 1939b), 240 (part of main diet of *Arripis trutta*), 363 (in stomachs of *Currupiscis kumu*). Doogue and Moreland, 1960: 195 (fig., description, habits, predators, fishing methods). Doogue and Moreland, 1961: 206 (after 1960 with notes on food quality added). Whitley, 1968a: 36 (listed). Russell, 1969: 108 (surface species, Goat Is., N. of Auckland). Stephenson, 1969: 427 (cymothoid isopod *Irona melanosticta* common on specimens from Bay of Islands and Hauraki Gulf). Grace, 1971: 132, 135 (Whangateau Harbour, surface schooling fish). Hewitt and Hine, 1972: 94 (list of parasite records).

*Hemiramphus australis*.—Moreland, 1957: 34 (Chatham Is. [DM 4534], new record).  
(Not *Hemiramphus australis* Steindachner, 1866.)

#### Diagnosis

*Hy. ihi* differs from *Hy. australis* and resembles *Hy. melanochir* in having fewer gill-rakers (Table 5), usually 32 or less on the first arch (compared to 34 or more) and 25 or less on the second arch (usually 27 or more). *Hy. ihi* has a relatively longer upper jaw (usually longer than wide) and lower jaw (usually longer than head length) than do either *Hy. australis* or *Hy. melanochir*, especially at larger sizes (Figs 16 and 17). The pelvic fins are placed further anterior in *Hy. ihi*: the  $P_2$ -C distance usually falls on the opercle or on the pectoral fin base instead of on the addressed pectoral fin as in both *Hy. australis* and *Hy. melanochir*.

#### Description

Upper jaw long and pointed, usually longer than wide (34 of 44 specimens, Fig. 16); width divided by length 0.82–1.08,  $\bar{x}$  0.94. Regression of upper jaw length on standard length significantly different from both *Hy. australis* and *Hy. melanochir*; regression of upper jaw width significantly different from *Hy. melanochir* (Table 6). Lower jaw length moderate, slightly longer than head length (Fig. 17); head length divided by lower jaw length 0.57–1.01,  $\bar{x}$  0.76 over entire size range. Pelvic fins placed slightly anterior to midway between pectoral fin origin and caudal fin base;  $P_2$ -C distance divided by  $P_1$ - $P_2$  0.83–1.11,  $\bar{x}$  0.98;  $P_2$ -C extension falls on opercle to mid-addressed pectoral fin, usually on opercle or pectoral fin base. Dorsal rays 15–18, usually 16; anal rays 17–20, usually 18; pectoral rays 11 or 12. Vertebrae (36–38) + (18–21) = 55–58, usually 37 + 19 = 56. Gill-rakers similar to the Victorian population of *Hy. melanochir*, 27–33 on first arch, usually 28–30; 21–25 on second arch, usually 22–24. Dorsal fin base about as long as anal fin base; dorsal base divided by anal base 0.95–1.09,  $\bar{x}$  1.03; regression of anal fin base on standard length significantly different from both *Hy. australis* and *Hy. melanochir* (Table 6).

#### Maximum size

*Hy. ihi* is apparently a smaller species than either of the Australian species of sea garfishes, reaching only 260 mm SL (male, BMNH 1886.11.18.91, Dunedin).

#### Types

No types are extant and Phillipps apparently did not designate any (J. Moreland, pers. comm.).

#### Discussion

In the original description of *Hy. ihi*, Phillipps (1932) claimed that the chief differentiating character between *Hy. ihi* and the Australian sea garfish *Hy. "intermedius"* (presumably *Hy. australis* and *Hy. melanochir* combined) was that the lower jaw was distinctly longer than the head in *ihi* and approximately equal in "*intermedius*". As Fig. 17 shows, the lower jaw in all three species is distinctly longer than the head at smaller sizes (up to about 200 mm SL). *Hy. australis* and *Hy. ihi* do, however, appear to have a slightly longer lower jaw than does *Hy. melanochir* but it is not statistically significant (Table 6). *Hy. ihi* is obviously the New Zealand representative of the Australian sea garfishes and is here accorded specific rank because of its more anteriorly placed pelvic fins and because *Hy. australis* and *Hy. melanochir* are considered species. The three species make up one zoogeographical species or superspecies.

**Table 7. Comparison of regression equations and F values for slopes and heights of eight morphometric characters for four populations of *Hy. melanochir* (\*\* = Significant at 99.9% level)**

Character	Regression equations Y =				F values					
	Tasmania	Victoria	S. Australia	W. Australia	Tasmania vs. Victoria		Victoria vs. S. Australia		S. Australia vs. W. Australia	
Lower jaw length .. .. .	0.1658X + 13.056	0.1558X + 13.475	0.1558X + 10.577	0.1625X + 10.323	<i>Slopes</i> 0.465	<i>Heights</i> 1.59	<i>Slopes</i> -0.001	<i>Heights</i> 13.30**	<i>Slopes</i> 0.346	<i>Heights</i> 1.34
Head length .. .. .	0.2141X - 2.040	0.1992X + 0.754	0.2110X - 0.558	0.2166X - 1.002	9.59	3.06	10.03	7.58	1.99	3.60
P <sub>1</sub> -P <sub>2</sub> .. .. .	0.4223X - 1.700	0.4170X - 1.472	0.4298X - 2.165	0.4263X - 1.929	0.266	0.914	2.51	7.02	0.336	0.661
P <sub>2</sub> -C .. .. .	0.3664X + 2.294	0.3761X + 0.844	0.3592X + 2.281	0.3628X + 1.966	1.62	0.225	8.81	12.81**	0.379	0.609
Base dorsal fin .. .. .	0.1323X + 1.825	0.1364X + 1.525	0.1369X + 1.404	0.1324X + 1.896	0.915	1.18	0.021	-0.033	3.09	2.63
Base anal fin .. .. .	0.1219X + 2.372	0.1252X + 2.336	0.1196X + 2.794	0.1200X + 2.607	0.472	2.16	1.66	2.70	0.012	0.133
Upper jaw length .. .. .	0.0426X - 0.218	0.0385X + 0.176	0.0442X - 0.260	0.0461X - 0.460	3.16	2.59	6.32	11.13	1.27	1.36
Upper jaw width .. .. .	0.0515X - 1.279	0.0500X - 0.606	0.0540X - 0.940	0.0557X - 1.185	0.358	9.21	3.88	6.29	0.694	0.180
Degrees of freedom .. .. .					1, 37-59		1, 50-61		1, 70-76	

*Distribution*

Restricted to New Zealand and the Chatham Islands.

*Material*

112 specimens (53.4–260 mm SL) from 27 collections arranged from north to south.

New Zealand: BMNH 1855.9.19.79; North Is., Bay of Islands; Haslar Coll.; 3 (111–188). ANSP 117424; Bay of Islands, E. side Urupukapuka I.; W.A. Starck II and J. Moreland; WAS NZ-17; Feb. 29, 1960; 6 (83.5–189). ANSP 117423; Bay of Islands, N.W. of Urupukapuka I.; W.A. Starck II and J. Moreland; WAS NZ 11 + 12; Feb. 25, 1960; 1 (170). SMF 2304; Hauraki Gulf; H. Suter; 1908; 1 (202) and SMF 2471; same data; 1 (211). USNM 205745; Port Charles, 36° 32' S.; Feb. 28, 1957; 5 (57.2–97.7); and DM 2291; same data 6 (70.2–87.5). SMN 3687; Auckland; Kramer; 1 (140). SU 15835; Auckland Harbour; Hubbs et al.; Feb. 1949; 2 (123–129). USNM 177041; near Auckland; J. Howard; Jan. 6–Feb. 1, 1953; 2 (81.7–139) and USNM 177062; same data; 4 (194–236). USNM 205747; Raumati Beach, 40° 55' S.; D. M. Patchett; Feb. 15, 1968; orig. DM 4865; 6 (179–193). BMNH 1873.12.13.48–9; Wellington Harbour; 2 (205–219). DM 4335; Wellington Harbour; 2 (203–221). ZMUC 341790–811; Wellington; Galathea 627; Jan. 23–24, 1952; 22 (76.1–197). CSIRO C.2043; Cook Straits; 1947–48; 1 (187). DM 4766; Port Ligar, Pelorus Sound; May 27, 1966; 2 (54.0–56.8). USNM 205743; Queen Charlotte Sound; J. Moreland; Sept. 1, 1951; 5 (53.4–87.1); DM 933; same data; 7 (56.6–76.4); and CSIRO; same data; 8 (70.5–132). BMNH 1913.12.4.4; Lyttelton Harbour; "Terra Nova"; 1 (187). DM 3606; Islington Bay, Lyttelton Harbour; Feb. 16, 1962; 2 (140–149). BMNH 1886.11.18.91; Dunedin; Otago Mus.; 1 (260). ANSP 101740; Otago coast; 5 (227–255). USNM 205744; Dunedin Harbour; J. Moreland; Jan. 21, 1957; 2 (109–114); and DM 2157; same data; 2 (88.5–113). MNHN B.1037; Nouvelle Zelande; Hast; 1 (247). NHMV uncat.; New Seeland; Reischek; 1881; 2 (147–194). BMNH 1855.9.19.1064; New Zealand; Haslar Coll.; 3 (126–200). USNM 39692; New Zealand; 1888; Otago Mus.; 1 (258). USNM 83332; New Zealand; Wilkes Exped.; 1 (250).

Chatham Islands: USNM 205746; Te Whanga Lagoon, 44° S., 176° 30' W.; Oct. 25, 1965; 2 (66.6–74.5); and DM 4534; same data; 2 (54.8–59.7).

**Hyporhamphus quoyi** (Valenciennes)

Short-nosed Garfish

Fig. 18, Tables 8–9

*Hemiramphus Quoyi* Valenciennes in Cuvier and Valenciennes, 1846: 35–6 (original description; Port Dourey, New Guinea). Whitley, 1928: 214–5 (synonymy; records from Qld., Gulf of Carpentaria, and Darwin [AMS I.1523], N.T.). McCulloch, 1929: 102 (listed; Qld., N. Australia). Anon., 1945: 8 (listed among Cairns, Qld. marketable fishes). Whitley, 1947: 149 (Dampier Arch. and Exmouth Gulf, new W.A. records). Roughley, 1951: 23 (Qld. and W.A., no N.S.W. records). Ogilby, 1954: 9 (common in Moreton Bay and Brisbane R., Qld.; ascends rivers to end of tidal influence; good food fish), fig. 7. Marshall *et. al.* 1959: 27 (description; Qld.), fig. (after Paradise and Whitley, 1927). Marshall, 1964: 99 (description; Qld.; food fish), pl. 24, fig. 107. Marshall, 1966: 174 (shortened from Marshall, 1964), pl. 24, fig. 107.

