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Congrid Leptocephali in Australasian  
Waters with Descriptions of *Conger*  
*wilsoni* (Bl. and Schn.) and  
*C. verreauxi* Kaup.

by

P. H. J. Castle

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Zoology Publications from Victoria  
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No. 37

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Congrid Leptocephali in Australasian Waters  
with Descriptions of *Conger wilsoni* (Bl. and Schn.)  
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By P. H. J. CASTLE,

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*Abstract*

FIFTEEN species, referred to ten genera, are present in a large collection of congrid leptocephali taken from around New Caledonia, Australia and New Zealand. These species are *Leptocephalus Ariosoma scheelei* (Strömman), *L. A. mauritianum* (Pappenheim), *L. A. anago* (Temm. and Schleg.), *L. ?Alloconger anagoides* (Bleeker), *L. Conger wilsoni* (Bl. and Schn.), *L. C. verreauxi* Kaup, *L. C. cinereus cinereus* Rüppell and *L. Scalanago lateralis* Whitley; the remaining seven, six of which are described as new species of *Leptocephalus*, cannot here be finally referred to known adult species but their larval pigmentation suggests that they belong to a further six genera. The adult of *L. Ariosoma mauritianum* spawns off both west and east Australia, that of *L. Scalanago lateralis* off west Australia only, while the majority of the other congrid species represented in this collection probably spawn north of New Caledonia.

*Conger wilsoni* is a slender eel with 141-149 vertebrae, eye 1.9-3.9 per cent of total length and a dorsal origin well behind pectoral tip; *C. verreauxi* is more robust with 157-165 vertebrae, eye 1.2-1.9 per cent of total length and a dorsal origin over the pectoral tip.

Keys to the adult congrid genera and species in New Zealand waters and to the larvae in the southwest Pacific and Western Australia are given.

INTRODUCTION

AN EARLIER account (Castle, 1963) describes the development of the two species of the genus *Gnathophis* (Congridae) in Australasian waters from a large collection of over 1,000 specimens of various eel larvae assembled from west and east Australia, New Caledonia and New Zealand. The gnathophid leptocephali in this collection number some 250 while another 250 are larvae of other genera of congrid eels. These congrid leptocephali therefore make up almost half of the total collection. This paper describes the balance of the congrid larvae which are referred to ten genera and 15 species. Six of these species cannot with finality be assigned to any particular adult species or to any known species of *Leptocephalus* and are described as distinctive congrid larvae. In this study it quickly became obvious that there is an inadequate knowledge of the Indo-Pacific congrid fauna. The absence of information on vertebral counts for most adult species often prevented final identification of larvae. The adults of the two species of *Conger* in New Zealand waters are relatively common but are in need of definitive descriptions to complete the knowledge of the systematics of the New Zealand Congridae which has already been initiated (Castle, 1960, 1963).

I am greatly indebted to the following institutions for the loan of material:— the Centre d'Océanographie de l'Institut Français d'Océanie, Nouméa, New Caledonia; the C.S.I.R.O. Division of Fisheries and Oceanography, Cronulla, N.S.W., Australia; the Australian Museum, Sydney; the Western Australian Museum,

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Perth; the Otago, Canterbury and Dominion Museums. I also wish to thank Professor L. R. Richardson, Department of Zoology, for his valuable suggestions. All larval type material described here is deposited with the Centre d'Océanographie de l'Institut Français d'Océanie in Nouméa, New Caledonia.

#### SYSTEMATIC ACCOUNT

Asano (1962, p. 63) has recently indicated the similarities and differences between the various genera of congrid eels and has distinguished two groups: (a) Subfamily Anagoinae, which includes *Anago* Jordan and Hubbs, 1925, *Ariosoma* Swainson, 1838, *Alloconger* Jordan and Hubbs, 1925, and *Chiloconger* Myers and Wade, 1941, and (b) Subfamily Congrinae, which includes the other genera of congrid eels. This distinction, based on the morphology of the adults, is also shown by the larvae, as I have already pointed out (Castle, 1963). Genera of the Anagoinae have a leptocephalus which possesses a round eye without a pigment patch below the iris; dorsal and anal fins restricted even in late development to the posterior tip of the body, that is, to the last 10–20 segments; somatic pigment on the lateral surface in the form of a short line of minute, compact chromatophores along each myoseptum below the lateral line; a series of larger, somatic chromatophores on the ventral midline for the anterior third of the intestine; as a closely packed splanchnic series along the upper aspect of the gut from the gall bladder to the vent (along the kidney ducts); and sometimes as a somatic series of chromatophores along the dorsal midline. Leptocephali of genera in the Congrinae have an oval eye with a crescentic patch of pigment below the iris; the dorsal fin originates variably according to the stage of growth but the origin is usually about 30–40 segments in front of the tail tip; somatic pigment in the form of a paired, ventral series of chromatophores as though along the intestine from the pectoral region usually through to the vent; midlateral pigment, if present, in the form of large, diffuse, regular but not segmental spots and sometimes longitudinal rows above and below this. At the present time Asano recognises about eight genera for this stem of the Congridae but as I have shown (1963, p. 17) *Rhynchocymba* Jordan and Hubbs, 1925, is a synonym of *Gnathophis* Kaup, 1859, and I believe that *Rhynchoconger* Jordan and Hubbs, 1925, and *Japonoconger* Asano, 1958, should be replaced by genera of the *Bathycongrus* Ogilby, 1898-group. The confusion in these genera cannot easily be resolved through the literature as early descriptions are often inadequate to show even generic distinctions. The general lack of knowledge of adult eels in the Indo-Pacific has been a major difficulty in the detailed study of collections of leptocephali, but an examination of such collections sometimes reveals data helpful in the identification of adults. Over recent years, collections of larvae have been increasing more rapidly than collections of adults, mainly due to the increased development of plankton studies. These collections of leptocephali can now be expected to provide an important adjunct to the development of the systematics of the Apodes.

#### LEPTOCEPHALI OF THE ANAGOINAE

Included in this group of larvae in the collection are five species, three of which are referred to *Ariosoma* Swainson, 1838, one provisionally to *Alloconger* Jordan and Hubbs, 1925, and the last which I cannot recognise as either *Chiloconger* or *Anago* (if indeed the latter is distinct from *Ariosoma*). There is therefore the possibility of a further genus in this subfamily, that this last species may belong to *Anago*, or that there is a further unknown species of *Chiloconger*. Leptocephali of the three genera are quite distinct in the distribution of chromatophores, but within *Ariosoma* with its three species described here only differences in numerical characters serve as specific characters. The same is true of other groups of leptocephali, not only of the Congridae. There are clear divisions in respect of pigment distribution enabling identification usually at the generic level and specific identification rests on numerical characters.

#### *Ariosoma* Swainson, 1838

1838. *Ariosoma* SWAINSON, *Nat. hist. class. fish. amphib. rept.* 1: 220.  
 1839. *Ophisoma* SWAINSON, *Nat. hist. class. fish. amphib. rept.* 2: 334.  
 1856a. *Congermuraena* KAUP, *Cat. apod. fish.* p. 108.  
 1870. *Congromuraena* GÜNTHER, *Cat. fish. Brit. Mus.*, 8: 40.  
 1898. *Congrellus* OGILBY (partim), *Proc. Linn. Soc. N.S.W.*, 23: 2801.  
 1925. ?*Anago* JORDAN AND HUBBS, *Mem. Carneg. Mus.*, 10 (2): 198.

Although there has been difficulty in establishing conclusively whether *Muraena balearica* De Laroche, 1809, or *Muraena mystax* De Laroche, 1809, was the basis for Swainson's *Ariosoma*, as I have already noted (1963, p. 18) the evidence is that it was *A. balearica*. Larvae of this species are well known from the central Atlantic and have been adequately described allowing me to recognise that closely similar larvae, differing only in the number of myomeres, occur in the present collection from the Australasian region. On the basis of the similarities, especially in the arrangement of pigment, these leptocephali are referred to *Ariosoma*.

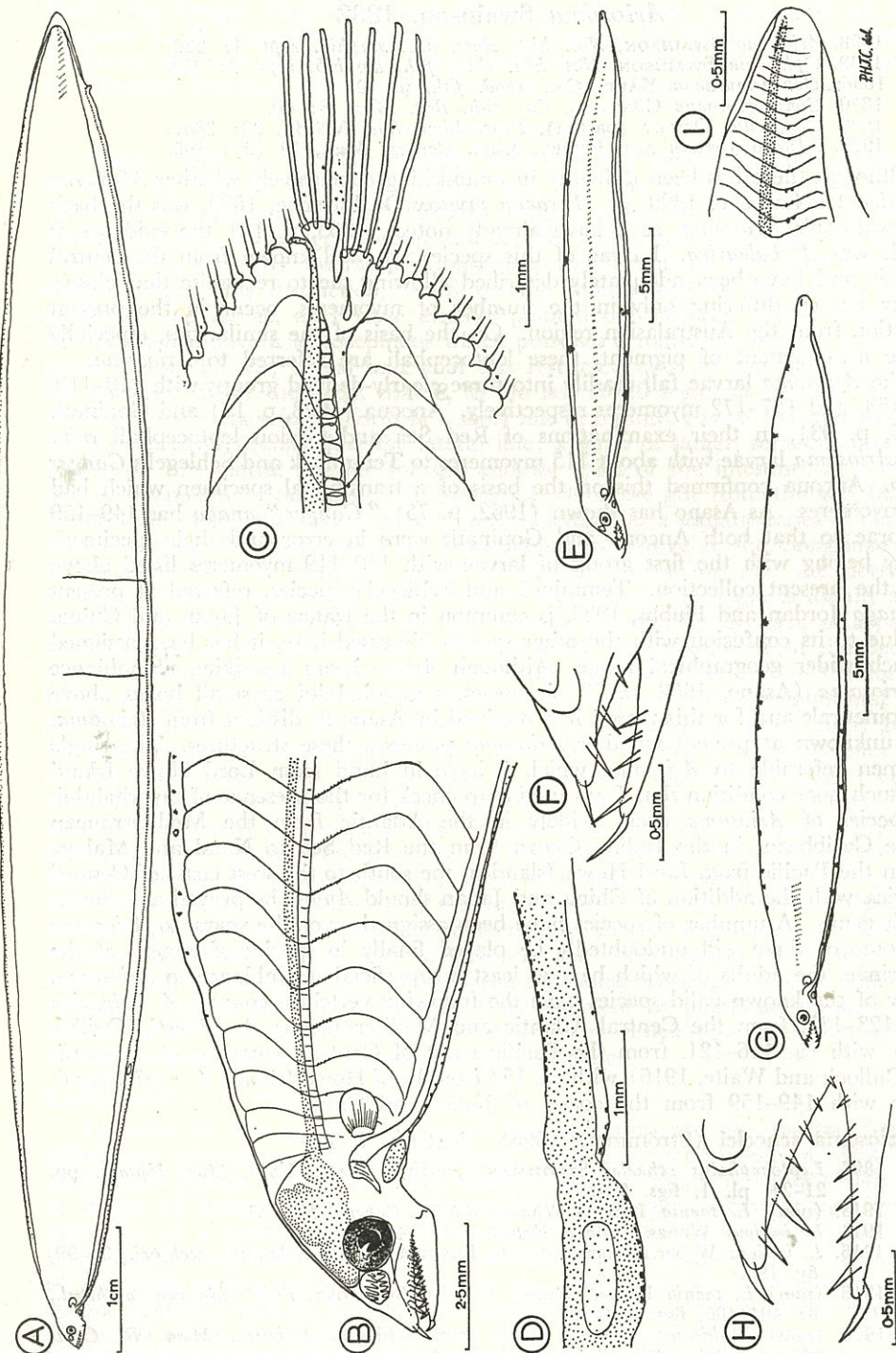
The *Ariosoma* larvae fall readily into three clearly-defined groups with 110–119, 134–153, and 157–172 myomeres respectively. Ancona (1928, p. 17) and Gopinath (1949, p. 93), in their examinations of Red Sea and Ceylon leptocephali refer their *Ariosoma* larvae with about 115 myomeres to Temminck and Schlegel's *Conger anago*. Ancona confirmed this on the basis of a transitional specimen which had 119 myomeres. As Asano has shown (1962, p. 75) "*Conger*" *anago* has 149–159 vertebrae so that both Ancona and Gopinath were in error and their specimens clearly belong with the first group of larvae with 110–119 myomeres listed above from the present collection. Temminck and Schlegel's species, referred at present to *Anago* Jordan and Hubbs, 1925, is common in the waters of Japan and China, but due to its confusion with the other species discussed here, it has been assigned a much wider geographical range. Although *Anago* bears a striking resemblance to *Ariosoma* (Asano, 1962, p. 72) it possesses myorhabdoi or small bones above the epineurals and for this reason it is retained by Asano as distinct from *Ariosoma*. It is unknown at present whether *Ariosoma* possesses these structures. The single specimen referable to *Ariosoma* which I have in hand from Lord Howe Island is in such poor condition that I am unable to check for the presence of myorhabdoi.