*Hemiramphus Gaimardi* Valenciennes in Cuvier and Valenciennes, 1846: 36–7 (original description; in part, specimens from New Guinea and Amboina).

*Hemiramphus melanurus* Valenciennes in Cuvier and Valenciennes, 1846: 42–3 (original description; Celebes Islands).

*Hemirhamphus quoyi*(i).—Schmeltz, 1879: 57 (Bowen, Qld.). Günther, 1880: 50 (Somerset, Cape York [BMNH 1879.5.14.474], Qld.). Kent, 1889: 240 (Port Darwin District). Cockerell, 1913: 51-2 (scale characters, Qld. specimens). McCulloch and Whitley, 1925: 138 (previous Qld. records). Paradice and Whitley, 1927: 80 (Pellew Is., Gulf of Carpentaria [AMS IA.1681-4]; fairly common), pl. 11, fig. 2. Grant, 1965: 37 (description after Munro, 1957; ocean beach estuaries and saline estuaries of entire Qld. coast; reaches 14 in., good food fish), fig. Grant, 1972: 62 (description after Munro, 1967; text after Grant, 1965).

*Belone quoyi*.—Kluzinger, 1880: 415 (synonymy; description; Port Darwin and Endeavour R. [SMN 2603, 2435]).

*Tylosurus quoyi*.—McCulloch and Whitley, 1925: 138 (based on Klunzinger, 1880).

*Reporhamphus quoyi*.—Whitley, 1948: 15 (listed, between North West Cape and 80-mile Beach, W.A.).

*Reporhamphus caudalis* Whitley, 1951: 393 (original description; Cape York, Qld.). Whitley, 1964b: 38 (listed).

*Hyporhamphus quoyi*.—Taylor, 1964: 105 (Arnhem Land [11 USNM collections], N.T.; description). Whitley, 1964b: 39 (listed).

*Hemirhamphus caudalis*.—Grant, 1972: 67 (brief description).

#### *Misidentification:*

*Hemiramphus limbatus*.—Borodin, 1932: 73 (Brisbane, Qld. [VMM 899]).

#### *Diagnosis*

A species of *Hyporhamphus* with a very short lower jaw, equal to the head length at about 100 mm SL, gradually decreasing to half the length of the head in adults. *Arrhamphus sclerolepis* has almost no lower jaw at all; all other Australian garfishes have a longer lower jaw. Upper jaw broadly rounded, much wider than long. Preorbital canal with a wide short posterior branch opening in a larger pore than other Australian garfishes (Fig. 2, l-n); ventral pore about as large as in *Hy. affinis* and *Hy. dussumieri* (Fig. 2, h-k).

#### *Description*

Upper jaw width divided by length 1.27-2.30, means for the five populations 1.69-1.83, overall mean 1.75. Dorsal rays 15-17, usually 16; anal rays 14-16, usually 15 or 16; pectoral rays usually 12, occasionally 11 or 13. Vertebrae (36-39) + (16-18) = 52-56. Gill-rakers on first arch (9-14) + (19-25) = 27-39; on second arch (4-7) + (18-25) = 22-31; counts increasing from Queensland westward (Table 8). Pelvic fins inserted closer to pectoral origin than to caudal base;  $P_2$ -C distance divided by  $P_1$ - $P_2$  0.96-1.25, population means 1.03-1.12, overall mean 1.08;  $P_2$ -C extension falls on preopercle, opercle, or between opercle and pectoral fin base, usually on the middle of the opercle. Dorsal fin base longer than anal fin base; dorsal base divided by anal 1.09-1.40, population means 1.26-1.30, overall mean 1.28. Maximum body depth greater than maximum body width.

#### *Maximum known size*

312 mm SL (AMS I.13243, Shark Bay, W.A.).

**Table 8. Number of fin rays, gill-rakers, and vertebrae in populations of *Hyporhamphus quoyi* from Australia and New Guinea. (<sup>1</sup>/holotype of *Reporhamphus caudalis* Whitley; <sup>2</sup>/holotype of *Hemiramphus quoyi* Valenciennes)**

Population	Dorsal					Anal					Pectoral				
	15	16	17	N	$\bar{x}$	14	15	16	N	$\bar{x}$	11	12	13		
N.S.W.-SE. Queensland .. ..	9	27	2	38	15.82	1	18	19	38	15.47	1	25	1		
NE. Queensland .. ..	3	19 <sup>1</sup>	8	30	16.17	..	16 <sup>1</sup>	14	30	15.47	..	13 <sup>1</sup>	2		
Gulf of Carpentaria .. ..	1	32	12	45	16.24	1	31	13	45	15.27	..	18	7		
N. Territory .. ..	2	10	1	13	15.92	..	12	1	13	15.08	..	12	..		
W. Australia .. ..	5	27	8	40	16.08	2	19	19	40	15.40	..	12	5		
New Guinea .. ..	4	39 <sup>2</sup>	8	51	16.08	3 <sup>2</sup>	38	10	51	15.14	6 <sup>2</sup>	31	3		
First Arch Gill-rakers															
	27	28	29	30	31	32	33	34	35	36	37	38	39	N	$\bar{x}$
N.S.W.-SE. Queensland .. ..	..	4	9	9	9	3	..	..	..	..	..	..	..	34	29.94
NE. Queensland .. ..	..	..	..	2	9	6 <sup>1</sup>	9	1	..	..	..	..	..	27	31.93
Gulf of Carpentaria .. ..	..	..	..	..	5	13	16	15	10	2	..	..	..	62	33.31
N. Territory .. ..	..	..	..	..	..	..	2	4	4	2	..	..	..	12	34.50
W. Australia .. ..	..	..	..	..	..	4	6	7	11	6	3	..	1	38	34.61
New Guinea .. ..	1	4	9	14	12 <sup>2</sup>	4	3	..	1	..	..	..	..	48	30.29
Second Arch Gill-rakers															
	22	23	24	25	26	27	28	29	30	31	N	$\bar{x}$			
N.S.W.-SE. Queensland .. ..	5	10	11	7	1	..	..	..	..	..	34	23.68			
NE. Queensland .. ..	..	..	6	2	12	4 <sup>1</sup>	2	..	..	..	26	25.77			
Gulf of Carpentaria .. ..	..	..	3	11	13	17	14	4	..	..	62	26.05			
N. Territory .. ..	..	..	..	..	..	2	6	4	..	..	12	28.17			
W. Australia .. ..	..	..	..	1	3	9	8	9	8	1	39	28.26			
New Guinea .. ..	1	8	14 <sup>2</sup>	13	7	5	..	..	..	..	48	24.67			
Vertebrae															
	52	53	54	55	56	N	$\bar{x}$								
SE. Queensland .. ..	..	..	1	4	..	5	54.80								
NE. Queensland .. ..	..	1	1	1 <sup>1</sup>	1	4	54.50								
Gulf of Carpentaria .. ..	..	13	20	4	..	37	53.76								
N. Territory .. ..	..	1	7	..	..	8	53.88								
W. Australia .. ..	..	..	2	21	7	30	55.17								
New Guinea .. ..	10	8	1	..	..	19	52.53								

*Types*

*Hemiramphus quoyi* Valenciennes, 1846. Holotype MNHN B.1068; New Guinea; Quoy and Gaimard; 1 (212). Lower jaw length 28.6 mm; head length 53.5 mm;  $P_1$ - $P_2$  79 mm;  $P_2$ -C 80.5 mm;  $P_2$ -C extension falls on posterior third of opercle; D 16; A 14;  $P_1$  11-11;  $RGR_1$  10 + 21 = 31;  $RGR_2$  5 + 19 = 24. Preorbital canal shown in Fig. 2l.

*Hemiramphus melanurus* Valenciennes, 1846. Holotype MNHN B.1057; Celebes; Quoy and Gaimard; female (183). Lower jaw length 26.0 mm; head length 39.4 mm;  $P_1$ - $P_2$  69.2 mm;  $P_2$ -C 78.2 mm;  $P_2$ -C extension falls on anterior third of opercle; D 15; A 15;  $P_1$  11-11;  $RGR_1$  11 + 22 = 33;  $RGR_2$  4 + 18 = 22.

*Hemiramphus gaimardi* Valenciennes, 1846. Lectotype MNHN B.1058; New Guinea; 166 mm; herein selected because it best fits Valenciennes' original description. Lower jaw length 25.3 mm; head length 36.4 mm;  $P_1$ - $P_2$  60.0 mm;  $P_2$ -C 70.8 mm;  $P_2$ -C extension falls on preopercle-opercle margin; D 16; A 15;  $P_1$  11-11;  $RGR_1$  9 + 19 = 28;  $RGR_2$  4 + 19 = 23. Paralectotypes MNHN B.1058, New Guinea, 1 (152); and MNHN 4591, Amboina, 1 (151). Preorbital canal of paralectotype B.1058 shown in Fig. 2m.

*Reporhamphus caudalis* Whitley, 1931. Holotype AMS I.444; Cape York, Queensland; exch. Qld. Mus., May 1886; 1 (94.3). Paratype same number and data; 1 (90.9). Data for holotype (paratype in parentheses). Lower jaw length 22.1 mm (25.3); head length 20.5 mm (19.2);  $P_1$ - $P_2$  35.8 mm (33.5);  $P_2$ -C 37.1 mm (36.2);  $P_2$ -C extension falls on posterior margin of opercle in both; D 16 (17); A 15 (15);  $P_1$  12-12 (?-12);  $RGR_1$  10 + 22 = 32 (11 + 21 = 32);  $RGR_2$  5 + 22 = 27 (4 + 20 = 24); total vertebrae 55 (54). Preorbital canal shown in Fig. 2n.