Species of *Ariosoma* occur widely in the Atlantic from the Mediterranean to the Caribbean, in the Indian Ocean from the Red Sea to Natal and Malaya and in the Pacific from Lord Howe Island in the south to the west coast of Central America with the addition of China and Japan should *Anago* be proved a synonym of this genus. A number of species have been assigned, over the years, to *Ariosoma* but some of these will undoubtedly be placed finally in species of genera of the Congrinae, the adults of which bear at least a superficial resemblance to *Ariosoma*. A few of the known valid species have the following vertebral counts: *A. balearica* with 123–137, from the Central Atlantic and Mediterranean; *A. gilberti* (Ogilby, 1898) with ca. 116–121, from the Pacific coast of Central America; *A. howensis* (McCulloch and Waite, 1916) with ca. 153 from Lord Howe Island; *A. (= ?Anago) anago* with 149–159 from the coasts of Japan and China.

#### L. *Ariosoma* *scheelei* (Strömman, 1896), Text-fig. 1, A-I

1896. *Leptocephalus scheelei* STROMMAN (partim), *Lept. Univ. Mus. Upsala*, pp. 21–24, pl. 1, figs. 6–7.  
 1913. (non) *L. taenia* LESSON. WEBER, *Siboga Exped.*, 57: 67.  
 1913. *L. indicus* WEBER, *Siboga Exped.*, 57: 74.  
 1916. *L. indicus* WEBER. WEBER AND DE BEAUFORT, *Fish. indo-aust. archipel.*, 3: 99, fig. 195.  
 1916. (non) *L. taenia* LESSON. WEBER AND DE BEAUFORT, *Fish. indo-aust. archipel.*, 3: 404–406, figs. 204–207.  
 1928. (non) *Ophisoma anago* (Temm. and Schleg.). ANCONA, *Mem. R. Com. talassogr. ital.*, 146: 13–14, pl. 1, fig. 1.  
 1928. (non) *L. Ophisomatis anagoi* (Temm. and Schleg.). ANCONA, *Mem. R. Com. talassogr. ital.*, 146: 17–27, pl. 2, figs. 1–4a.  
 1934. ?Larva I. DERANIYAGALA, *Ceylon J. Sci.*, B19 (1): 91–92, fig. 1.





TEXT-FIG. 1.—*L. Ariosoma scheelei* (Strömman, 1896). Figs. A-D, 105mm total length, IFO Station 7-2; Fig. A, lateral view; Fig. B, lateral view of head; Fig. C, tip of caudal region; Fig. D, distribution of pigment at level of gall bladder. Figs. E-F, 15.1mm total length, IFO Station 7-5; Fig. E, lateral view; Fig. F, teeth. Figs. G-I, 31.2mm total length, IFO Station S.3; Fig. G, lateral view; Fig. H, teeth; Fig. I, tip of caudal region.

1936. *L. scheelei* Strömman. BERTIN, *Bull. Inst. oceanogr. Monaco*, 694: 3-5, fig. 4.  
 1939. ?*Ariosoma nigrimanus* NORMAN, *Sci. Rep. John Murray Exped.*, 7 (1): 39-40, fig. 12.  
 1949. (non) *Congrellus anago* (Temm. and Schleg.). GOPINATH, *Rec. Ind. Mus.*, 47 (1): 93, pl. 10, fig. 4, tex-fig. 1c.  
 1956. (non) *L. Ophisomatis anagoi* (Temm. and Schleg.). FOWLER, *Fish. Red Sea Sth. Arabia. I*, p. 114.

MATERIAL EXAMINED: *Centre d'Océanographie de l'Institut Français d'Océanie Collection (64 specimens)*: 15.1mm total length, IFO Station 7-5, 22° 35' S, 166° 16' E, 26/7/62, MWT5 (5ft Isaacs-Kidd midwater trawl) horizontal tow, ca. 120 metres; 16.2, 123.5, St S.1, 21° 45' S, 165° 10' E, 6/6/62, MWT5, H, ca. 120m; 20.0, 27.2, 57.8, 71.2, 71.5, 71.8, 73.3, 77.2, 78.1, 79.8, 111.0, 115.3, 128.3, 128.4, St S.2, 20° 10' S, 163° 27' E, 7/6/62, MWT5, H, ca. 95m; 23.2, 25.3, 26.1, 30.0, 31.2, 71.1, 105.2, St S.3, 18° 10' S, 162° 00' E, 8/6/62, MWT5, H, ca. 95m; 25.6, 36.1, 37.8, 40.7, 73.7, St 7-4, 22° 35' S, 166° 16' E, 17/7/62, MWT5, H, ca. 35m; 30.5, MWT 3 I, 10 miles west of Bulari Pass, New Caledonia, 1/8/61, MWT3, H, ca. 40m, sample 6, 42.4, MWT3, H, ca. 17m, sample 1, 142.5, MWT3, H, ca. 83m, sample 3; 34.8, 61.5, St P57-5-1, 20° 06' S, 168° 40' E, 9/9/57 (0045hrs), S $\frac{1}{2}$ mH (0.5m net, No. 2 mesh, horizontal tow), ca. 20m; 37.4, St 56-4-19, 14° 15' S, 172° 14' E, 21/10/56 (0001hrs), S $\frac{1}{2}$ mH, ca. 50m; 37.6, St 56-5-3, 15° 45' S, 166° 27' E, 31/10/56 (2248hrs), S $\frac{1}{2}$ mO, ca. 150m; 40.5, 51.2, 85.0, 99.0, St S.7, 10° 48' S, 159° 00' E, 12/6/62, MWT5, H, ca. 95m; 40.9, St MWT 2, 10 miles west of Bulari Pass, 30/11/61, MWT3, H, ca. 67m, sample 2; 41.9, St S.5, 13° 30' S, 162° 05' E, 10/6/62, MWT5, H, ca. 95m; 44.0, 45.8, St 7-1, 22° 35' S, 166° 16' E, 17/7/62, MWT5, H, ca. 70m; 45.2, St P58-3-3-6, 22° 41' S, 166° 15' E, 11/4/58 (0500hrs), S $\frac{1}{2}$ mO, ca. 30m; 53.2, 62.3, St 56-3-4, 17° 52' S, 168° 08' E, 17/5/56 (0250hrs), S $\frac{1}{2}$ mH, ca. 5m; 68.0, 77.5, St D10, 14° 50' S, 157° 52.5' E, 16/5/60 (2003hrs), S $\frac{1}{2}$ mO, 0-300m; 75.9, St D10b, 14° 13' S, 157° 55' E, 17/5/60 (0214hrs), S $\frac{1}{2}$ mO, 0-300m; 76.1, St D14, 10° 16' S, 158° 37.5' E, 18/5/60 (2012hrs), S $\frac{1}{2}$ mO, 0-300m; 78.0, St D9b, 15° 21' S, 157° 57' E, 16/5/60 (1415hrs), S $\frac{1}{2}$ mO, 0-300m; 91.8, St D12, 12° 39' S, 157° 59' E, 17/5/60 (2003hrs), S $\frac{1}{2}$ mO, 0-300m; 96.5, 105.0, 131.2, St 7-6, 22° 35' S, 166° 16' E, 26/7/62, MWT5, H, ca. 50m; 105.0, St 7-2, 22° 35' S, 166° 16' E, 17/7/62, MWT5, H, ca. 70m; 106.9, St 7-8, 22° 35' S, 166° 16' E, 26/7/62, MWT5, H, ca. 20m; 112.9, ca. 120 (damaged), 121.1, St S.10, 17° 40' S, 162° 25' E, 22/6/62, MWT5, H, ca. 95m; 122.7, St 7-7, 22° 35' S, 166° 16' E, 26/7/62, MWT5, H, ca. 160m; 126.3, St LL57-5-4, 21° 33' S, 166° 31' E, 11/9/57, stomach of lancet fish, *Alepisaurus ferox*; 154.8, St S.11, 21° 31' S, 164° 48' E, 25/6/62, MWT5, H, ca. 95m.

*Australian Museum Collection (2 specimens)*: 119.2, Aust. Mus. regd. no. IB.3999, Collaroy, New South Wales, 17/9/58; 131.0, Aust. Mus. regd. no. IB.2954, Hawk's Nest Beach, New South Wales.

*Western Australian Museum Collection (1 specimen)*: 85.8, Accession No. P5172, 49 miles west of West End, Rottnest Island, Western Australia, 1/8/61 (0330-0430hrs), larval net, 110m.

DESCRIPTION: 67 specimens: total lengths 15.1mm-154.8mm, myomeres 110-119, dorsal and anal fin-rays greatest in number in the longest specimen, 102 and 106 respectively. Description made from a full-grown specimen, IFO St 7-2 (measurements in mm): total length 105.0, head 3.3, snout 1.2, eye 0.8, cleft of mouth 1.5, postorbital 1.5, pectoral 0.9, snout-vent 100.0, predorsal ca. 98.5, depth just before eye 1.7, at pectoral origin 2.7, at midpoint between pectoral and vent 12.3, at vent 4.3. Branchiostegal and pectoral rays not developed, dorsal rays 77, anal rays 67, caudal rays 3 + 3 + 1. Teeth  $\frac{1+10}{1+9}$ . Myomeres 105 + 10 = 115. a-d = ca. 2. 1st vertical blood vessel at myomere 18, last at 58. Anterior margin of gall bladder at myomere 22.



Body moderately elongate, much compressed except along head, its depth about eight times in total length, tapering equally in front of, and behind, the midpoint of the body. Head very short, about 30 in total length, with the throat indented so that the head is clearly differentiated from the trunk; snout conical, about 3.0 in head, its dorsal profile slightly convex; nasal organ large, close in front of eye, with the nostrils not yet developed; eye small, 4.2 in head, round; cleft of mouth oblique, extending to below middle of pupil; teeth in both jaws acute but rather broad-based; an anterior grasping tooth in each jaw followed by a single series of teeth which gradually diminish in size posteriorly. Pectoral fin short, about 2.0 in postorbital, delicate, rounded; dorsal and anal fins with poorly developed rays, dorsal originating only a little in advance of level of vent, caudal with well developed hypurals and fin-rays.

Pigmentation in preservative as follows:—below the midlateral level on each myoseptum from the third to the last an oblique line of minute, compact, oval somatic chromatophores few in number anteriorly but increasing to about 16–20 in the middle of the body, decreasing in number along the caudal region; from the fifth segment to the origin of the dorsal fin a series of relatively large somatic chromatophores, 1–2 on each segment, along the dorsal midline; from the pectoral region to the posterior margin of the gall bladder on the body wall of the ventral midline, a regular series of small, compact chromatophores, 6–8 to each segment; posterior to this series, continuing to the vent, a paired, regular row of very small, dense, splanchnic chromatophores on the dorsal aspect of the intestine, about 12–14 for each segment; scattered small spots on the basal portions of many of the dorsal and anal fin-rays; a few spots over the base of the caudal fin; chorioid pigment present.

REMARKS: The group of specimens described above agrees well with Strömman's 140mm specimen of *L. scheelei* from the Timor Sea, redescribed by Bertin (1936, pp. 3–5, fig. 4). This specimen has 114 myomeres of which 103 are preanal, the vent is almost subterminal, the eye is small and round, the nostrils are set closely together in front of the eye, the pectoral is small, pigment is distributed in an oblique line of minute, compact spots below the midlateral line on each myoseptum, in a series along the dorsal midline and on the dorsal, anal and caudal bases, all exactly as in present specimens of comparable length. Strömman (1896, p. 22) describes the ventral pigment as follows: "On the lower side for about the first fifth of the body's length there extends a row of pigmentary spots very close together especially at the hinder end. A little beyond where this row ceases, two other rows of spots begin, one on each side of the body; they run just above the alimentary canal and reach as far as the vent. These spots are so close together that to the naked eye they appear to form two continuous dark lines." This is exactly as found in the present specimens although the two posterior rows on the dorsal aspect of the intestine (actually following the kidney ducts) are so close together that they appear as one in some specimens.

Weber's specimen of *L. indicus* (1913, p. 74) from the Sulu Sea, 115.0mm total length, has pigment spots on each myoseptum (as in *L. Ariosoma scheelei*), spots on the bases of the dorsal, anal and caudal rays and 115 segments of which 73 are preanal. There are no larval teeth but a few definitive teeth are present. These characters suggest that the specimen is a metamorphosing specimen of *L. Ariosoma scheelei*. The present collection contains three specimens which are at metamorphosis, 119.2mm, 126.3mm and 131.0mm total lengths, all of which have about 80 preanal myomeres and are probably at a slightly earlier stage than Weber's specimen.

The same author describes as *L. taenia* Lesson, 34 specimens of *L. Ariosoma scheelei* from the Banda Sea and neighbouring areas. These larvae, 56mm–124mm in length, have about 115 segments, the vent is essentially subterminal and the pigmentation is similar to that found in Strömman's *L. scheelei* although Weber makes no mention of pigment on the dorsal midline. I am satisfied, nevertheless that these leptocephali are *L. Ariosoma scheelei*. On the other hand, a small specimen, 19.5mm total length, which Weber also refers to *L. taenia* lacks the characters which are possessed by *L. Ariosoma scheelei* of equal size. There are 106 myomeres, there is no pigment except in the chorioid but the vent is very close to the end of the body. Although in such a small specimen errors may be made in counting the posterior segments, specimens of *L. Ariosoma scheelei* of

comparable length in the present collection show large, conspicuous pigment spots along the dorsal and ventral margins, a feature which could not easily be overlooked.

Gopinath (1949, p. 93, text-fig. 1c, pl. 10) describes and figures 216 leptocephali from the Trivandrum coast of southern India, all as *Congrellus anago*. These specimens were 110mm–158mm total lengths with about 115 myomeres and they have pigment as in *L. Ariosoma scheelei*. So far as I can determine from his account all of them have about 78 myomeres before the vent, and this seems to have been the only reason for Gopinath regarding them as distinct from *L. scheelei*. However, they are all relatively large leptocephali and in this respect agree with Weber's specimen. They are probably undergoing metamorphosis. The single specimen, 90mm in length, described and figured by Deraniyagala (1934, pp. 91–92, fig. 1) as Larva I from the Pearl Banks in the Gulf of Mannar, Ceylon, has 114 myomeres of which 103 are preanal. Pigmentation in this specimen is not described but in view of the posterior vent and strong general similarity to *L. Ariosoma scheelei* I regard Deraniyagala's larva as belonging to this species.

Ancona (1928, pp. 17–27, pl. 2, figs. 1–4a) has described 27 leptocephali, 15.5mm–139mm total lengths as *L. Ariosoma anago*, from the Red Sea, which I regard as *L. Ariosoma scheelei*. Ancona's specimens have 112–117 myomeres (compared with the 149–159 of *A. anago*), the pigmentation is typical of *L. Ariosoma scheelei* in all stages of development and the vent is essentially subterminal.

Ancona examined a small (195mm) juvenile of "*A. anago*", but the radiograph showed only 119 vertebrae. Norman (1939, p. 39, fig. 12) describes and figures *Ariosoma nigrimanus* as so far the only known species of the genus from the Gulf of Aden. Norman does not give a vertebral count but in view of its area of capture *A. nigrimanus* is a possible adult of Ancona's leptocephali and juvenile.

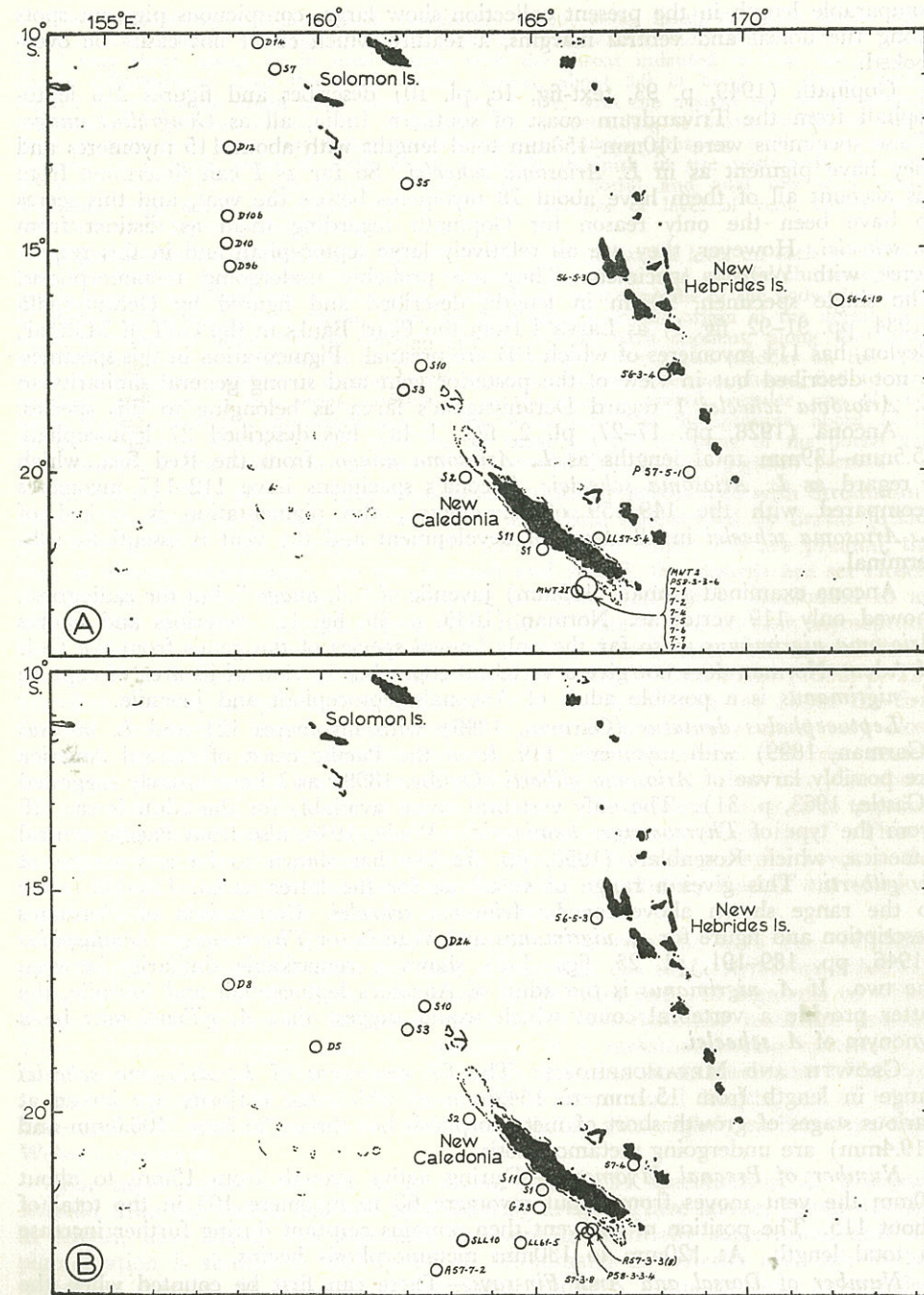
*Leptocephalus dentatus* (Garman, 1899) with myomeres 121 and *L. obtusus* (Garman, 1899) with myomeres 119, from the Pacific coast of central America are possibly larvae of *Ariosoma gilberti* (Ogilby, 1898) as I have already suggested (Castle, 1963, p. 31). The only vertebral count available for the adult is ca. 116 from the type of *Thyreoconger hemiaspidus* Wade, 1946, also from Pacific central America, which Rosenblatt (1958, pp. 52–54) has shown to be a synonym of *A. gilberti*. This gives a range of vertebrae for the latter as ca. 116–121, close to the range shown above for *L. Ariosoma scheelei*. Comparison of Norman's description and figure for *A. nigrimanus* and Wade's for *Thyreoconger hemiaspidus* (1946, pp. 189–191, pl. 25, figs. 1–3) shows a remarkable similarity between the two. If *A. nigrimanus* is the adult of Ancona's leptocephali and juvenile, the latter provide a vertebral count which would suggest that *A. gilberti* may be a synonym of *A. scheelei*.

GROWTH AND METAMORPHOSIS: The 67 specimens of *L. Ariosoma scheelei* range in length from 15.1mm to 154.8mm of which the majority are larvae at various stages of growth short of metamorphosis but three (96.7mm, 106.0mm and 119.4mm) are undergoing metamorphosis.

Number of Preanal Myomeres.—During active growth from 15mm to about 40mm the vent moves from about myomere 60 to myomere 105 in the total of about 115. The position of the vent then remains constant during further increase in total length. At 120mm to 130mm metamorphosis begins.

Number of Dorsal and Anal Fin-rays.—These can first be counted when the larva is only 40mm in length at which time they number about 50 in the anal and 60 in the dorsal. The origin of the dorsal fin is never appreciably in advance of the level of the vent in larvae prior to metamorphosis (even in individuals of 130mm), usually only about two myomeres in front of it, so that extremely rapid movement of the dorsal origin to its final position over the pectoral, must occur during metamorphosis.





TEXT-FIG. 2.—Fig. A, distribution of 64 specimens of *L. Ariosoma scheelei* in the southwest Pacific. Fig. B, distribution of 32 specimens of *L. Ariosoma anago* in the southwest Pacific. IFO Station Nos. indicated.

*Teeth*.—Although some specimens of *L. Ariosoma scheelei* (including the one described above) show little differentiation in size and grouping of teeth, most have teeth which are very similar to those of *Gnathophis* (see Castle, 1963, pp. 32-34). There is always an anterior grasping tooth in each jaw, which in the upper jaw is sometimes preceded by a small, needle-like tooth on the anterodorsal surface of the snout; the grasping tooth is followed by a series of up to nine large teeth and then as many as 12 smaller teeth; there are always fewer posterior smaller teeth in the lower jaw. As in *Gnathophis*, as growth proceeds the bases of the larval teeth become overgrown by the fleshy snout and they appear to be relatively shorter in late leptocephali.

*Pigmentation*.—At 15mm the leptocephalus of *Ariosoma scheelei* has two minute, compact spots on each myoseptum below the midlateral line along the whole of the body except on the tip of the caudal region; dorsal pigment is restricted to about four large stellate spots along the dorsal midline; about four similar spots equally spaced along the midventral bodywall; a few compact spots on the dorsal aspect of the tip of the spinal cord. At about 30mm total length there are about 4-5 spots on each myoseptum, about 18-20 dorsal spots, about 12 ventral spots and pigment on the tip of the caudal region. At the time when the posterior movement of the vent ceases (40mm) the dorsal spots become more compact, the caudal pigment is lost and the ventral stellate chromatophores are replaced by the small, somatic spots in a row on the ventral midline before the gall bladder and the two rows of minute, compact spots on the dorsal aspect of the intestine. Spots on the bases of the dorsal and anal rays begin to form at about 50mm total length.

#### GEOGRAPHICAL RANGE AND LOCATION OF SPAWNING AREAS (Text-fig. 2, A)

Except for the two metamorphosing specimens of *L. Ariosoma scheelei* beach-cast at Sydney and a single, nearly full-grown larva collected off Rottnest Island, Western Australia, all of the present material, that is, 64 specimens, came from the area included by the Solomons, New Hebrides and New Caledonia. The leptocephali are rare and the adult, if present, may be very rare in the Australian region. Small specimens of from 15mm to 35mm were collected in the area immediately surrounding New Caledonia and New Hebrides in 20-120 metres. Larger specimens are more widely distributed. It is therefore probable that spawning of *Ariosoma scheelei* in the southwest Pacific occurs in the waters around New Caledonia. In consideration of the size of specimens previously recorded from the Banda and Sulu Seas and neighbouring areas by previous authors it is likely that larvae move from the New Caledonia region westwards through the Malayan Archipelago as well as occasionally to Western and Eastern Australia. Ancona's studies of this species shows that it must also spawn in the Red Sea since his smallest specimen was 15.5mm total length; Gopinath's 216 larvae from southern India are all very large and it is unlikely that the species spawns in this area; these larvae are probably derived from the Red Sea.

Should *A. gilberti* from the Pacific central America finally prove to be a synonym of *A. scheelei*, the geographical range of the latter will extend across the whole of the Indo-Pacific. Briggs (1961, p. 552) lists seven species of shallow-water tropical eels which have a similar distribution, a relatively high number of trans-Pacific species for any one group of shore fishes. Generally the trans-Pacific species which Briggs lists are active pelagic fishes in which such a distribution can be explained in part by their ability to move about for some distances independent of the bottom. Others, like the eels and including *Albula vulpes* and *Chanos chanos*, have an extended pelagic larval life.