*Geographic variation*

The Australian material was divided into five geographic areas for comparisons: New South Wales—SE. Queensland (north to Maryborough); NE. Queensland (from the Cumberland Group off MacKay north); Gulf of Carpentaria; Northern Territory; and Western Australia. Meristic data for these five populations (and New Guinea) are compared in Table 8. There is an increasing cline in number of gill-rakers on both the first and second gill-arches from Queensland to the Northern Territory to Western Australia. The New Guinea population is most similar to SE. Queensland. There are also geographic differences in vertebral number. The northern populations clearly have fewer vertebrae than the Western Australian population and probably fewer than in SE. Queensland but that sample is inadequate. The New Guinea population has still fewer vertebrae. There are no significant differences between the populations in the numbers of fin-rays, the Australian and New Guinea populations usually having 16 dorsal, 15 anal, and 12 pectoral rays.

There are also significant morphometric differences among some of the five Australian populations of *Hy. quoyi* in six of eight characters (Table 9). The New South Wales-SE. Queensland population differs significantly from the NE. Queensland population in the heights of regression lines for three characters: lower jaw length, head length, and  $P_1$ - $P_2$  distance. The NE. Queensland population also differs from the Gulf of Carpentaria population in lower jaw length but not in the other two characters. Combining the Gulf of Carpentaria with the Northern Territory and Western Australian populations showed the western group still significantly different in lower jaw length from NE. Queensland (F for heights 11.69\*\*). For both head length and  $P_1$ - $P_2$  distance, NE. Queensland was combined with the western three populations and compared with N.S.W.-SE. Queensland. This test showed no



**Table 9. Comparison of regression equations and F values for slopes and heights of eight morphometric characters for five Australian populations of *Hy. quoyi* (\*\* = Significant at 99.9% level)**

Character	Regression equations Y =				
	SE. Queensland	NE. Queensland	Gulf of Carpentaria	Northern Territory	Western Australia
Lower jaw length ..	0.0631X + 18.386	0.0434X + 18.721	0.0593X + 13.96	0.0420X + 17.80	0.0430X + 17.449
Head length ..	0.2182X - 0.344	0.2182X + 0.514	0.2204X + 0.705	0.2244X + 0.458	0.1837X + 4.768
P <sub>1</sub> -P <sub>2</sub> ..	0.3973X - 1.340	0.3908X - 1.978	0.3780X - 1.627	0.3270X + 6.203	0.3875X - 0.955
P <sub>2</sub> -C ..	0.4100X - 1.446	0.4115X - 0.628	0.4276X - 2.078	0.4337X - 3.079	0.4114X - 1.458
Base dorsal fin ..	0.1522X - 0.273	0.1511X + 0.461	0.1550X + 0.069	0.1569X - 0.310	0.1539X - 0.156
Base anal fin ..	0.1084X + 0.962	0.1118X + 1.184	0.1197X + 0.096	0.1125X + 0.913	0.1122X + 0.865
Upper jaw length	0.0334X - 0.208	0.0297X + 0.336	0.0266X + 0.437	0.0363X - 0.523	0.0277X + 0.694
Upper jaw width ..	0.0561X - 0.282	0.0568X - 0.206	0.0591X - 0.399	0.0807X - 3.353	0.0557X + 0.164

Character	F values							
	SE. Queensland vs. NE. Queensland		NE. Queensland vs. Gulf of Carpentaria		Gulf of Carpentaria vs. Northern Territory		Northern Territory vs. Western Australia	
	<i>Slopes</i>	<i>Heights</i>	<i>Slopes</i>	<i>Heights</i>	<i>Slopes</i>	<i>Heights</i>	<i>Slopes</i>	<i>Heights</i>
Lower jaw length ..	3.32	14.62**	1.52	17.49**	0.422	6.16	0.001	0.085
Head length ..	-0.089	14.98**	0.199	4.78	0.160	0.195	0.657	2.31
P <sub>1</sub> -P <sub>2</sub> ..	1.00	15.75**	2.37	11.44	9.98	0.644	9.42	13.10**
P <sub>2</sub> -C ..	0.007	6.24	4.00	2.86	0.152	-0.160	1.30	14.88**
Base dorsal fin ..	0.043	4.47	0.791	0.062	0.059	-0.032	0.041	1.21
Base anal fin ..	0.851	9.17	3.97	-0.091	0.860	1.69	-0.041	0.345
Upper jaw length ..	3.42	-0.011	1.94	9.55	2.87	27.38**	1.42	0.331
Upper jaw width ..	0.130	2.28	1.31	1.98	12.37**	5.68	14.84**	4.26
Degrees of freedom	1, 47-49		1, 64-66		1, 53-54		1, 41-46	

significant differences for head length (F for heights 11.13) but it was significant for  $P_1$ - $P_2$  distance (F for heights 36.54\*\*). For  $P_2$ -C distance, the Western Australia population is significantly different from the Northern Territory (F for heights 14.88\*\*) but not from the combined four eastern populations (F for heights 10.97). The Gulf of Carpentaria population is significantly different from the Northern Territory in both upper jaw length and width (Table 9), and it is also significantly different when tested against the combined Northern Territory and Western Australia groups in upper jaw length (F for heights 19.32\*\*). For upper jaw width, the Northern Territory is also significantly different from Western Australia. There are no significant differences between any of the populations in either the length of the dorsal or anal fin bases.

The geographic variation in *Hy. quoyi* shows some similarities to that found in *Arrhamphus sclerolepis*. It differs in that the number of gill-rakers shows a sharper division along the middle of the eastern Queensland coast in *Arrhamphus* than in *Hy. quoyi*. The differences in vertebral number divide *Arrhamphus* into two subspecies whereas the differences in *Hy. quoyi* show latitudinal correlations that may indicate that vertebral number in this species is temperature dependent. Final evaluation of the geographic variation in *Hy. quoyi* must await completion of variational studies throughout the range of the species.

#### Distribution

A tropical species whose range is centered around the East Indies, Philippine Islands, and Australia. In Australia, found from Yamba Bay, Clarence River, N.S.W. (CSIRO uncat. juvenile) north along the Queensland coast, around Cape York, throughout the Gulf of Carpentaria, and along the southern coast of the Timor Sea into the Indian Ocean south to Shark Bay, Western Australia (Fig. 18).

#### Australian Material

223 specimens (27.2-312 mm SL) from 60 collections arranged from south to north along the east coast and then from east to west along the north coast of Australia.

New South Wales: CSIRO; Clarence R., Yamba Bay; May 20, 1946; 1 (67.6).

Queensland, 87 specimens (27.2-295 mm) from 29 collections: VMM 899; Brisbane; W. K. Vanderbilt, "Alva"; 1931-32; 2 (268). MCZ 33018; Brisbane; W. K. Vanderbilt; 1932; 1 (295). SU 13039; Brisbane R., J. D. Ogilby; 1 (267). CSIRO; Moreton Bay; May 1, 1945; 1 (35.0). CSIRO; N. end Bribie Is. Cr.; Jan. 22, 1945; 2 (77.0-90.0). CSIRO; Bribie Is. Banks, Caloundra; May 1944; 2 (59.3-73.3). CSIRO; Noosa R. near entrance; April 22, 1944; 9 (53.0-106). CSIRO; Noosa R. at Tewantin; Sept. 24, 1945; 1 (83.1). CSIRO; Noosa R. near Tewantin buoys; July 16, 1944; 7 (74.3-90.8). CSIRO; Noosa R.; 1944; 4 (84.2-111). CSIRO; The Bluff, S. Fraser Is. off Maryborough; Aug. 24, 1950; 4 (68.3-79.5). AMS IA.1680; St Bees Is., Cumberland Group; W. E. J. Paradise, HMAS "Geranium"; Dec. 1923; 1 (204). AMS IA.6726, 6728; Lindeman Is., Cumberland Group; G. P. Whitley; 2 (202-231) + 2 heads. AMS IA.6111-2; Hayman Is., Cumberland Group; Embury; 2 (215-227). AMS IA.6122-5; Hayman Is., Cumberland Group; Embury; 6 (36.9-111). AMS IA.2308-11; Cumberland Group; W. E. J. Paradise, HMAS "Geranium"; Oct. 1924; 4 (139-161). BMNH 1871.9.13.116; Pt Bowen; purch. from Schmeltz; 1 (121). AMS IB.1487; Magnetic Is. off Townsville; G. Coates; Aug. 1, 1945; 1 (277). MCZ 38536; Turtle Bay, near Cairns; E. J. Coulter; June 16, 1953; 1 (174). AMS I.14505; Walker Bay near Cooktown; A. R. McCulloch; Aug. 1918; 1 (165). SMN 2435 + 2603; Endeavour R., Cooktown; Müller; 2 (215-221). USNM 176835, 176893; "Great Barrier Reef"; J. Howard; April 8-May 29, 1953; 7 (168-243). CSIRO; Marrett R., Princess Charlotte Bay; M/V "Australia"; Sept. 27, 1948; 8 (56.9-91.6). CSIRO; Little N. Marrett R.; Sept. 27, 1948; 2 (27.2-41.0). AMS L.11814; Murray Is., Torres Strait; Hedley and McCulloch; Aug.-Oct. 1907; 1 (129). ANSP 82304; Darnley Is., Torres Strait; orig. QM I.1078; 1 (218). AMS L.444; Cape York; exch. Qld Mus.; May 1886; types of *Reporhamphus caudalis* Whitley; 2 (90.9-94.3). BMNH 1879.5.14.474; Somerset, Cape York; "Challenger"; 2 (236-250). AMS IB.6888-9; Inscription Point, Sweers Is., South Wellesley Is., Gulf of Carpentaria; D. McMichael and J. Yaldwyn; 3 (78.5-101). USNM 206579; "Queensland", prob. S.E. Qld; purch. Sydney fish mkt.; BBC-1466; April 8, 1970; 5 (201-252).