**L. Ariosoma mauritianum** (Pappenheim, 1914)

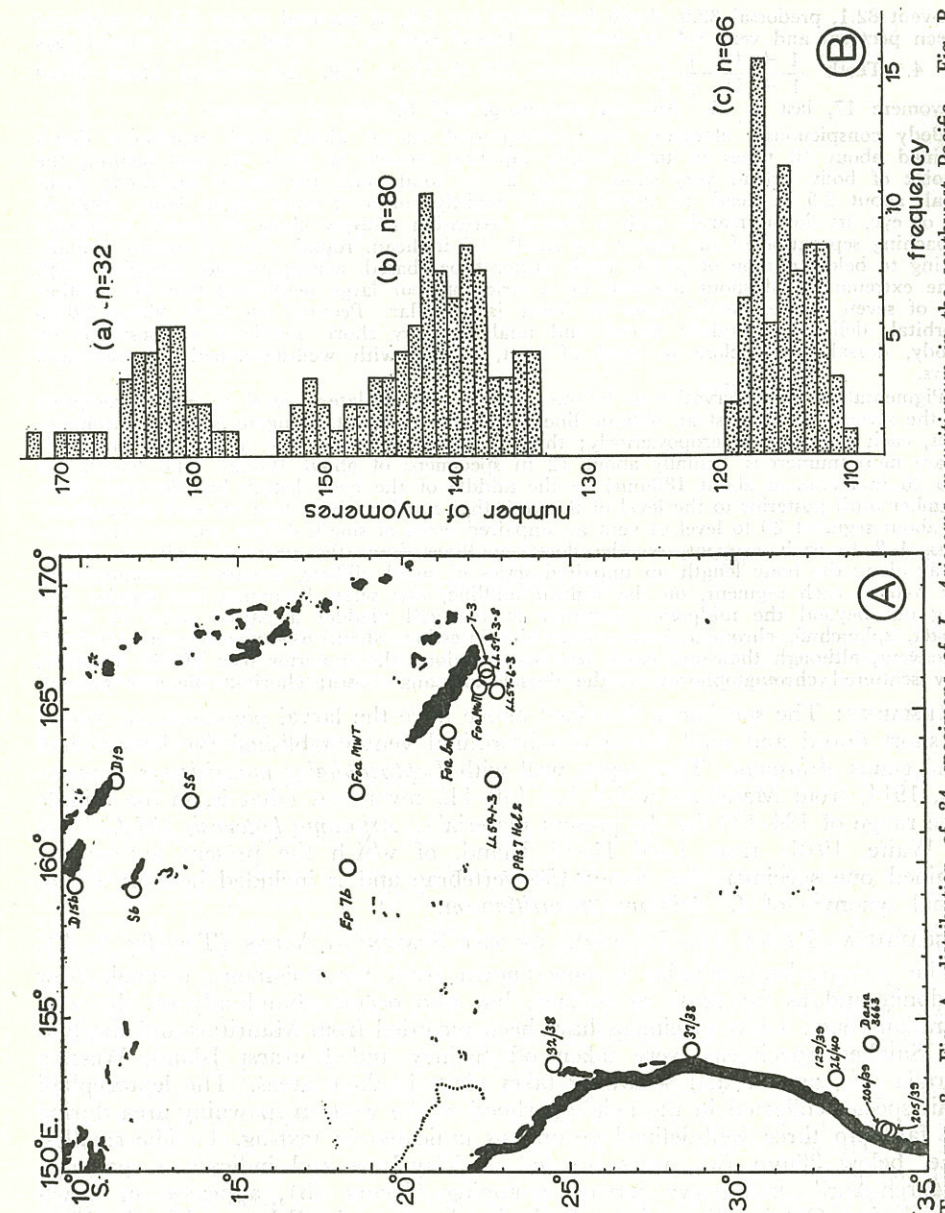
1914. *L. mauritianus* PAPPENHEIM, *Dtsch. Südpol Exped.*, 7 (2): 189, pl. 10, fig. 8.  
 1916. ?*Congeruraena howensis* McCULLOCH AND WAITE, *Trans. Proc. roy. Soc. S. Aust.*, 40: 438, pl. 40, fig. 2.  
 1928. *L. mauritianus* Pappenheim. ANCONA, *Mem. R. Com. talassogr. ital.*, 146: 36-37, pl. 2, figs. 12-12a.  
 1930. *L. mauritianus* Pappenheim. ANCONA, *Ann. idrogr.*, 11: 270, fig. 4.

**MATERIAL EXAMINED:** *Centre d'Océanographie de l'Institut Français d'Océanie Collection* (19 specimens): 43.7mm total length, IFO Station D15b, 9° 50' S, 159° 20' E, 22/5/60 (0219hrs), S<sub>1</sub>mO (0.5 metre net, No. 2 mesh, oblique tow), 0-300m; 53.6, 163.7, St S.6, 11° 51' S, 159° 13' E, 10/6/62, MWT5, H, ca. 95m; 56.0, St S.5, 13° 30' S, 162° 05' E, 10/6/62, MWT5, H, ca. 95m; 57.5, 89.8, 110.0, St P As 7 Hel 2, 23° 28' S, 159° 23' E, 8/5/58 (2015hrs), HeO (Heligoland larval fish net, oblique), ca. 100m; 81.2, St 7-3, 22° 35' S, 166° 16' E, 17/7/62, MWT5, H, ca. 35m; 93.9, St D19, 11° 19' S, 162° 43' E, 23/5/60 (2027hrs), S<sub>1</sub>mO, 0-300m; 98.6, St Foa lm, 21° 21' S, 164° 15' E, 11/1/62, S1mO (1.0m net, No. 2 mesh, oblique), ca. 167m, sample 4; 126.6, 210.0, 269.0, 278.0, St LL 57-3-8, 22° 35' S, 166° 08' E, 9/7/57, stomach of lancet fish, *Alepisaurus ferox*; 145.1, St LL 57-6-3, 22° 50' S, 165° 36' E, 7/12/57, stomach of lancet fish, *Alepisaurus ferox*; 151.2, St Ep7b, 18° 23' S, 159° 47' E, 16/9/60 (0209hrs), S<sub>1</sub>mO, 0-300m; 173.0, St Foa MWT, 18° 35' S, 159° 47' E, 13/1/62, MWT3, H, ca. 100m, sample 4; ca. 181, St Foa MWT, 22° 20' S, 165° 42' E, 10/1/62, MWT3, H, ca. 100m, sample 1; 198.0, St LL 59-1-3, 22° 45' S, 162° 44' E, 30/1/59, stomach of lancet fish, *Alepisaurus ferox*.

*C.S.I.R.O. Division of Fisheries and Oceanography (Cronulla) Collection* (14 specimens): 11.8, 16.0, 16.8, *Warreen Station* 32/38, 24° 29.5' S, 153° 26.5' E, 20/9/38, N100, H, surface, 30 mins; 12.7, 19.4, 26.1, St 32/38, 24° 29.5' S, 153° 26.5' E, 20/9/38, N70, H, 25m, 30mins; 35.0, *Tasman Sea*, 3/4/49, N70, surface; 49.0, *Warreen St* 30/48, 32° 03' S, 113° 30' E, 24/8/48, N70, H, surface, 15mins; 60.8, St 205/39, 34° 03' S, 151° 11.5' E, 4/8/39, N70, O, 0-25m; 76.2, St 26/40, 32° 34' S, 152° 55' E, 20/4/40, N100, O, 0-200m; 86.4, St 129/39, 32° 34' S, 152° 55' E, 3/5/39, N100, H, 100m, 60mins; 100.6, St 206/39, 33° 56' S, 151° 19' E, 4/8/39, N200, H, surface; 117.4, St 37/38, 28° 37' S, 153° 54' E, 22/9/38, N70, H, 100m, 30mins; 230.3, St 3/49, 32° 03' S, 114° 53.5' E, 7/4/49, N70, H, surface, 10mins.

*Australian Museum Collection* (1 specimen): 102.1, Aust. Mus. regd. No. IA.3815, *Dana Station* 3663, haul 9, *Tasman Sea*, 33° 33' S, 154° 04' E, 23/2/29, ca. 50m.

*Western Australian Museum Collection* (47 specimens): 11.1, Accession No. P5229, *Lancelin*, 16 miles west of West End, Rottneest Island, Western Australia, 4/4/62 (0030hrs), larval net, 37 metres; 14.4, P5287, 34mls, 3/7/62 (0300-0100hrs), ln, 37m; 17.4, P5291, 44mls, 3/7/62 (0300-0330hrs), N70, surface; 19.1, P5308, 44mls, 3/7/62 (0300-0330hrs), N70, surface; 59.4, P5169, 50mls, 11/9/61 (2345-0015hrs), ln, 110m; 70.5, P5537, 45mls, 10/10/62 (0150hrs), ln, 37m; 87.3, P5553, 44mls, 7/11/62 (0230hrs), N70, surface; 88.5, P5554, 43mls, 7/11/62, ln, 110m; 91.4, 137.3, P5556, 25mls, 13/11/62 (0100hrs), ln, 37m; 92.2, P5541, 43mls, 10/10/62 (0330hrs), ln, 110m; 96.3, 100.9, P5552, 45mls, 7/11/62 (0140hrs), ln, 37m; 99.6, P5539, 44mls, 10/10/62 (0239hrs), ln, 37m; 104.4, P5559, 40mls, 15/11/62 (0320hrs), ln, 110m; 113.6, 133.5, P5555, 42mls, 7/11/62 (0440hrs), ln, 37m; 118.0, P5550, 43mls, 7/11/62 (0010hrs), ln, 37m; 121.2, P5551, 44mls, 7/11/62 (0100hrs), ln, 37m; 121.3, P5244, 20mls, 4/4/62 (0430hrs), N70, surface; 137.1, 184.0, P5150, 43mls, 7/3/62 (0115-0145hrs), ln, 37m; 138.7, P5154, 40mls, 7/3/62 (0330-0400hrs), ln, 37m; 139.5, 165.6, 168.8, 176.9, 177.5, P5156, 43mls, 12/2/62 (0000-0030hrs), ln, 37m; 139.8, P5178, 40mls, Feb./Mar., 1962, ln, 37m; 145.0, 182.5, P5177, 42mls, 12/2/62



(0100-0130hrs), ln, 37m; 146.9, P5176, 39mls, 12/2/62 (0315-0345hrs), ln, 110m; 150.1, 163.0, 167.3, 168.6, P5155, 40mls, 13/2/62 (0230-0300hrs), ln, 37m; 171.2, 178.5, 190.5, P5151, 41mls, 12/2/62 (0145-0215hrs), ln, 37m; 178.3, P5296, 38mls, 7/3/62, ln, 37m; 190.1, P5226, 40mls, 30/3/62 (0230hrs), ln, 37m; 193.1, 204.3, P5166, 38mls, 12/2/62 (0415-0445hrs), ln, 37m; 194.5, P5183, *Umitaka Maru*, 13° 45' N, 115° 12' E, 8/11/62, ln; 198.0, P5247, *Lancelin*, 43mls, 30/3/62, ln, 37m.

**DESCRIPTION:** 81 specimens: total lengths 11.1mm-278.0mm, myomeres 134-153, maximum number of dorsal fin-rays observed 120, anal 111. Description made from a half-grown specimen, Western Australian Museum Acc. No. P5553 (measurements in mm): total length 87.3, head 3.6, snout 1.5, eye 0.8, cleft of mouth 1.9, postorbital 1.5, pectoral 0.8,



snout-vent 82.1, predorsal 82.9, depth just before eye 1.8, at pectoral origin 2.5, at midpoint between pectoral and vent 8.4, at vent 2.0. Dorsal rays ca. 45, anal rays 40, caudal rays 5 + 4. Teeth  $\frac{1 + IV + 7}{1 + IV + 5}$ . Myomeres 128 + 11 = 139. 1st vertical blood vessel

at myomere 17, last at 75. Anterior margin of gall bladder at myomere 27.

Body conspicuously elongate, much compressed except along head, maximum depth contained about 10 times in total length, tapering equally in front of, and behind, the midpoint of body. Head very short, about 24 in total, with the throat indented; snout conical, about 2.5 in head, its dorsal profile slightly concave; nasal organ large, close in front of eye, its dorsal margin with a ventral extension midway along its length indicating approaching separation of the nares; eye small, 4.5 in head, round; cleft of mouth oblique, reaching to below middle of pupil; teeth rather broad-based, acute; anterior grasping tooth on the extreme tip of snout followed by a series of four large teeth and then by another series of seven smaller teeth; those on lower jaw similar. Pectoral fin short, about 2.0 in postorbital, delicate, rounded; dorsal and anal fin very short, restricted to posterior tip of body, dorsal origin close to level of vent, caudal with well-developed hypurals and fin-rays.

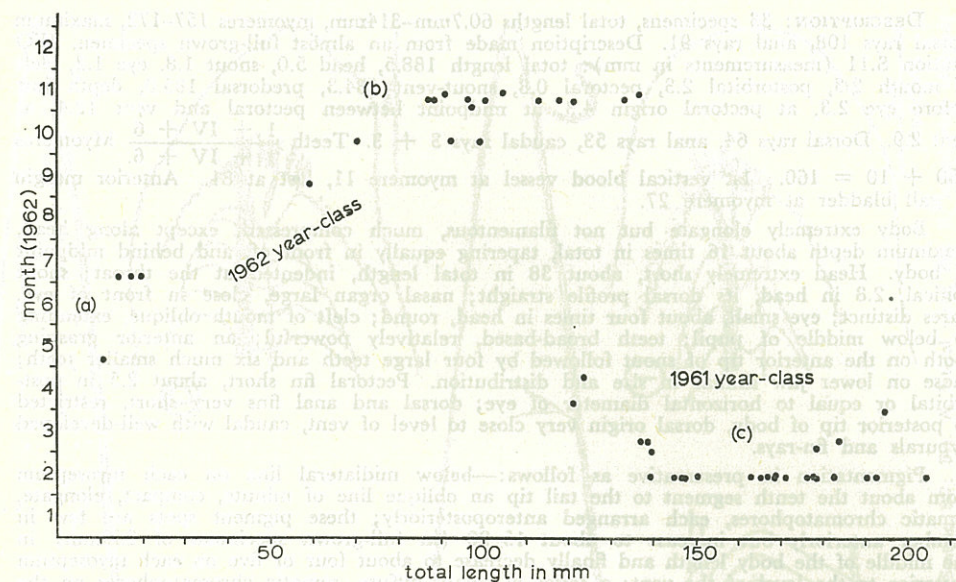
Pigmentation in preservative as follows:—below the midlateral level on each myoseptum from the seventh to the last an oblique line of minute, compact, elongate, somatic chromatophores, each arranged anteroposteriorly; these pigment spots are few in number anteriorly and are more numerous (usually about 12 in specimens of about 100mm total length but up to 20 in larvae of about 180mm) in the middle of the body length but decrease again in number until posterior to the level of the vent they number about four on each myoseptum; from about segment 20 to level of vent an unpaired series of small, diffuse, somatic chromatophores, 1-2 to each segment, on the dorsal midline; from the pectoral region to about halfway along the body length an unpaired series of small, diffuse, somatic chromatophores, about 5-6 to each segment, on the ventral midline, this series becoming less regular and fading out beyond the midpoint; posterior to the gall bladder a paired series of small, compact, splanchnic chromatophores above the intestine, about 6-9 per segment, through to the vent, although these are much less regular along the posterior part of the intestine; a few scattered chromatophores on the dorsal and anal bases; chorioid pigment present.

REMARKS: The specimens described above have the larval pigmentation, round eye, short dorsal and anal fins and subterminal vent established for leptocephali of the genus *Ariosoma*. They agree well with *Leptocephalus mauritianus* Pappenheim, 1914, from Mauritius which has 140-145 myomeres (that is, in the middle of the range of 134-153 for the present material). *Ariosoma howensis* (McCulloch and Waite, 1916) from Lord Howe Island, of which the present author has examined one specimen, has about 154 vertebrae and is included here as a provisional synonym of *L. Ariosoma mauritianum*.

#### GEOGRAPHICAL RANGE AND LOCATION OF THE SPAWNING AREAS (Text-fig. 3, A).

The present leptocephalus is now known from the Solomons, through New Caledonia and as far south as Sydney, but also occurs abundantly on the west Australian coast; a few specimens have been recorded from Mauritius and the Red Sea. Smallest specimens were taken off Sydney and Rottnest Island, Western Australia and suggest that spawning takes place in these areas. The leptocephali of this species collected in the neighbourhood of the western spawning area during 1962 fall into three well-defined groups, as indicated in text-fig. 4. The smallest larvae, below 20mm (a), were trawled in May-June and indicate a spawning in March-April; half-grown larvae, averaging 100mm (b), appeared in trawls made during October-November. Early in the year, in February-March, 1962, only large, full-grown larvae of about 150mm-200mm were collected and these are clearly larvae from the March-April spawning of the previous year, 1961. The larval life of *Ariosoma mauritianum* is therefore at least one year but is probably not much more than this, especially since most of the larger larvae appear to be close to metamorphosis.

The species is not so abundant as *L. Ariosoma scheelei* in the New Caledonia area and the smallest specimen from this region is 43.7mm in total length suggesting that spawning probably does not occur here. Ancona (1928, p. 37) records a 117mm specimen of *L. Ariosoma mauritianum* from the Red Sea, and together with the Mauritius examples, a third spawning area, off east Africa, is suggested.



TEXT-FIG. 4.—Lengths of 46 leptocephali of *Ariosoma mauritianum* collected off Western Australia during 1962; (a) very young larvae from the March-April spawning, (b) half-grown larvae, (c) full-grown larvae from the March-April spawning of 1961.

#### *L. Ariosoma anago* (Temminck and Schlegel, 1842)

1842. *Conger anago* TEMMINCK AND SCHLEGEL, *Fauna Japonica*, p. 259, pl. 113, fig. 1.

For detailed synonymy see Asano, 1962, pp. 72-73.

MATERIAL EXAMINED: *Centre d'Océanographie de l'Institut Français d'Océanie Collection* (32 specimens): 60.7mm total length, IFO Station D5, 18° 32' S, 159° 50' E, 14/5/60 (0820hrs), S $\frac{1}{2}$ mO (0.5 metre net, No. 2 mesh, oblique tow), 0-300m; 90.5, St A 57-3-3 (8), 22° 37' S, 166° 20' E, 6/3/57 (1930hrs), S $\frac{1}{2}$ mH, ca. 10m; 117.9, St P58-3-3-4, 21° 41' S, 166° 15' E, 31/3/58 (2200hrs), S $\frac{1}{2}$ mH, ca. 15m; 119.1, St D24, 16° 13.5' S, 162° 47' E, 25/5/60 (2329hrs), S $\frac{1}{2}$ mO, 0-300m; 119.5, 124.3, 135.2, 140.5, 168.8, 179.2, 181.6, St S.2, 20° 10' S, 163° 27' E, 7/6/62, MWT5, H, ca. 95m; 129.5, 169.5, St S.1, 21° 45' S, 165° 10' E, 6/6/62, MWT5, H, ca. 120m; 142.2, 188.5, St S.11, 21° 31' S, 164° 48' E, 25/6/62, MWT5, H, ca. 95m; 145.1, 159.0, St S.3, 18° 10' S, 162° 00' E, 8/6/62, MWT5, H, ca. 95m; 151.0, St A57-7-2, 23° 27' S, 162° 40' E, 6/7/57 (1800hrs), S $\frac{1}{2}$ mH, ca. 20m; 160.4, St D8, 17° 07' S, 157° 47' E, 15/5/60 (2003hrs), S $\frac{1}{2}$ mO, 0-300m; 162.0, 190.7, 236.3, St S.10, 17° 40' S, 162° 25' E, 22/6/62, MWT5, H, ca. 95m; 248.1, 296.0, and two specimens in poor condition, St 57-4, south coast of Lifu (Loyalty Islands), 22/7/57, stomach of skipjack, *Katsuwonus pelamis*; 279.1, 289.5, St LL 57-3-8, 22° 35' S, 166° 08' E, 9/7/57 stomach of lancet fish, *Alepisaurus ferox*; 314.0, St G 23, 22° 07' S, 165° 04' E, 22/3/62, S1mO (1.0m net, No. 2 mesh, oblique tow), ca. 167m, sample 23; one specimen in poor condition St LL 61-5, 22° 54' S, 164° 38' E, 5/7/61, stomach of striped marlin, *Makaira audax*; two specimens in poor condition, St G LL 10, 20° 55' S, 163° 18' E, 21/3/62, stomach of lancet fish, *Alepisaurus ferox*.

*Western Australian Museum Collection* (1 specimen): 167.9, Accession No. P5241, *Lancelin*, 45 miles west of West End, Rottnest Island, Western Australia, 11/4/62 (0230hrs), larval net, 37m.



**DESCRIPTION:** 33 specimens, total lengths 60.7mm–314mm, myomeres 157–172, maximum dorsal rays 108, anal rays 91. Description made from an almost full-grown specimen, IFO Station S.11 (measurements in mm): total length 188.5, head 5.0, snout 1.8, eye 1.2, cleft of mouth 2.3, postorbital 2.3, pectoral 0.8, snout-vent 184.3, predorsal 185.0, depth just before eye 2.3, at pectoral origin 4.3, at midpoint between pectoral and vent 12.4, at vent 2.9. Dorsal rays 64, anal rays 53, caudal rays 3 + 3. Teeth  $\frac{1 + IV + 6}{1 + IV + 6}$ . Myomeres  $150 + 10 = 160$ . 1st vertical blood vessel at myomere 11, last at 81. Anterior margin of gall bladder at myomere 27.

Body extremely elongate but not filamentous, much compressed, except along head, maximum depth about 16 times in total, tapering equally in front of, and behind midpoint of body. Head extremely short, about 38 in total length, indented at the throat; snout conical, 2.8 in head, its dorsal profile straight; nasal organ large, close in front of eye, nares distinct; eye small, about four times in head, round; cleft of mouth oblique, extending to below middle of pupil; teeth broad-based, relatively powerful; an anterior grasping tooth on the anterior tip of snout followed by four large teeth and six much smaller teeth; those on lower jaw similar in size and distribution. Pectoral fin short, about 2.5 in post-orbital or equal to horizontal diameter of eye; dorsal and anal fins very short, restricted to posterior tip of body, dorsal origin very close to level of vent, caudal with well-developed hypurals and fin-rays.

Pigmentation in preservative as follows:—below midlateral line on each myoseptum from about the tenth segment to the tail tip an oblique line of minute, compact, elongate, somatic chromatophores, each arranged anteroposteriorly; these pigment spots are few in number anteriorly but increase to about 15–20 (in full-grown specimens of 250mm) in the middle of the body length and finally decrease to about four or five on each myoseptum posterior to the level of the vent; a series of small, diffuse, somatic chromatophores on the dorsal midline from the 15th segment to the level of the vent, 1–2 per segment but more widely spaced posteriorly; a series of small, diffuse, somatic chromatophores along the ventral midline from the pectoral region to about the midpoint of the body length, about six per segment, the series fading out gradually towards the midpoint; posterior to the gall bladder a paired series of small, compact, splanchnic chromatophores along the dorsal aspect of the intestine to the vent, about 9–10 per segment but much less frequent posteriorly; a spot on the bases of most dorsal and anal rays; chorioid pigment present.

**REMARKS:** In the 45 specimens of *Ariosoma anago* examined by Asano (1962, p. 73) vertebrae numbered 149–159, a range which is appreciably lower than that of the leptocephali here referred to this species (157–172). However, at the present state of knowledge of the adult species of *Ariosoma* in the Indo-Pacific I hesitate to separate these leptocephali from *A. anago* on the basis of this difference.

Only one relatively small specimen, measuring 60.7mm total length, is present in the above collection while the others are all over 90mm and reach 300mm, a very large size for congrid leptocephali. In all specimens the vent is very close to the tip of the caudal region indicating that there are no metamorphosing larvae in the collection. However, some show well-developed fin-rays and ossification of the skull, etc., indicating that they are probably full-grown.