Northern Territory, 94 specimens (38.7–216 mm) from 17 collections: AMS IA.1681–4; Sir Edward Pellew Group, Gulf of Carpentaria; W. E. J. Paradice, HMAS "Geranium"; Dec. 1923; 6 (131–216). ANSP 86430; Pellew Group; orig. QM I.3973; 1 (140). USNM 173783; Emerald R., Groote Eylandt; R. R. Miller 48–15; June 3–5, 1948; 4 (111–149). AMS I.16155; Thompson Bay, S. end Port Langdon, Groote Eylandt; R. R. Miller 48–10; May 1, 1948; 3 (94.2–125). USNM 173785; Little Lagoon, 2 miles E. Umbakumba, Groote Eylandt; R. R. Miller 48–19; June 26, 1948; 3 (88.7–118). USNM 173784; Bartalumba Bay, Groote Eylandt; R. R. Miller 48–17; June 7, 1948; 2 (110–115). USNM 173782; S. end Winchelsea Is. off N. coast Groote Eylandt; R. R. Miller 48–13a; June 6, 1948; 2 (93.4–110). USNM 173781; Bickerton Is. N.W. of Groote Eylandt; R. R. Miller 48–13; June 2, 1948; 2 (72.1–76.7). USNM 173787; Port Bradshaw S. of Cape Arnhem; R. R. Miller 48–24; July 26, 1948; 22 (77.8–158); and AMS I.16154; 10. USNM 173788; Port Bradshaw S. of Cape Arnhem; R. R. Miller 48–25; July 23, 1948; 20 (81.5–121). USNM 173789; Port Bradshaw S. of Cape Arnhem; R. R. Miller 48–28; July 25, 1948; 4 (94.2–125). USNM 173786; Yirrkalla, N. of Cape Arnhem; R. R. Miller 48–21; July 29–Aug. 11, 1948; 2 (135–146). CSIRO; off Black Point, Port Essington, Cobourg Peninsula; Oct. 3, 1949; 1 (38.7). USNM 173779; Nightcliff, 7 mi. N. of Darwin; R. R. Miller 48–2; March 19–25, 1948; 8 (101–183). CSIRO C. 1724; Darwin; 1 (133). AMS I.1523; Darwin; W. E. J. Paradice, HMAS "Geranium"; Aug. 1923; 1 (145). AMS IA.7750–1; Darwin; M. Ward; 2 (146–150).

Western Australia, 40 specimens (36.3–312 mm) from 12 collections: AMS I.15224; Cockatoo Is., Buccaneer Archipelago; June 1911; 1 (255). WAM P-13302; Cockatoo Is., Buccaneer Archipelago; G. A. Robinson; 1911; 1 (146). AMNH 40009; Cape Bossut; D. E. Rosen, G. J. Nelson, and W. H. Butler; DER 69–78; April 16, 1969; 2 (160–170). AMS I.13240–2; Port Hedland; W.A. Fish. Dept; Aug. 1914; 3 (200–235). WAM P-19106; Port Hedland; A. Kalnins; May 31, 1965; 1 (144). AMS IB.2642; Depuch Is.; CSIRO; 1 (217). AMNH 40007; S. of Mandu Mandu Cr., North West Cape; D. E. Rosen, G. J. Nelson, and W. H. Butler; DER 69–59; April 4, 1969; 7 (112–153). AMNH 40001; S. of Mandu Mandu Cr., North West Cape; D. E. Rosen, G. J. Nelson, and W. H. Butler; DER 69–57; April 3, 1969; 4 (118–128). AMNH 40006; 5 mi. S. Yardi Station, North West Cape; D. E. Rosen, G. J. Nelson, and W. H. Butler; DER 69–55; April 2, 1969; 17 (69.5–124). AMS I.13243; Shark Bay; W.A. Fish. Dept; Aug. 1914; 1 (312). AMS IB.1642; Cape Peron, Shark Bay; CSIRO; 1 (118). WAM P-uncat.; Shark Bay; R. J. McKay; March 2, 1962; 1 (36.3).

### **Hyporhamphus affinis** (Günther)

Fig. 19

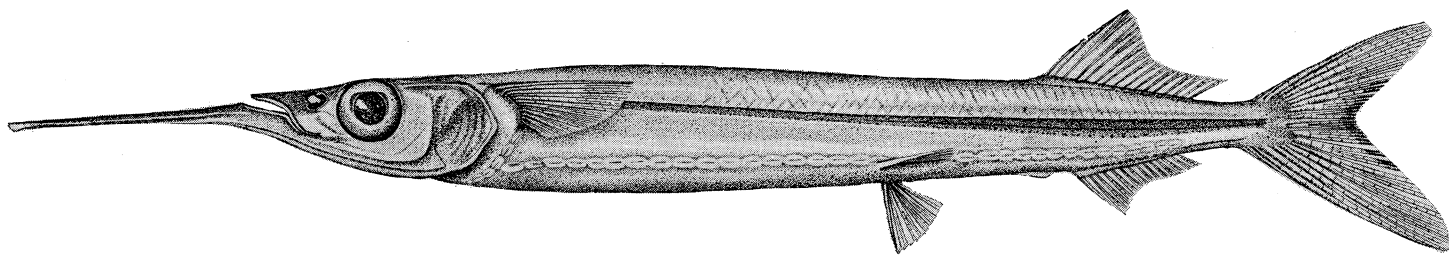
*Hemirhamphus affinis* Günther, 1866: 267 (original description; "South Seas").

#### *Diagnosis*

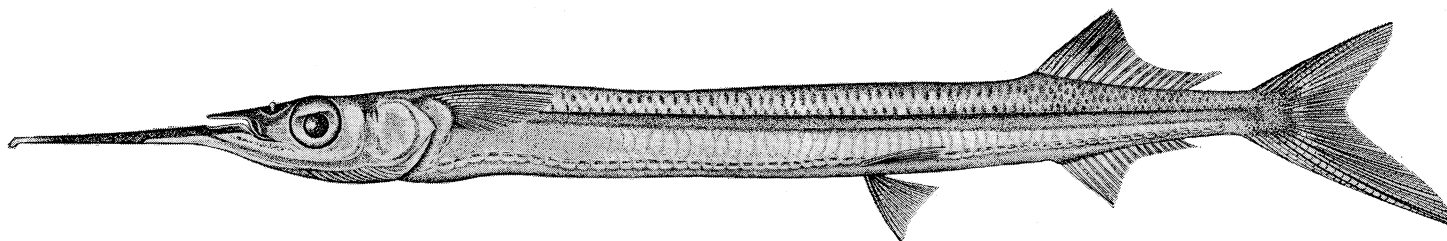
Generally similar to *Hy. dussumieri* but different in having fewer gill-rakers on the first arch (35 or fewer vs. 36 or more), lacking the prominent line of pigment along the ventral part of the lateral line, having the body depth distinctly greater than body width, and having the preorbital distance greater than the upper jaw length. In this last character, *Hy. affinis* is similar to *Hy. balinensis* (Bleeker) of New Guinea and the East Indies but the preorbital distance is only 1.03–1.35 ( $\bar{x}$  1.19) times the upper jaw length in *Hy. affinis* compared to nearly twice as long in *Hy. balinensis*.

#### *Description*

Posterior branch of preorbital canal present; additional pores frequently present, usually one at junction of posterior and ventral branches, and one at junction of dorsal and ventral branches (Fig. 2, h–i). Lower jaw about equal to head length; head length divided by lower jaw length 0.82–1.24,  $\bar{x}$  0.95. Dorsal rays 15 or 16, rarely 17; anal rays 15–17, rarely 18 in Australian specimens (up to 19 elsewhere); pectoral rays 11 or 12, rarely 13. Vertebrae (38–40) + (16–18) = 55–57. Gill-rakers on first arch (8–10) + (20–26) = 28–35 in Australian specimens, 30–38



Above.—Figure 19. *Hyporhamphus affinis*, AMNH DER 69-51, 105 mm SL, Bush Bay S. of Carnarvon, W.A. Below.—Figure 20.  
*Hyporhamphus dussumieri*, USNM 206575, 230 mm SL, One Tree Is., Great Barrier Reef, Qld.



elsewhere, on second arch (3-6) + (18-23) = 22-28 in Australian specimens, 20-27 elsewhere. Pelvic fins located midway between pectoral fin origin and caudal base;  $P_1-P_2$  distance equal to  $P_2-C$  distance;  $P_2-C$  distance divided by  $P_1-P_2$  0.94-1.09,  $\bar{x}$  1.01;  $P_2-C$  extension reaches from posterior third of opercle to pectoral fin base. Dorsal fin base longer than anal fin base; dorsal base divided by anal base 1.06-1.33,  $\bar{x}$  1.20. Preorbital distance slightly greater than upper jaw length; preorbital distance divided by upper jaw length 1.04-1.35,  $\bar{x}$  1.19. Preorbital distance shorter than orbit; orbit divided by preorbital distance 1.13-1.82,  $\bar{x}$  1.48. Width of upper jaw distinctly greater than length; width divided by length 1.04-1.76,  $\bar{x}$  1.49.

*Maximum known size*

243 mm SL (Gilbert Islands), 151 mm in Australia (CSIRO C.1732, Timor Sea).

*Lectotype*

BMNH pre-reg.; "South Seas"; 1 (100); herein selected because it is the larger syntype and it is in the better condition. Lower jaw length 29.1 mm; head length 21.0 mm;  $P_1-P_2$  41.3 mm;  $P_2-C$  35.5 mm;  $P_2-C$  extension nearly reaches posterior end of adpressed pectoral fin; D 16; A 16;  $P_1$  12-12;  $RGR_1$  9 + 24 = 33;  $RGR_2$  4 + 20 = 24; preorbital canal with posterior branch and two pores in middle of canal (Fig. 2h). Paralectotype BMNH pre-reg.; "South Seas"; 1 (82.0).

*Distribution*

A wide-spread and poorly studied tropical species known from the East Indies to the South Pacific. In Australia, known only from the Timor Sea, Northern Territory and Western Australia.

*Australian Material*

16 specimens (48.2-151 mm SL) from 6 collections.

Northern Territory. CSIRO C.1732; Timor Sea; Sept. 22, 1949, 1 (151). CSIRO C.725; Timor Sea; 1 (139). CSIRO C.1727; Joseph Bonaparte Gulf, Timor Sea; Sept. 12, 1949; 1 (135). CSIRO C.1731; Timor Sea; Sept. 22, 1949; 1 (131). CSIRO; Timor Sea; Sept. 22, 1949; 1 (48.2).

Western Australia. AMNH uncat.; Bush Bay, 20 mi. S. of Carnarvon; D. E. Rosen G. J. Nelson, and W. H. Butler; DER 69-51; 11 (68.5-105).

**Hyporhamphus dussumieri** (Valenciennes)

Fig. 20, Table 10

*Hemiramphus Dussumieri* Valenciennes in Cuvier and Valenciennes, 1846: 33-5 (original description; Seychelles Islands). Whitley, 1927: 10 (Michaelmas Cay [AMS IA.2733-5], N. Qld.). Marshall, 1964: 100 (listed, N. Qld.).

*Hemiramphus Reynaldi* Valenciennes in Cuvier and Valenciennes, 1846: 39-40 (original description; Trincomalee, Ceylon and Calcutta, India).

*Hyporhamphus dussumieri*.—McCulloch, 1929: 102 (listed; Qld. included in range). Munro, 1957: 55 (description, Qld.), fig. 394. Taylor, 1964: 106 (Arnhem Land [USNM 173778], N.T.; description). Whitley, 1964b: 38 (listed).

*Misidentification:*

*Farhians marginatus*.—Whitley, 1964a: 150 (Swain Reefs [AMS IB.6048], Great Barrier Reef).

*Diagnosis*

Similar to *Hy. affinis* but with a more prominent line of pigment along the ventral part of the lateral line (Fig. 20) and with a short preorbital distance, shorter than the length of the upper jaw. Lower jaw about as long as head. Preorbital canal with posterior branch (Fig. 2j-k); dorsal, ventral, and posterior branches of canal generally narrower than in *Hy. quoyi* but much wider than in *Hy. australis* or *Hy. melanochir*.

*Description*

Dorsal rays 15-17 in Australia (Table 10), usually 16, (14-18 elsewhere); anal rays 14-17 in Australia, usually 16, (14-18 elsewhere); pectoral rays 11 or 12; vertebrae (38-42) + (17-19) = 56-60 (52-56 elsewhere). Gill-rakers on first arch (9-12) + (25-28) = 33-40 in Australia, usually 35-37, (32-46 elsewhere); on second arch (3-7) + (21-25) = 25-33 in Australia, usually 26-28, (24-35 elsewhere). Pelvic fins located about midway between pectoral fin origin and caudal fin base; P<sub>2</sub>-C extension falls on pectoral fin base or adpressed pectoral fin, usually on the anterior third of the adpressed fin in Australian specimens. Dorsal fin base much longer than anal fin base. Maximum body depth only slightly greater than maximum body width. Upper jaw width much greater than length.

*Maximum known size*

230 mm SL in Australia (USNM 206575, One Tree Is., Great Barrier Reef), 254 mm elsewhere.

*Types*

*Hemiramphus dussumieri* Valenciennes, 1846. Holotype MNHN B.1063; Seychelles Is.; Dussumier; 1830; 1 (254). Lower jaw length 44.5 mm; head length 53.0 mm; P<sub>1</sub>-P<sub>2</sub> 105 mm; P<sub>2</sub>-C 98.2 mm; P<sub>2</sub>-C extension falls just posterior to the pectoral fin base; D 15; A 15; P<sub>1</sub> 11-11; RGR<sub>1</sub> 14 + 32 = 46; RGR<sub>2</sub> 5 + 29 = 34; posterior branch of preorbital canal present, ventral branch longer than dorsal or posterior branches (Fig. 2j).

*Hemiramphus reynaldi* Valenciennes, 1846. Syntypes MNHN B.1064; Trincomalæ, Ceylon; Reynald; 1829; 2 (171-173); and MNHN A.7631; Calcutta; Dussumier; 1830; 1 (181). No lectotype is selected because of a lack of clear understanding of geographic variation in *Hy. dussumieri*. The dorsal and anal counts in the original description fit the syntype from Calcutta (16-15) but the description seems to have been based on Reynald's Ceylon specimens with Dussumier's Calcutta specimen being added in at the end of the description.

*Geographic variation*

There is significant geographic variation in meristic and morphometric characters within Australian waters and between Australian and extra-territorial populations of *Hy. dussumieri*. Final interpretation must await completion of a study of the species throughout its range. Variation within Australian waters and a partial outline of extra-territorial variation are treated here.

**Table 10. Number of fin rays, gill-rakers, and vertebrae in some populations of *Hyporhamphus dussumieri* (\* = holotype of *Hemiramphus dussumieri*)**

Population	Dorsal Rays							Anal Rays									
	14	15	16	17	18	N	$\bar{x}$	14	15	16	17	18	N	$\bar{x}$			
Indian Ocean .. ..	1	7*	11	2	1	22	15.77	2	5*	12	2	1	22	15.77			
Oceania .. ..	9	25	3	..	..	37	14.84	13	23	1	..	..	37	14.68			
New Guinea .. ..	7	49	2	..	..	58	14.91	31	26	1	..	..	58	14.48			
Western Australia .. ..	..	3	3	..	..	6	15.50	2	4	..	..	..	6	14.67			
Arnhem Land .. ..	..	1	1	..	..	2	15.50	..	1	1	..	..	2	15.50			
Capricorns .. ..	..	11	18	2	..	31	15.71	..	3	25	3	..	31	16.00			
Other Barrier Reef .. ..	..	9	32	1	..	42	15.81	..	9	32	1	..	42	15.81			
Total, Barrier Reef .. ..	..	20	50	3	..	73	15.77	..	12	57	4	..	73	15.89			
First Arch Gill-rakers																	
	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	N	$\bar{x}$
Indian Ocean .. ..	1	1	5	1	3	4	..	1	2	..	2	1	1	..	1*	23	37.48
Oceania .. ..	..	..	..	..	3	1	6	8	6	3	2	2	..	..	..	31	39.29
New Guinea .. ..	..	..	..	..	1	8	7	18	7	7	2	2	1	..	..	53	39.26
Western Australia .. ..	..	..	..	..	..	..	..	..	4	..	..	1	..	..	..	5	40.60
Arnhem Land .. ..	..	..	..	..	1	..	..	..	1	..	..	..	..	..	..	2	37.50
Capricorns .. ..	..	1	5	5	7	10	2	..	..	..	..	..	..	..	..	30	35.87
Other Barrier Reef .. ..	..	..	2	10	13	6	1	1	..	..	..	..	..	..	..	33	35.91
Total, Barrier Reef .. ..	..	1	7	15	20	16	3	1	..	..	..	..	..	..	..	63	35.89
Second Arch Gill-rakers																	
Population	24	25	26	27	28	29	30	31	32	33	34	35	N	$\bar{x}$			
Indian Ocean .. ..	3	1	3	6	3	1	..	1	1	..	2*	..	21	27.67			
Oceania .. ..	..	..	..	..	2	4	14	1	8	2	..	1	32	30.63			
New Guinea .. ..	..	..	..	..	3	5	13	12	13	3	4	1	54	31.05			
Western Australia .. ..	..	..	..	..	..	..	..	2	2	1	..	..	5	31.80			
Arnhem Land .. ..	..	..	..	..	..	1	..	..	..	..	..	..	1	29			
Capricorns .. ..	..	7	6	7	6	2	1	1	..	..	..	..	30	26.90			
Other Barrier Reef .. ..	..	..	4	11	8	4	2	1	..	..	..	..	30	27.73			
Total, Barrier Reef .. ..	..	7	10	18	14	6	3	2	..	..	..	..	60	27.32			
Vertebrae																	
	52	53	54	55	56	57	58	59	60	N	$\bar{x}$						
Indian Ocean .. ..	..	..	..	3	10	..	..	..	..	13	55.77						
Oceania .. ..	..	3	6	1	..	..	..	..	..	10	53.80						
New Guinea .. ..	..	1	3	25	21	1	..	..	..	51	54.35						
Western Australia .. ..	..	..	..	..	..	6	..	..	..	6	57.00						
Arnhem Land .. ..	..	..	..	..	1	1	..	..	..	2	56.50						
Capricorns .. ..	..	..	..	..	..	..	5	17	5	27	59.00						
Other Barrier Reef .. ..	..	..	..	..	1	3	23	3	..	30	57.93						
Total, Barrier Reef .. ..	..	..	..	..	1	3	28	20	5	57	58.44						

As a group, the Australian specimens have more vertebrae (56-60 vs. 52-56), and more dorsal and anal fin rays (modally 16-16 instead of 15-14 or 15-15) (Table 10). In the number of gill-rakers on both the first and second arches, the Australian specimens generally have fewer gill-rakers than do specimens from New Guinea and Oceania, but about the same number as some specimens from the Indian Ocean (Table 10). However, the wide range in gill-raker counts for the Indian Ocean specimens (32-46, N = 23) compared to the New Guinea sample (36-44, N = 53) suggests that there may be two taxa among the Indian Ocean specimens.

This general picture is further complicated by differences between Australian specimens. The population in the Capricorn Group is the most different of the Australian populations from the population in New Guinea. Specimens from farther north on the Great Barrier Reef are slightly more similar to New Guinea specimens. The modal number of vertebrae in the Capricorns is 59 (range 58-60); the modal number on the rest of the Barrier Reef is 58 (range 56-59). Barrier Reef specimens are separable from New Guinea specimens on the basis of vertebral number. However, the two specimens from Arnhem Land (56 and 57 vertebrae) and the six from Western Australia (all with 57 vertebrae) are intermediate between the New Guinea and Barrier Reef populations. In number of gill-rakers and anal fin rays, the Arnhem Land specimens fit the Barrier Reef population reasonably well but the Western Australian specimens agree with the New Guinea population.

Morphometric differences were also found between some of the Australian populations. Analysis of covariance tests were run for the regressions on standard length of eight characters for the two largest samples, One Tree Island in the Capricorns versus Little Hope Island and Endeavour Reef south of Cooktown. Significant differences were found in the heights for three characters: head length,  $P_1$ - $P_2$  distance, and upper jaw width. To increase the sample size and avoid comparing only local subpopulations, the One Tree sample was combined with specimens from Heron Island to form a Capricorn sample and this was tested against the combined specimens from the rest of the Great Barrier Reef to the north. The heights of head length and upper jaw width were still significantly different. The  $P_1$ - $P_2$  distance was no longer different but the slopes of anal base length were.