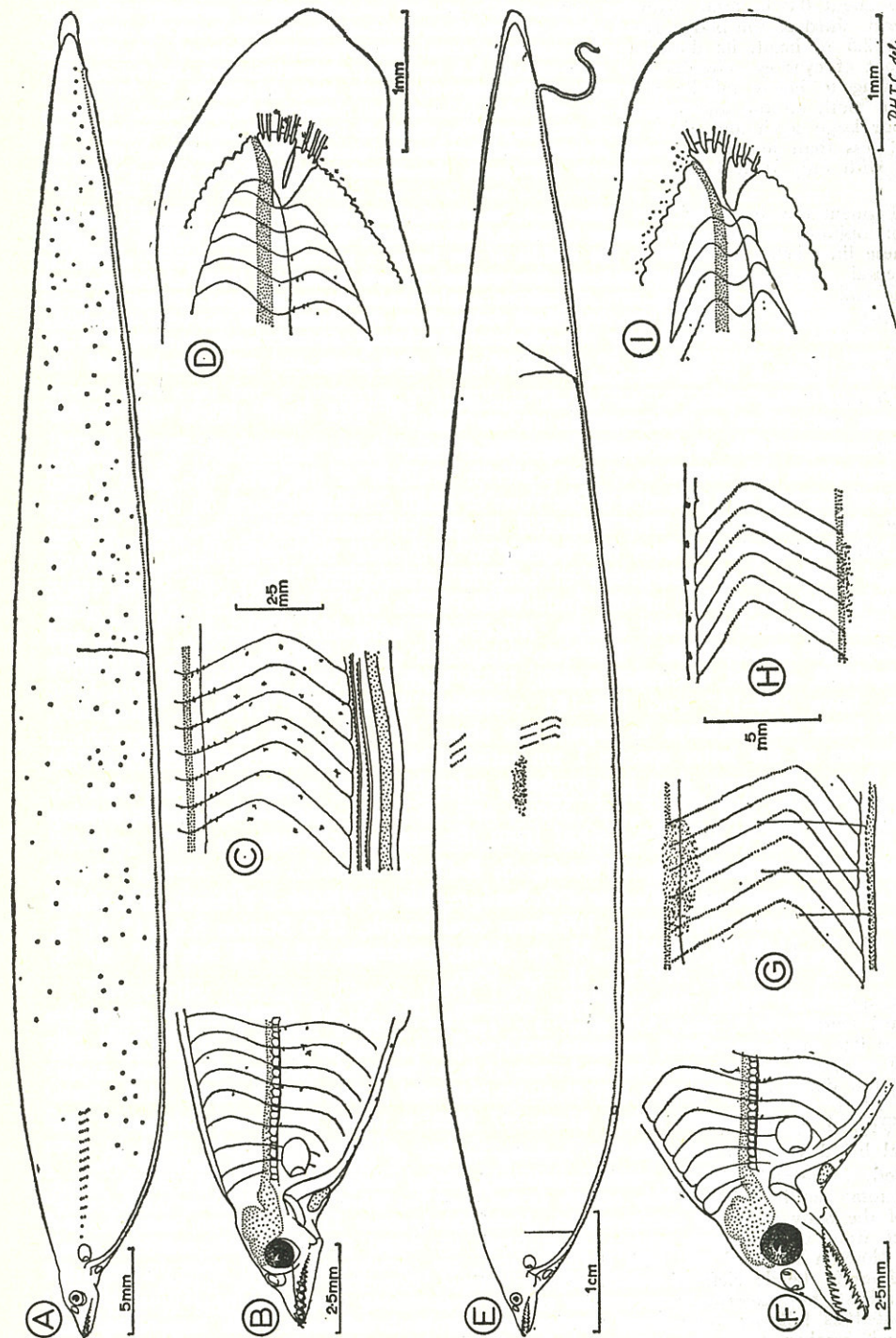
**L. ?*Alloconger anagoides*** (Bleeker, 1864), Text-fig. 5, A-D

1864. *Ophisoma anagoides* BLEEKER, *Atlas ich. Indes. Orient. Neerl.*, 4: 27, pl. 149, fig. 3.

For further synonymy see Asano, 1962, p. 76.

**MATERIAL EXAMINED:** *Centre d'Océanographie de l'Institut Français d'Océanie Collection* (2 specimens): ca. 58mm total length (damaged), IFO Station G LL 13, 23° 31' S, 165° 53' E, 4/4/62, stomach of lancet fish, *Alepisaurus ferox*; 76.3, St S.7, 10° 48' S, 159° 00' E, 12/6/62, MWT5, H, ca. 95m.

**DESCRIPTION:** Made from the undamaged specimen (measurements in mm): standard length 75.3, head 4.1, snout 1.6, eye 1.1, cleft of mouth 2.4, postorbital 1.8, pectoral 1.2, snout-vent 73.0, predorsal 74.9, depth just before eye 1.8, at pectoral origin 3.1, at midpoint between pectoral and vent 8.6, at vent 2.5. Pectoral rays undeveloped, only a few dorsal and anal rays present at tip of caudal region, caudal rays 5 + 3. Teeth  $\frac{1 + 1 + IV + 8}{1 + IV + 7}$ . Myomeres 127 + 11 = 138. Last vertical blood vessel at myomere 68. Anterior margin of gall bladder at myomere 21.



**TEXT-FIG. 5.**—Figs. A-D, *L. ?Alloconger anagoides* (Bleeker, 1864), 76.3mm total length, IFO Station S.7: Fig. A, lateral view; Fig. B, lateral view of head; Fig. C, lateral view at about myomere 50 to show lateral pigment and splanchnic chromatophores on the kidney ducts; Fig. D, tip of caudal region. Figs. E-I, *Leptocephalus scalaris* n. sp., type, 108.8mm total length, IFO Station S.6: Fig. E, lateral view; Fig. F, lateral view at about myomere 53 to show pigment below lateral line; and Fig. G, H, I, tip of caudal region. P.H.J.C. del.



Body moderately elongate, much compressed except along head, deep, the maximum depth about 8.0 in total, reducing very rapidly at the head but more gradually along the posterior third of the body. Head short, about 18 in total, distinct from trunk; snout acute, about 2.5 in head, its dorsal profile concave; nasal organ poorly developed, placed close in front of eye; eye circular, 2.0 in snout or 5.5 in head; cleft of mouth slightly oblique, extending to below middle of pupil; teeth relatively acute and distributed as follows: a minute tooth on the anterodorsal tip of snout followed by a large grasping tooth, a series of four large teeth and eight much smaller teeth, those of lower jaw similar. Pectoral fin short, less than length of snout, delicate, subcircular in shape; dorsal and anal fins very short with only their basal structures developed, the dorsal origin slightly behind level of vent.

Pigmentation in formalin as follows:—a short, oblique line of minute, compact, somatic chromatophores on each myoseptum below the lateral line, the maximum number of spots in these lines being about six in the middle of the body; a paired row of regular, essentially segmental, somatic chromatophores on the ventral surface from the level of the pectoral to the gall bladder; a paired row of compact, splanchnic chromatophores in the order of eight per segment arranged along the kidney ducts above the intestine to the vent; numerous small, somatic spots scattered over the whole of the lateral surface, more numerous below the lateral line; scattered spots on the dorsal and anal bases and over the base of the caudal fin; pigment in the chorioid.

Vertical blood vessels to the viscera numerous, beginning at the tenth myomere and occurring every three or four segments to the 68th.

REMARKS: The leptocephali described here show similarities to *Ariosoma* leptocephali in the round eye, the posterior position of the vent, the short dorsal and anal fins and the presence of the rows of small chromatophores on the myosepta below the lateral line. The scattered lateral chromatophores, however, suggest that this leptocephalus does not belong in *Ariosoma*, but nevertheless, it clearly belongs in the Anagoinae-group of congrid leptocephali. Only one other genus of this group is present in the Indo-West-Pacific and this is *Alloconger* Jordan and Hubbs, with its two species *Alloconger anagoides* (Bleeker, 1864) and *A. shiranago* Asano, 1958. The two subspecies of *A. shiranago*, *A. s. shiranago* Asano, 1958, and *A. s. major* Asano, 1958, both of which are known only from Japan, have 144–147 and 156–161 vertebrae respectively while *A. anagoides*, known from Indo-Malaya to Japan, has about 143. In view of the geographical distribution of the latter species I am satisfied that if the leptocephalus described above is an *Alloconger* then it is probably referable to *A. anagoides*. The relatively large size of the two larvae (ca. 58mm and 76.3mm) suggest that the spawning area for the species may be distant from the area of capture.

*Leptocephalus scalaris* n.sp. (Text-fig. 5, E-I)

MATERIAL EXAMINED: *Centre d'Océanographie de l'Institut Français d'Océanie Collection* (2 specimens): type, 108.8mm total length, IFO Station S.6, 11° 51' S, 159° 13' E, 11/6/62, MWT5, H, ca. 95m; paratype, 51.1, St S.5, 13° 30' S, 162° 05' E, 10/6/62, MWT5, H, ca. 95m.

DESCRIPTION: Made from the type specimen, IFO St S.6 (measurements in mm): standard length 107.7, head 5.0, snout 2.2, eye 1.2, cleft of mouth 3.1, postorbital 2.0, pectoral 0.9, snout-vent 102.5, predorsal 103.1, depth just before eye 2.4, at pectoral origin 5.4, at midpoint between pectoral and vent 15.0, at vent 3.8. Pectoral rays undeveloped, only a few dorsal and anal rays present at tip of caudal region, caudal rays 4 + 3. Teeth  $\frac{1 + VI + 10}{1 + VIII + 5}$  Myomeres 130 + 17 = 147 (133 + 18 = 151 in the paratype). Last vertical blood vessel at myomere 92. Anterior margin of gall bladder at myomere 20.

Body moderately elongate, much compressed except along head, deep, the depth about 6.5 in total length, reducing very rapidly at the head but more gradually along the posterior half of the body to tip of caudal region. Head short, about 21 in total, not conspicuously distinct from trunk; snout acute, 2.3 in head, its dorsal profile slightly concave; nasal organ close in front of eye, with distinct nares; eye circular, contained twice in snout or four times in head; cleft of mouth slightly oblique, extending to below middle of pupil; teeth robust, not excessively acute, the smaller ones curved forward a little at their tips, distributed as follows:—one large anterior grasping tooth followed by six large teeth and 10 much smaller ones, the pattern similar in the lower jaw. Pectoral fin short, about half the length of snout, rounded, delicate; dorsal fin originating about 20 segments in advance of level of vent, anal fin very short.

Pigmentation in formalin as follows:—an oblique line of minute, compact, somatic elongate chromatophores on each myoseptum below the lateral line, reaching 20–24 in number at the midpoint of the body, briefly separated from a row of similar spots above the angle of each myoseptum below the lateral line (see text-fig 5, H) reaching a maximum of about 12 spots; a row of up to 12 similar spots above the angle of each myoseptum above the lateral line (text-fig. 5, G); irregularly scattered ventral, somatic chromatophores in the order of four per segment before the level of the gall bladder; a row of minute, compact, splanchnic chromatophores on each kidney duct above the intestine; a few diffuse chromatophores along the dorsal midline; scattered pigment on the bases of the terminal dorsal and anal rays and over the base of the caudal fin; halfway along the midlateral line an oval patch of numerous, minute, somatic chromatophores but this only occurs in the larger specimen and its presence may be abnormal; chorioid pigment present.

Vertical blood vessels to the viscera very numerous, beginning at the 5th myomere and occurring every two or three myomeres to the 92nd myomere. Gall bladder spherical. End of intestine with about 10mm trailing free from the body wall. (*L. scalarum* = ladder, in reference to the ladder-like pattern of the rows of pigment spots).

REMARKS: The present species conforms well in possessing a round eye, short dorsal and anal fins, a posterior vent and rows of chromatophores on the myosepta below the lateral line with Anagoinae-type leptocephali. It has no scattered lateral chromatophores as in the larva previously referred to *Alloconger anagoides* and has the last vertical blood vessel at the level of myomere 92, compared with myomere 68 in *L. Alloconger anagoides*. In addition, the new species has additional lines of minute chromatophores in two places on each myoseptum. As far as I am able to determine from the literature there is no known species of *Leptocephalus* which has this remarkable pattern of lateral pigment. *L. scalaris* is therefore unique amongst congrid leptocephali. Ancona (1928, p. 32) describes *L. macreteron* which has the posterior part of the intestine free from the body (as in the present species) but without the additional pigment on the myosepta. I believe this pigment to be abnormal in both species and that *L. macreteron* is referable to *L. Ariosoma mauritianum*.