Upon first comparing the Capricorn population with samples from the Indian Ocean, Oceania, and New Guinea, it seemed necessary to recognize a separate subspecies from the Barrier Reef. Material recently collected from Little Hope Island and Endeavour Reef and six specimens from Western Australia have led me to wait until I have completed a thorough study of geographic variation in *Hy. dussumieri* before describing any new taxa.

### *Distribution*

A wide-spread tropical species found from Madagascar through the East Indies to the Philippines, New Guinea, Australia and Oceania. In Australia common on the Great Barrier Reef plus one collection from Arnhem Land and two collections from Western Australia.

### *Australian Material*

218 specimens (27.6-230 mm SL) from 27 collections.

Queensland, 210 specimens (27.6-230 mm) from 24 collections arranged from north to south. CSIRO; Thursday I., Torres Strait; Oct. 26, 1949; 1 (47.7). IRSNB 16882; Lizard I.; Barrier Reef Exped.; Aug. 30, 1967; 1 (169). ANSP 117033; Little Hope I. N.W. of Endeavour Reef; J. C. Tyler; TS, A-8; Jan. 7, 1969; 3 (57.1-75.3). ANSP 117034; Endeavour Reef; J. C. Tyler and C. L. Smith; TS, A-13; Jan. 13, 1969; 1 (73.3). ANSP



117032; Little Hope I. N.W. of Endeavour Reef; J. C. Tyler and C. L. Smith; TS, A-20; Jan. 18, 1969; 52 (45.0-65.0); and USNM 206749; 40 (45.0-124); same data. ANSP 117031; coast W. of Little Hope I.; J. C. Tyler; TS, A-32; Jan. 25, 1969; 3 (93.4-110). AMS IA.2733-5, 2737; Michaelmas Cay off Cairns; T. Iredale and G. P. Whitley; May-June 1926; 4 (137-156). AMS IA.2946; Michaelmas Cay off Cairns; C. Hedley; 1 (140). CSIRO; Keeper Reef, 30 mi. N.N.E. Cape Cleveland; Nov. 24, 1951; 1 (54.3). CSIRO; Bramble Reef, off Townsville; Nov. 14, 1953; 1 (29.2). CSIRO; Bramble Reef, off Townsville; Nov. 15, 1953; 5 (40.7-57.0). AMS IB.6048; Gillett Cay, Swain Reefs; AMS exped.; Oct. 1962; 1 (160). QM I.9304; Heron I., Capricorn Group; 1 (122). USNM 206562; Heron I., Capricorn Group; J. H. Choat; May 17, 1966; 4 (114-150). AMS I.15386-006; 1 mi. W. of Heron I.; B. Goldman and J. Paxton; Feb. 10, 1969; 1 (50.0). AMS FT-265; One Tree Is., Capricorn Group; 1 (129). USNM BBC-1383, 1386, 1394, 1401, 1406 (USNM 206559), 1407, 1411 (USNM 206560), 1416 (USNM 206575); One Tree I., Capricorn Group; B. B. Collette et al., 1969 One-Tree Exped.; Nov.-Dec. 1969; 89 (27.6-230).

Northern Territory. USNM 173778; Yirrkalla N. of Cape Arnhem; R. R. Miller 48-21; July 29-Aug. 11, 1948; 2 (158-166).

Western Australia. AMNH 40008; S. of Mandu Mandu Cr., North West Cape; D. E. Rosen, G. J. Nelson, and W. H. Butler; DER 69-59; April 14, 1969; 1 (116). AMNH 40010; S. of Mandu Mandu Cr., North West Cape; D. E. Rosen, G. J. Nelson, and W. H. Butler; DER 69-57; April 3, 1969; 5 (68.6-122).

### **Rhynchorhamphus georgii** (Valenciennes)

Fig. 21

*Hemiramphus Georgii* Valenciennes in Cuvier and Valenciennes, 1846: 37-9 (original description; Bombay and Coromandel, India). Marshall, 1951: 2 (Magnetic I., Qld. [FBQ 39], new Australian record). Marshall, 1964: 100 (Qld., listed).

*Hemiramphus Russeli* Valenciennes in Cuvier and Valenciennes, 1846: 32-3 (original description; Pondichery, India).

*Hemiramphus leucopterus* Valenciennes in Cuvier and Valenciennes, 1846: 48 (original description; Bombay, India).

*Hemiramphus Eclancheri* Valenciennes in Cuvier and Valenciennes, 1846: 51-2 (original description; "Marquesas Is.").

*Hemirhamphus Cantori* Bleeker, 1866: 145-6 (original description; E. Indies).

*Loligorhamphus normani* Whitley, 1931b: 105-6 (original description, genus and species; Townsville, Qld.), pl. 12, figs 2-3. Munro, 1957: 57 (description, N. Qld.), fig. 405 (after Whitley, 1931b). Whitley, 1964b: 39 (listed). Marshall, 1964: 98 (after Whitley, 1931b), pl. 24, fig. 6 (after Whitley, 1931b). Marshall, 1966: 174 (after Whitley, 1931b), pl. 24, fig. 6 (after Whitley, 1931b). Grant, 1972: 62 (brief description).

*Rhynchorhamphus georgii*.—Munro, 1957: 55 (Qld., description, fig. 391). Whitley, 1964b: 39 (listed). Grant, 1965: 36 (uncommon in Qld. waters). Grant, 1972: 60 (repeat of 1965 ed.).

#### *Diagnosis*

A peculiar species of garfish that differs from all Australian species in having a large domed upper jaw, a fimbriate nasal papilla (Fig. 3 bottom), and a large number of gill-rakers, 52-67 on the first arch (compared to 18-39 in other Australian garfishes) and 45-61 on the second arch (compared to 15-33).

*Description*

Only five Australian specimens were available so this description is based on 52 specimens from throughout the range. Preorbital canal a long narrow tube with no posterior branch; one or two central pores in addition to dorsal and ventral openings (Fig. 1, c-f). Upper jaw much longer than wide. Dorsal fin rays 14-17, usually 15; anal rays 14 or 15; pectoral rays 10-12. Vertebrae (37-40) + (18-19) = 56-59. Gill-rakers on first arch (12-16) + (39-50) = 52-67; on second arch (6-10) + (38-52) = 46-62. Dorsal fin base much longer than anal fin base. Pelvic fins placed far posteriorly;  $P_1$ - $P_2$  much greater than  $P_2$ -C;  $P_2$ -C extension falls on the posterior third of the addressed pectoral fin or posterior to the tip of the fin.

*Maximum known size*

207 mm SL in Australia (CSIRO, Wessel Is., N.T.), 231 mm elsewhere (AMS B.7517, Madras, India).

*Types*

*Hemiramphus georgii* Valenciennes, 1846. Holotype MNHN B.1062; Bombay; Dussumier; 1830; female, 185 mm. D 17; A 15;  $P_1$  11-11;  $RGR_1$  16 + 47 = 63;  $RGR_2$  10 + 49 = 59; preorbital canal shown in Fig. 1c. Paratype MNHN B.1061; Mahé Bay, Coromandel, India; Dussumier; 201 mm.

*Hemiramphus eclancheri* Valenciennes, 1846. Holotype MNHN 4592; "Marquises"; Eclancher; 107 mm. D 16; A 15;  $P_1$  11-11;  $RGR_1$  13 + 41 = 54;  $RGR_2$  7 + 40 = 47.

*Hemiramphus leucopterus* Valenciennes, 1846. Holotype MNHN B.1065; Bombay; Dussumier; 89.5 mm. D 15; A 14;  $P_1$  11-11;  $RGR_1$  12 + 43 = 55;  $RGR_2$  6 + 46 = 52.

*Hemiramphus russeli* Valenciennes, 1846. Holotype MNHN B.1067; Pondichery, India; Sonnerat; 202 mm. D 14; A ?;  $P_1$  ?-11;  $RGR_1$  ?; head and half the skin fastened onto a stick.

*Hemiramphus cantori* Bleeker, 1866. Original description based on 62 specimens. Syntypes probably include BMNH 1866.5.2.16; Bleeker; 1 (166). D 15; A 15;  $P_1$  10-10;  $RGR_1$  14 + 43 = 57;  $RGR_2$  8 + 45 = 53; and Rijksmus. Nat. Hist. Leiden 6953 (50 specimens).

*Loligorhamphus normani* Whitley, 1931. Holotype AMS IA.2319; Townsville, Qld.; W.E.J. Paradiçe; 126 mm. D 14; A 15;  $P_1$  12-12;  $RGR_1$  14 + 44 = 58;  $RGR_2$  9 + 45 = 54; preorbital canal shown in Fig. 1d.

*Discussion*

*Rhynchorhamphus* has been considered monotypic until recently when Parin and Shcherbachev (1972) and I independently discovered a second species which they described as *R. arabicus* based on two specimens from southern Yemen. I have four additional specimens (MCZ 41922) from Aden Harbour and can confirm the validity of *R. arabicus* which has even more gill-rakers (69-78 on the first arch compared to 52-67) than *R. georgii*. A revision of *Rhynchorhamphus* was nearly complete at the time the present paper was submitted.

*Distribution*

Known from the Indian Ocean, the East Indies, the South China Sea, the Philippine Islands, and northern Australia. In Australia, known only from eastern Queensland and the Northern Territory.

*Australian Material*

5 specimens (126–207 mm SL) from 5 collections.

Queensland. AMS IA.2319; off Townsville; W. E. J. Paradise; HMAS "Geranium", 1 (126); holotype of *Loligorhampus normani* Whitley. BMNH 1927.2.10.21; off Townsville; W. E. J. Paradise; HMAS "Geranium"; Aug. 1924, 1 (132). FBQ 39; Horseshoe Bay, Magnetic Is.; G. Coates; Sept. 1949; 1 (179). FBQ 3608; off Cairns; 1 (164).

Northern Territory. CSIRO; Jensen Bay, Wessel Is.; July 28, 1949; 1 (207).

**Zenarchopterus buffonis** (Valenciennes)

*Hemiramphus buffonis* Valenciennes in Cuvier and Valenciennes, 1846: 48–9 (original description; Pulo-Pinan).

*Zenarchopterus buffonis*.—Marshall, 1951: 2 (Townsville, Qld., new Australian record). Munro, 1957: 57 (tropical Qld., description), fig. 407. Whitley, 1964b: 39 (listed). Taylor, 1964: 108–9 (description; Arnhem Land [3 USNM collections], N.T.). Munro, 1964: 146 (listed, Leichhardtian region—tropical Australia). Marshall, 1964: 102 (N. Qld.). Collette, 1966: 3 (listed). Grant, 1972: 66 (N. Qld. estuarine species).

*Misidentification:*

*Zenarchopterus dispar*.—Whitley, 1954: 28–9 (Depuch, W.A. [AMS IB.2640], new W.A. record).

*Diagnosis*

A species of *Zenarchopterus* which differs from all other species in the genus in having a prominent dark brown stripe along the midline of the snout. Upper jaw distinctly wider than long; width divided by length 1.05–1.35,  $\bar{x}$  1.16. Sixth anal ray of adult males expanded and somewhat elongated, but not reaching base of caudal fin. Fourth to seventh dorsal rays of adult males slightly elongated.

*Description*

Dorsal rays 11 or 12, rarely 13; anal rays 12 or 13; pectoral rays 10 or 11. Predorsal scales 27–32. Vertebrae (27–31) + (11–13) = 40–44. Pectoral fin much shorter than head; head length divided by pectoral length 1.48–6.07,  $\bar{x}$  4.73. Lower jaw much longer than head; head length divided by lower jaw length 0.50–0.66,  $\bar{x}$  0.56.

*Maximum known size*

117 mm SL (AMS IB.2640, Depuch Is., W.A.).

*Types*

MNHN B.1076; Pulo Pinan; Dussumier; 1830; 6 (53.3-74.0); 3 additional syntypes MNHN B.2184; 52.6-69.0 removed because they appear to represent another species.

*Distribution*

Andaman Islands, Malay Peninsula, East Indies, Philippine Islands and northern Australia. Across northern Australia from Gladstone Harbour, Queensland through Arnhem Land, Northern Territory, to Port Hedland and Depuch Island, Western Australia.

*Australian Material*

68 specimens (7.3-117 mm SL) from 10 collections arranged from east to west.

Queensland: USNM 206653; Gladstone Harbour; B. B. Collette 1417; Dec. 11, 1969; 14 (7.3-42.2). CSIRO; Mary R.; Aug. 25, 1950; 1 (86.5). AMS IB.1234-6; Fitzroy R.; G. P. Whitley; 3 (70.3-98.5).

Northern Territory: USNM 173768; west side Port Bradshaw, S. of Cape Arnhem; R. R. Miller 48-28; July 25, 1948; 21 (45.5-74.0); and AMS I.16153-001; 10. USNM 173766; Nightcliff, 7 mi. N. of Darwin; R. R. Miller and party; RRM 48-2; March 19, 1948; 5 (21.0-93.3). USNM 173767; Woods Inlet, 1 mi. W. of Delissville Aboriginal Station near Darwin; R. R. Miller and P. Basset-Smith; RRM 48-5; March 26-30, 1948; 4 (73.4-111). SIO 61-701-23A; Darwin; Naga Exped. 61-257; April 21, 1961; 2 (89.1-91.4). AMS IA.7632; Northern Territory; M. Ward; 1 (101).

Western Australia: AMNH 40013; Port Hedland; D. E. Rosen, G. Nelson, and W. H. Butler; DER 69-75; April 13, 1969; 6 (38.4-69.4). AMS IB.2640; Depuch Is.; CSIRO; 1 (117).

**Zenarchopterus caudovittatus** (Weber)

Fig. 22

*Hemiramphus* (*Zenarchopterus*) *caudovittatus* Weber, 1908: 229-30 (original description; Merauke River, New Guinea), pl. 13, figs 1a, 1b.

*Zenarchopterus caudovittatus*.—Taylor, 1964: 106, 108 (Arnhem Land [USNM 173769], N.T.; description), pl. 15.

*Misidentifications:*

*Hemiramphus amblyurus*.—Macleay, 1878: 364 (Port Darwin, N.T.). Macleay, 1881: 248 (Darwin; description). Taylor, 1964: 106 (references to Macleay papers).

*Diagnosis*

A species of *Zenarchopterus* which differs from the other four Australian species of the genus in its very long upper jaw, very long pectoral fin, and relatively short lower jaw. Upper jaw width divided by length 0.62-0.67,  $\bar{x}$  0.64 compared to 0.81-1.35 in the other four species. Pectoral fin about as long as head; head length divided by pectoral fin length 0.94-1.00,  $\bar{x}$  0.97 compared to 1.28-6.07 for the other four species. Head longer than lower jaw; head length divided by lower jaw length 1.31-1.79,  $\bar{x}$  1.56 compared to 0.50-0.75 for the other four species. *Z. caudovittatus* also has more vertebrae (46) than the other four species (38-42). Sixth anal ray of males widened but not elongated beyond rest of anal fin rays. None of the male dorsal rays elongated beyond the rest of the dorsal fin.

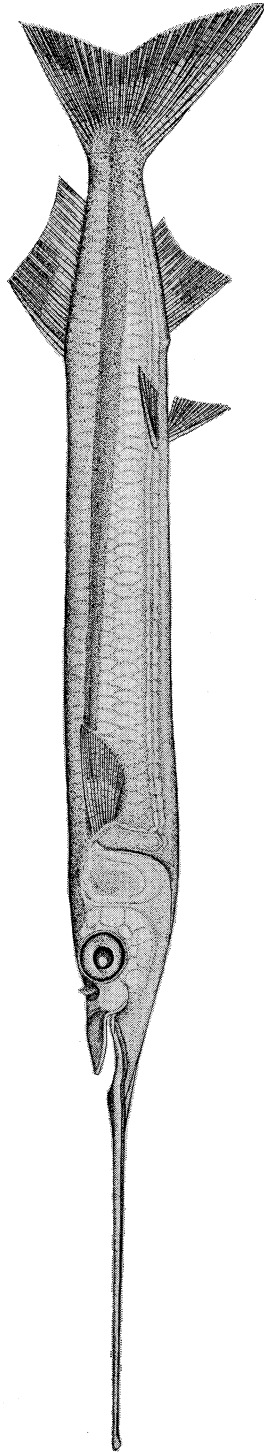


Figure 21. *Rhynchorhamphus georgii* USNM 138686, 161 mm SL, Borneo.

*Description*

Dorsal rays 12 or 13; anal rays 13 or 14; pectoral rays 10 or 11. Gill-rakers on first arch (4-5) + (11-14) = 16-18; on second arch 2 + (11-14) = 13-16. Vertebrae (30-32) + (14-16) = 46. Predorsal scales 30-32.

*Maximum known size*

111 mm SL in Australia.

*Types*

Not seen.

*Discussion*

The records of *Z. amblyurus* (Bleeker) by Macleay (1878 and 1881) from Darwin are herein referred to *Z. caudovittatus* because no Australian specimens of *Z. amblyurus*, = *Z. ectuntio* (Hamilton-Buchanan), have been located in any museum collections. *Z. caudovittatus* is similar to *Z. ectuntio* and different from all other Australian species of *Zenarchopterus* in its very long upper jaw.

*Distribution*

Merauke River, New Guinea and Arnhem Land, Australia.

*Australian Material*

USNM 173769; E. Alligator R., 6 mi. W. of Oenpelli, Arnhem Land; R. R. Miller and W. E. Harney; RRM 48-40; Oct. 13, 1948; 5 (43.7-111).

***Zenarchopterus dispar*** (Valenciennes)

*Hemiramphus dispar* Valenciennes in Cuvier and Valenciennes, 1846: 58-62 (original description; ?Madagascar?).

*Zenarchopterus vaisiganis* Jordan and Seale, 1906: 208 (original description; Vaisigano River at Apia, Samoa), fig. 11.

*Zenarchopterus dispar*.—Ogilby, 1913: 92 (Torres Strait, Qld.). McCulloch and Whitley, 1925: 139 (Ogilby's 1913 record). McCulloch, 1929: 104 (Qld., listed). Munro, 1957: 57 (description; trop. Qld. and W.A.), fig. 406. Whitley, 1964b: 39 (listed). Marshall, 1964: 101 (Qld. mangrove swamps; description), pl. 25, fig. 110 and colour pl. 6, fig. 110. Marshall, 1966: 174 (Qld., listed), pl. 25, fig. 110 and colour pl. 6, fig. 110. Grant, 1972: 66 (brief description, Qld.).

*Zenarchopterus* (sic) *dispar*.—Shipway, 1947: 27 (Cairns, Qld.; estuarine), fig. Carr, 1947: 4 (poisoned in Mitchell R., Qld.).

*Diagnosis*

A species of *Zenarchopterus* with the upper jaw distinctly wider than long; width divided by length 1.03-1.17,  $\bar{x}$  1.10. Snout uniform brown without any dark band on the midline. Pectoral fin shorter than head length; head length divided

by pectoral length 1.28–1.57,  $\bar{x}$  1.38. Lower jaw much longer than head; head length divided by lower jaw length 0.52–0.65,  $\bar{x}$  0.59. Anal rays 6 and 7 of adult males greatly thickened and elongated, both rays reaching well beyond the caudal base. Either dorsal ray 4 or 5 or both elongated and thickened.

#### *Description*

Dorsal rays 11 or 12; anal rays 12 or 13; pectoral rays 9 or 10. Gill-rakers on first arch (4–5) + (11–14) = 15–18; on second arch (1–2) + (11–14) = 13–15. Predorsal scales 29–36. Vertebrae 28 + (14–15) = 42–43.

#### *Maximum known size*

121 mm SL (QM I.7654, Magnetic Is., Qld.).

#### *Types*

*Hemirhamphus dispar*. Syntypes MNHN 4594 and 4595; “Madagascar”; 5 (80.0–93.2).

*Zenarchopterus vaisiganis*. Syntypes USNM 51718 and AMS I.7385; Vaisigano River at Apia, Samoa; Jordan and Kellog; 4 males (89.7–98.7) plus 1 male (103).

#### *Distribution*

New Caledonia, Fiji, Samoa, Solomon Islands, New Guinea, and Australia. Australia distribution given as “tropical Qld. and W.A.” by Munro (1957: 57) but I have seen specimens from only near Townsville, Queensland and from the Blackmore River near Darwin, Northern Territory.