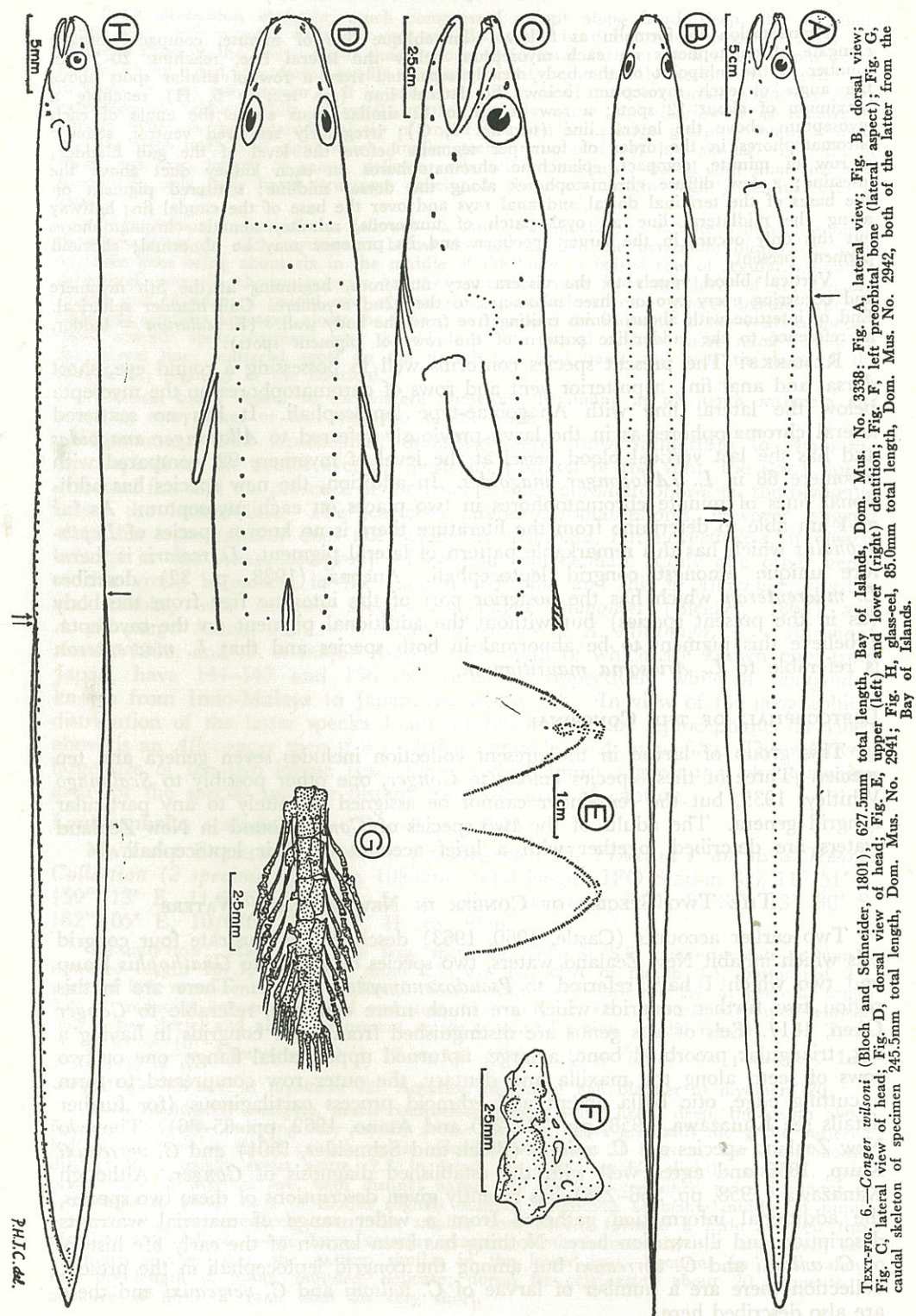
#### LEPTOCEPHALI OF THE CONGRINAE

This group of larvae in the present collection includes seven genera and ten species. Three of these species belong to *Conger*, one other possibly to *Scalanago* Whitley, 1935, but the remainder cannot be assigned definitely to any particular congrid genera. The adults of the two species of *Conger* found in New Zealand waters are described together with a brief account of their leptocephali.

#### THE TWO SPECIES OF CONGER IN NEW ZEALAND WATERS

Two earlier accounts (Castle, 1960, 1963) describe and illustrate four congrid eels which inhabit New Zealand waters, two species belonging to *Gnathopis* Kaup and two which I have referred to *Pseudoxenomystax* Breder. There are in this region two further congrids which are much more common, referable to *Conger* Oken, 1817. Eels of this genus are distinguished from other congrids in having a flat, triangular preorbital bone, a large, upturned upper labial flange, one or two rows of teeth along the maxilla and dentary, the outer row compressed to form a cutting edge, otic bulla absent and ethmoid process cartilaginous (for further details see Kanazawa, 1958, pp. 224–225 and Asano, 1962, pp. 85–86). The two New Zealand species are *C. wilsoni* (Bloch and Schneider, 1801) and *C. verreauxi* Kaup, 1856 and agree well with the established diagnosis of *Conger*. Although Kanazawa (1958, pp. 256–258) has recently given descriptions of these two species, the additional information gathered from a wider range of material warrants description and illustration here. Nothing has been known of the early life history of *C. wilsoni* and *C. verreauxi* but among the congrid leptocephali in the present collection there are a number of larvae of *C. wilsoni* and *C. verreauxi* and these are also described here.





TEXT-FIG. 6.—*Conger wilsoni* (Bloch and Schneider, 1801), 627.5mm total length, Bay of Islands, Dom. Mus. No. 3338; Fig. A, lateral view; Fig. B, dorsal view; Fig. C, lateral view; Fig. D, dorsal view; Fig. E, upper (left) and lower (right) dentition; Fig. F, glass-etch, 245.5mm total length, Dom. Mus. No. 2941; Fig. G, glass-etch, 245.5mm total length, Dom. Mus. No. 2941; Fig. H, glass-etch, 85.0mm total length, Dom. Mus. No. 2942; Fig. I, glass-etch, 85.0mm total length, Dom. Mus. No. 2942, both of the latter from the Bay of Islands.

*C. wilsoni* is a relatively slender eel, seldom reaching more than 1000mm in length, which has 141–149 vertebrae, 36–41 lateral line pores before the level of the vent, dorsal fin-rays 294–330, branchiostegal rays 8–9, a relatively large eye, the horizontal diameter of which is 1.9–3.9 per cent of total length (decreasing slightly in relation to increase in total length), the dorsal fin originating about half the length of the pectoral fin behind the pectoral tip and the teeth on the maxilla and dentary numbering about 45–66; it has a northern distribution in New Zealand, from East Cape northwards, but is also known from Western Australia, South Australia, Tasmania through to southern Queensland; it shows similarities to *C. oceanicus* (Mitchell, 1814) from the western Atlantic and *C. philippinus* Kanazawa, 1958, from the western Pacific (see Kanazawa, 1958, pp. 256–257). *C. wilsoni* is also similar to *C. verreauxi*, the second species known from New Zealand, but the latter is a much more robust eel, reaching 2,000mm in length, having 157–165 vertebrae, 40–44 lateral line pores before the level of the vent, dorsal fin-rays 331–347, branchiostegal rays 10–11, a small eye 1.2–1.9 per cent of total length, the dorsal fin originating about level with the pectoral tip and teeth on each jaw 35–67; it has an essentially southern distribution in New Zealand from Cook Strait southwards but is taken northwards to the Bay of Islands and along the southeast coast of Australia.

***Conger wilsoni* (Bloch and Schneider, 1801), Text-fig. 6, A-H**

1801. *Gymnothorax wilsoni* BLOCH AND SCHNEIDER, *Syst. Ich.*, p. 529.  
 1872. *Conger wilsoni* (Bl. and Schn.). CASTELNAU, *Proc. Zool. Acclim. Soc. Victoria*, 1: 193.  
 1923. *Leptocephalus wilsoni* (Bl. and Schn.). LORD, *Pap. Proc. R. Soc. Tasmania*, p. 64.  
 1928. *Leptocephallus wilsoni* (Bl. and Schn.). McCULLOCH, *Mem. Aust. Mus.*, 5 (1): 65.  
 1932. *Leptocephalus monganius* PHILLIPPS, *N.Z. Jour. Sci. Tech.*, 13 (4): 230.  
 1936. *Leptocephalus labiatus* (Castelnau). GRIFFIN, *Trans. roy. Soc. N.Z.*, 66: 16, pl. 6, figs. 2, 2a, 2b.  
 1944. *Leptocephalus wilsoni hesperius* WHITLEY, *Proc. roy. Soc. N.S.W.*, p. 25, fig. 1.  
 1958. *Conger wilsoni* (Bl. and Schn.). KANAZAWA, *Proc. U.S. nat. Mus.*, 108: 256, pl. 1, H, fig. 2, w.

**MATERIAL EXAMINED:** 25 specimens, 69.6mm–627.5mm total lengths; Uru-pukapuka Island, Bay of Islands; rotenone; February, 1961. Five specimens, 75.0mm–245.5mm total lengths; Uru-pukapuka Island, Bay of Islands; rotenone; March, 1960; Dom. Mus. No. 2941. One specimen, 815mm total length; Perirua Peninsula; Dom. Mus. No. 1902. One specimen, 904mm total length (skin and head); Mangonui, Doubtless Bay; Dom. Mus. No. 433 (type of *Leptocephalus monganius* Phillipps, 1932). One specimen, 245.5mm total length, Dom. Mus. No. 3340, stained in alizarin as a skeletal preparation.

**DESCRIPTION:** Proportional measurements (in per cent of total length) and counts from 30 specimens: total lengths 69.6mm–815mm, standard 97.4–99.1, head 12.5–16.3, snout 3.2–4.5, eye 1.9–3.9, interorbital 2.1–3.6, upper jaw 4.5–6.4, postorbital 7.7–9.8, branchial aperture 1.1–2.3, branchial interspace 2.1–4.2, pectoral 3.4–5.5, preanal 35.2–40.8, predorsal 19.1–21.9, depth before eye 2.9–5.0, at pectoral origin 4.2–6.9, at vent 4.0–6.0, at midpoint of caudal region 3.1–5.2. Branchiostegal rays 8–9, pectoral rays 16–18, dorsal rays before level of vent 57–65, dorsal rays 294–330, anal rays 229–261, caudal rays 4–5 + 4–5, lateral line pores before level of vent 36–41, vertebrae 141–149.

A slender eel which seldom grows to more than 1,000mm, rounded to oval in section, with the vent always well in front of the midpoint of the body. The head is markedly depressed, especially in smaller specimens, the lips are thick and the eye is large. The dorsal begins distinctly behind the level of the pectoral tip. Olive blue-black above, white, tinged with yellow below, the dorsal and anal fins white with a conspicuous but narrow black margin and the eye with a brilliant silver-green patch above the pupil.

Head sharply conical, conspicuously depressed, in most specimens the jaw muscles bulging upwards so that the head is clearly differentiated from the trunk, short, about 7.5 in total length; snout rather blunt but flattened or depressed dorsally, about 4.0 in head,



not projecting noticeably in advance of tip of lower jaw; the latter rounded in ventral view, relatively slender, shovel-like; mouth terminal, slightly oblique, with cleft extending to below posterior margin of pupil and contained less than 3.0 in head; upper lip well-developed, especially anteriorly, beginning a little behind tip of snout, becoming weaker posteriorly; lower lip more strongly developed, also beginning behind tip of lower jaw; tongue strong, pointed, extending forwards to a point halfway between the levels of the anterior and posterior nostrils.

Teeth relatively small, but a little larger anteriorly than posteriorly, most bluntly conical and villiform in smaller specimens, a few sharp and slightly recurved, those on the maxilla and dentary flattened anteroposteriorly with their bases much wider than their tips. Maxillary teeth about 45 in a specimen of 630mm total length, uniserial, forming a sharp cutting edge; a few minute teeth in a second longitudinal row medial to the main row about one-third of the way along the outer row. Premaxillary-ethmoid teeth about as large as those on the anterior extremity of the maxilla, about a dozen in number, forming a narrow, curved patch, about twice as broad as long, which barely shows in advance of the tip of the lower jaw when the mouth is closed. Vomerine teeth in an oval patch, about one-third the length of the maxillary row, much larger anteriorly than those more posteriorly placed and about 30 in number. Teeth on the dentary similar to those on the maxilla but with a few extra teeth in a short row in front as well as a short subsidiary row of about eight teeth medial to the main row.

Anterior nostril terminal, tubular, with the tube directed forwards. Posterior nostril small, oval, placed close to the anterior margin of eye and above the horizontal diameter, usually widely open. Eye subcircular, relatively large, contained more than four times in the postorbital. Fleshy interorbital about equal to eye. Branchial aperture lateral, about equal to eye, having a concave free edge, oblique, with the upper extremity above middle of pectoral base and well in advance of level of lower extremity. Vent not protruding conspicuously into the lateral profile.

Dorsal and anal fins delicate, not high and about equally developed. Dorsal originating about half to two-thirds of the pectoral behind level of pectoral tip. Anal fin not as high as dorsal. Caudal fin continuous with dorsal and anal tips, not abbreviated, pointed. Pectoral elongate-oval in shape, with a rounded posterior margin, originating at about the midlateral level, its base oblique and the fin directed slightly posterodorsally, about equal to cleft of mouth in length.

Lateral line moderately conspicuous but barely raised above lateral surface, arising high on head and reaching midlateral level just posterior to level of vent. Pores simple, minute and visible almost to tail tip. Cephalic sensory pores consisting of one occipital pore; one pore on the upper lip at the level of the anterior margin of eye; a large pore immediately behind and level with corner of mouth; two pores set closely together in a short groove on the anterodorsal tip of snout; one pore in front of, and one behind, base of anterior nostril tube; a minute pore on ventral surface of snout; eight mandibular pores in a curved line from the operculum to the tip of lower jaw. Surface sensory organs on the head in most specimens by a transverse row of minute papillae across nape and a semicircular row in front of pectoral base. Most lateral line pores with minute papillae anterodorsal to them.