#### *Australian Material*

7 specimens (72–121 mm SL) from 3 collections.

Queensland: AMS IB.3588; Townsville; E. Worrell; 5 (96.3–120). QM I.7654; Magnetic Is. off Townsville; 1 (121).

Northern Territory: AMS IB.4300; Blackmore River, S. part of Darwin Harbour; C. W. Holman; 1 (72).

### **Zenarchopterus gilli** Smith

*Hemirhamphus brevirostris* Günther, 1866: 274 (original description; East Indies).

*Zenarchopterus gilli* Smith, 1945: 432 (new name to replace *He. brevirostris* Günther, preoccupied by *He. brevirostris* Cuvier). Taylor, 1964: 109–110 (Arnhem Land [4 USNM collections], N.T.; description). Collette, 1966: 3 (listed).

#### *Misidentification*

*Z. dispar*.—Stephenson *et al.*, 1931: 39 (Low Isles, [AMS IA.4467–8], Qld.). Whitley, 1932a: 277 (Low Isles, same specimens; description).

#### *Diagnosis*

A species of *Zenarchopterus* with the upper jaw about as long as wide; width divided by length 0.90–1.24,  $\bar{x}$  1.03. Top of snout uniform brown, lacking the prominent dark line along the midline of the snout of *Z. buffonis*. Sixth anal ray of

males greatly enlarged and elongated, reaching the tip of the caudal fin in adults. Fourth dorsal ray of adult males elongated, thickened distally, curving back to the base of the caudal fin. Vertebrae fewer than in other Australian species of *Zenarchopterus*, 38–39 compared to 40–46.

#### *Description*

As Taylor (1964: 110) has pointed out, there is sexual dimorphism in dorsal and anal ray counts in *Z. gilli*. Females have 10 dorsal and 10–12 anal rays, usually 10 dorsal and 11 anal. Males have 11 or 12 dorsal and 13 anal rays, usually 11 dorsal and 13 anal. Pectoral rays 9 or 10. Predorsal scales 25–31. Gill-rakers 4 + (11–13) = 15–17 on the first arch; (1–2) + (12–13) = 14–15 on the second arch. Pectoral fin much shorter than head; head length divided by pectoral length 1.48–1.87,  $\bar{x}$  1.65. Lower jaw much longer than head; head length divided by lower jaw length 0.54–0.75,  $\bar{x}$  0.67. Vertebrae (25–27) + (11–14) = 38–39.

#### *Maximum known size*

72.2 mm SL in Australia.

#### *Types*

Not found.

#### *Distribution*

One of the most widespread species in the genus, reported from Madagascar, Mozambique, Seychelles I., Andaman Is., East Indies, Caroline Is., Fiji, and Guam as well as northern Australia. In Australia known from Mary R. and the Low Isles, Qld. and several localities in Arnhem Land.

#### *Australian Material*

129 specimens (24.1–72.2 mm SL) from 8 collections.

Queensland: CSIRO; Rocky Pt, Mary R.; Sept. 2, 1950; 3 (56.8–61.0). CSIRO; Deception Is. Narrows; Aug. 31, 1950; 1 (47.7). AMS IA.4467–8; Low Isles off Port Douglas; 3 (40.1–68.6).

Northern Territory: USNM 173763; Emerald R., Groote Eylandt; Gulf of Carpentaria; R. R. Miller and J. Blitner; RRM 48–15; 80 (24.1–65.4) and AMS IB.4712–3; 20. USNM 173764; Port Bradshaw, S. of Cape Arnhem, Gulf of Carpentaria; R. R. Miller 48–27; July 24, 1948; 15 (39.2–72.2). USNM 173765; Port Bradshaw; R. R. Miller 48–28; July 25, 1948; 6 (38.3–67.6). USNM 173880; East Point Reef, 6 mi. N.N.W. Darwin; R. R. Miller 48–3; March 26, 1948; 1 (26.0).

### ***Zenarchopterus rasori* (Popta)**

Fig. 23

*Hemiramphus rasori* Popta, 1912: 192–3 (original description; Muna Is., Celebes).

*Zenarchopterus rasori*.—Taylor, 1964: 108 (Arnhem Land [USNM 173770], N.T.; description), pl. 16.



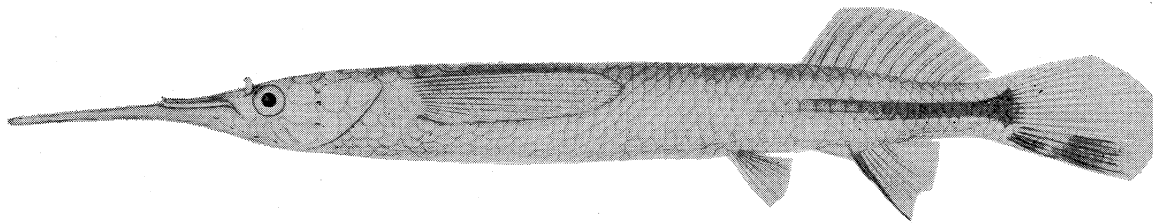


Figure 22. *Zenarchopterus caudovittatus*, USNM 173769, 99.4 mm SL, male, E. Alligator R., Arnhem Land, N.T. (From Taylor, 1964: pl. 15).

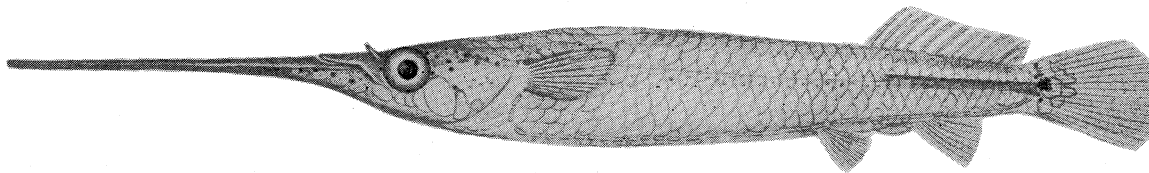


Figure 23. *Zenarchopterus rasori*, USNM 173770, 54.6 mm SL, female, Delissaville, Arnhem Land, N.T. (From Taylor, 1964: pl. 16.).

*Diagnosis*

A species of *Zenarchopterus* with the upper jaw slightly longer than wide; width divided by length 0.81–0.87,  $\bar{x}$  0.84. This is shorter than in *Z. caudovittatus* (0.62–0.67) and longer than in the other three Australian species of the genus (0.90–1.35). Small black basicaudal spot present at end of lateral silvery band. Pectoral fin much shorter than head length; head length divided by pectoral length 1.76. Lower jaw much longer than head length; head length divided by lower jaw length 0.61–0.64,  $\bar{x}$  0.63.

*Description*

Dorsal rays 11 or 12; anal rays 8 or 9; pectoral rays 9 or 10. Predorsal scales 26–29. Gill-rakers (3–4) + (8–12) = 12–15 on first arch; 1 + (9–12) = 10–13 on second arch. Vertebrae (27–29) + (12–13) = 41. Males unknown.

*Holotype*

SMF 6520; Raha, Muna Is., southeast Celebes; J. Elbert; 1909; Sunda Expedition; female (67.3 mm). D 11; A 9; P<sub>1</sub> 9–9; RGR<sub>1</sub> 4 + 8 = 12; RGR<sub>2</sub> 1 + 9 = 10. Vertebrae 29 + 12 = 41.

*Distribution*

Muna Island, Celebes, and Arnhem Land, Australia.

*Australian Material*

USNM 173770; Woods Inlet, 1 mi. W. of Delissaville Aboriginal Station near Darwin, Arnhem Land; R. R. Miller and P. Basset-Smith; RRM 48–5; March 26–30, 1948; 2 females (54.6–59.8).

**ACKNOWLEDGMENTS**

The bulk of this research was carried out while I was stationed at the Australian Museum in 1969–70. It could not have been completed without the whole-hearted cooperation which I received from the Trustees of the Museum; the Director, Dr Frank H. Talbot; the Curator of Fishes, Dr John R. Paxton; the Director of New South Wales State Fisheries, Dr Donald D. Francois; and the Sydney Fish Market Inspector, Mr R. W. Budd. I thank the following for making material available: Dr M. L. Bauchot (MNHN); Mr C. R. Boccia (VMM); Dr J. E. Böhlke (ANSP); Dr M. Boeseman (Rijksmus. Nat. Hist., Leiden); Mr R. W. Budd (Sydney Fish Mkt.); Mrs M. Dick (MCZ); Dr W. N. Eschmeyer (CAS); Dr W. Freihofner (SU); Mr J. Glover (SAM); Dr J. P. Gosse (IRSNB); Dr P. H. Greenwood (BMNH); Mr G. G. T. Harrison (FBQ); Dr P. Kähsbauer (NHMV); Mrs P. Kailola (Dept Agr., Stock, and Fish., Port Moresby, New Guinea); Dr W. Klauswitz (SMF); Dr W. Ladiges (ZMH); Mr R. J. McKay (formerly at WAM); Mr I. S. R. Munro (CSIRO); Dr J. Nielsen (ZMUC); Mr G. Palmer (BMNH); Dr J. R. Paxton (AMS); Mrs S. Quinnell (QM); Dr D. E. Rosen (AMNH); Dr J. C. Tyler (ANSP) and Dr G. von Wahlert (SMN). The card catalogue on Australian fishes kept up by Mr Gilbert P. Whitley, the former Curator of Fishes in the Australian Museum, was very useful in adding references to my own card catalogue on the family. Most of the radiographs were taken by Mr George Clipper and many of them were also read by Mr Clipper. Miss Linda Hoxie ran the morphometric data through the time-share computer. Figs 5, 7, 8, 13, 14, 15, 19, and 20 were drawn by Mrs Mildred Carrington, Fig. 21 by Mrs Keiko Hiratsuka Moore, and Figs 22 and 23 by Mrs Dorothea Schultz. The maps and outline drawings were finished by Mrs Moore. Mr R. J. McKay, Dr J. R. Paxton, and Dr D. M. Cohen read drafts of the manuscript and suggested improvements. Mrs Sara E. Collette helped in many ways.

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