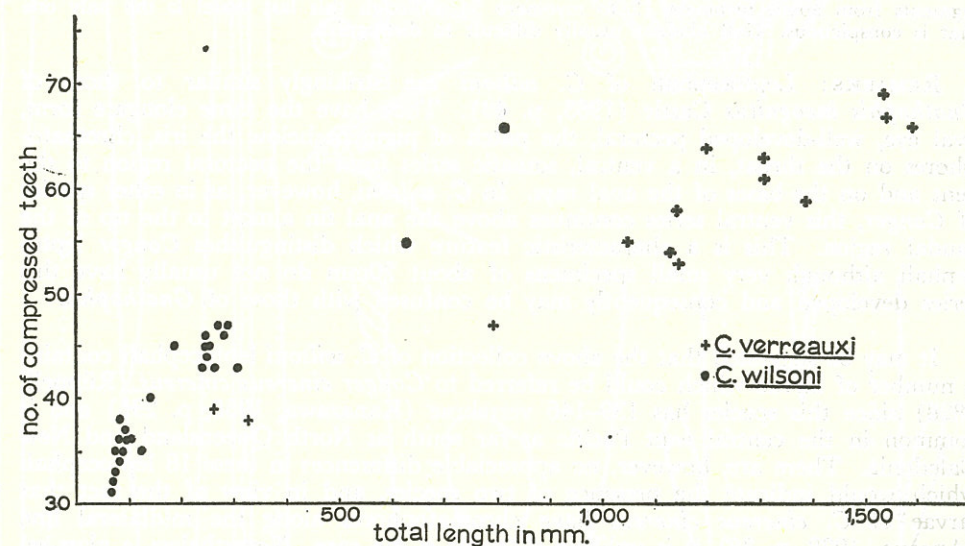
Colour in life olive blue-black over the dorsal surface and to a point halfway between lateral line and ventral midline, mostly creamish-white below, sometimes tinged with yellow. Head often with a patch of silver posterior to eye. Iris blue-purple anteriorly and posteriorly with a brilliant crescentic patch of silver green above but this fades rapidly on death. Dorsal and anal fins white with a complete, narrow black margin.

REMARKS: The most recent account of *Conger wilsoni* is that of Kanazawa (1958, pp. 256-257, fig. 2, w, pl. 1, H) who studied four specimens from Australia. My specimens conform essentially with Kanazawa's description but the range of variation in most proportions and counts is greater since there are 30 specimens in the present collection. *C. wilsoni* does not deepen in the body greatly during growth as does *C. verreauxi* and remains a slender eel with a cylindrical body very little compressed along the caudal region. *C. wilsoni* has much more numerous teeth on the maxilla and dentary than does *C. verreauxi*. At 257mm total length, *C. wilsoni* has teeth 45/46 on each half of the upper and lower jaw respectively, while at 815mm it has 66/69. This increase with growth is shown graphically in text-fig. 7. Other differences between *C. wilsoni* and *C. verreauxi* have already been indicated.

### L. *Conger wilsoni* (Text-fig. 9, A-C)

MATERIAL EXAMINED: *Centre d'Océanographie de l'Institut Français d'Océanie Collection* (14 specimens): 25.2mm total length, IFO Station D10b, 14° 13' S, 157° 55' E, 17/5/60 (0214hrs), S<sub>1</sub>mO (0.5m net, No. 2 mesh, oblique tow), 0-300 metres; 33.7, 33.9, 81.5, St S.2, 20° 10' S, 163° 27' E, 7/6/62, MWT5, H, ca. 95m; 42.1, 43.8, St S.5, 13° 30' S, 162° 05' E, 10/6/62, MWT5, H, ca. 95m; 46.7, 49.1, St 7-8, 22° 35' S, 166° 16' E, 26/7/62, MWT5, H, ca. 20m; 49.5, St S.7, 10° 48' S, 159° 00' E, 12/6/62, MWT5, H, ca. 50m; 74.0, St S.4, 15° 48' S, 161° 00' E, 9/6/62, MWT5, H, ca. 95m; 76.8, St P57-5-1, 20° 06' S, 168° 40' E, 9/9/57 (0030hrs), S<sub>1</sub>mO, 200m; 86.0, St 56-5-4, 14° 50' S, 166° 15' E, 2/11/56 (0045hrs), S<sub>1</sub>mH, ca. 30m; 89.7, St 56-4-6, 6° 50' S, 169° 55' E, 30/9/56 (2324hrs), S<sub>1</sub>mH, ca. 100m; 94.4, St S.1, 21° 45' S, 165° 10' E, 6/6/62, MWT5, H, ca. 120m.

*Western Australian Museum Collection* (1 specimen): 90.3, Accession No. P5167, 47 miles west of West End, Rottnest Island, Western Australia, 24/1/62 (0145-0215hrs), larval net, 37 metres.





Body moderately elongate, much compressed except along head, not deep, the maximum depth about nine times in total length, reducing more gradually in front of the midpoint. Head short, about 14 in total, relatively distinct from trunk; snout blunt, about 3.5 in head, its dorsal profile convex; anterior nostril tube directed forwards, posterior nostril with a simple raised rim and placed above horizontal diameter of eye; eye oval, the greatest diameter vertical, but the horizontal diameter 1.3 in snout; cleft of mouth slightly oblique, extending to below posterior margin of pupil; teeth very acute, barely curved; branchial aperture curved, its ventral margin not yet attached to the lateral surface. Pectoral fin short, about equal to length of snout, almost circular in shape with the fin-rays not developed; dorsal fin low, originating at myomere 70, fin-rays very numerous and closely packed; anal fin similar; caudal pointed.

Pigmentation in formalin consisting of a conspicuous brown to black crescentic patch below the posteroventral margin of the iris; a rounded chromatophore deep in the throat; a paired, ventral, somatic series of about 70 rounded chromatophores following the course of the intestine from the 10th myomere, thence on each segment to the vent; this series continues as scattered chromatophores on the bodywall above the anal fin; a series of minute, irregularly shaped chromatophores on the bases of most of the anal rays; a few on the bases of the dorsal terminal rays; a scattering of minute pigment spots over the base of the caudal fin; chorioid pigment present.

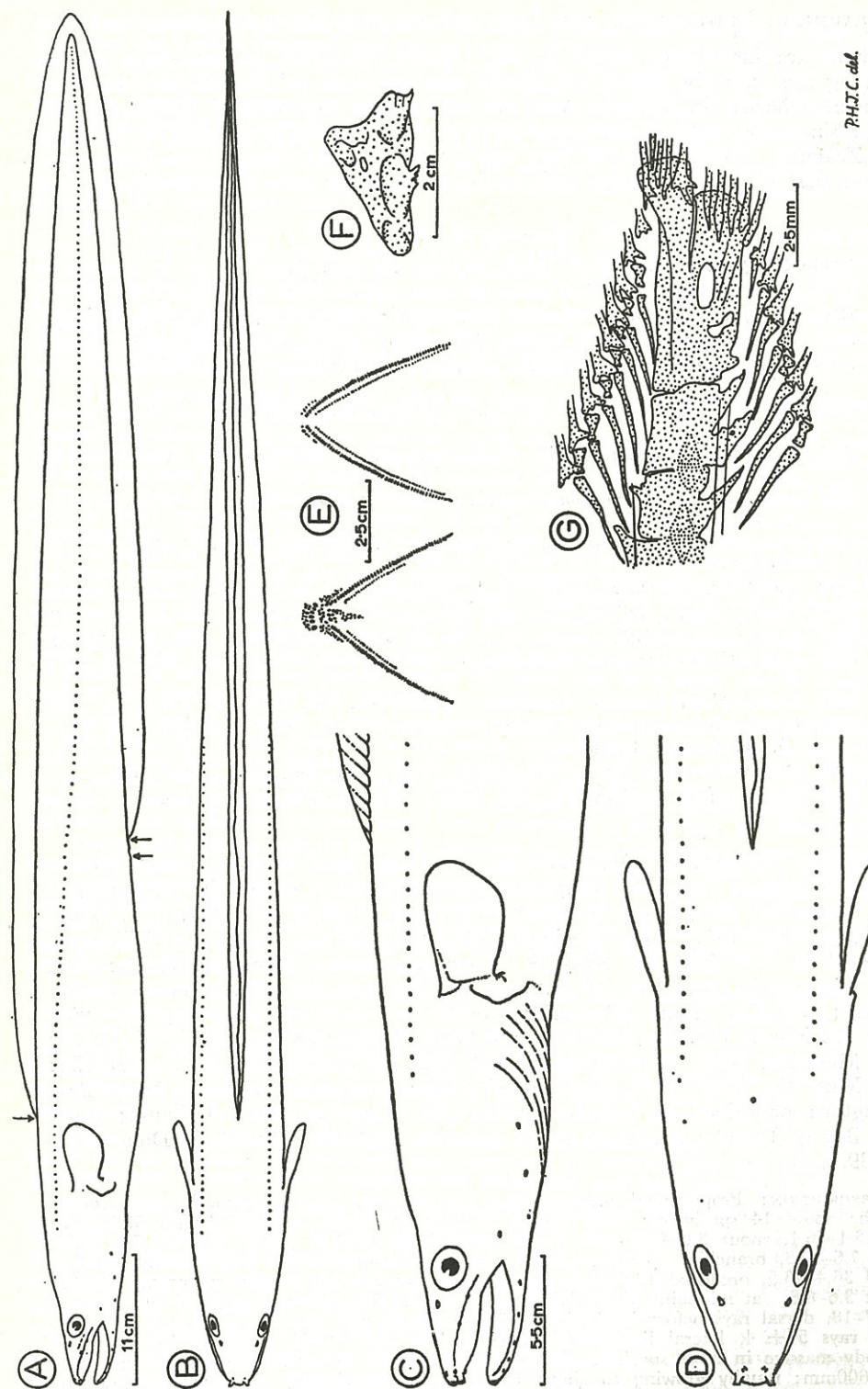
Vertical blood vessels to the viscera numerous, occurring irregularly every four or five segments from about myomere 12 to myomere 54 although this last vessel is the only one that is conspicuous. Gall bladder usually difficult to distinguish.

REMARKS: Leptocephali of *C. wilsoni* are strikingly similar to those of *Gnathophis incognitus* Castle (1963, p. 43). They have the same elongate form, oval eye, well-developed pectoral, the patch of pigment below the iris, chromatophores on the throat, in a ventral, somatic series from the pectoral region to the vent and on the bases of the anal rays. In *C. wilsoni*, however, as in other species of *Conger*, this ventral series continues above the anal fin almost to the tip of the caudal region. This is a characteristic feature which distinguishes *Conger* leptocephali although very small specimens of about 20mm do not usually have this series developed and consequently may be confused with those of *Gnathophis*.

It may be suggested that the above collection of *C. wilsoni* leptocephali contains a number of larvae which could be referred to *Conger cinereus cinereus* (Rüppell, 1828) since this species has 139-146 vertebrae (Kanazawa, 1958, p. 235) and is common in the central west Pacific as far south as North Queensland and New Caledonia. There are, however, no appreciable differences in these 18 leptocephali which would indicate the presence of two species, and in view of the fact that larvae of *C. cinereus cinereus* have chromatophores along the midlateral line (Ancona, 1928, p. 38) it is unlikely that this is the case. Nevertheless, a glass-eel collected in the Solomon Islands and in the present collection shows features which are characteristic of *C. cinereus cinereus*, that is, two cephalic pores behind the eye and the sixth suborbital pore above the level of the corner of the mouth (see text-fig. 9, D). Relevant data for this specimen are as follows:—*C.S.I.R.O. Division of Fisheries and Oceanography (Cronulla) Collection*: 85.7mm total length, *Fairwind* collection, Kieta, Bougainville Island, Solomon Islands, 21/10/49, submarine light.

#### GROWTH AND METAMORPHOSIS

Growth of the leptocephalus of *C. wilsoni* proceeds much as in *Gnathophis*, the main difference being the gradual development of a very blunt snout, thick, fleshy lips which are characteristic of the adult, the tube of the anterior nostril becomes directed forwards and not downwards and the anal fin lengthens so that the pigment spots above it increase in number; in *Gnathophis* there are none of these spots behind the vent.



TEXT-FIG. 8.—*Conger verreauxi* Kaup, 1856, 1150mm total length, Port Levy; Fig. A, lateral view; Fig. B, dorsal view; Fig. C, lateral view of head; Fig. D, dorsal view of head; Fig. E, upper (left) and lower (right) dentition; Fig. F, left preorbital bone (lateral aspect); Fig. G, caudal skeleton.



## GEOGRAPHICAL DISTRIBUTION AND LOCATION OF THE SPAWNING AREAS

There are insufficient larvae in the present collection to indicate a precise spawning area but the larvae are clearly smallest north of New Caledonia. One specimen collected in Western Australia at 90.3mm has reached metamorphosis, while a single glass-eel and the largest larva in the collection were taken off northern New Zealand. The absence of very small larvae in collections from these areas suggests that *C. wilsoni* spawns well to the north of its area of adult distribution.

*Conger verreauxi* Kaup, 1856 (Text-fig. 8, A-G)

- 1856b. *Conger verreauxi* KAUP, *Arch. Naturg.*, 22 (1): 72.  
 1870. (non) *Conger vulgaris* CUVIER. GUNTHER, *Cat. Fish. Brit. Mus.*, 8: 39.  
 1872. (non) *Conger vulgaris* CUVIER. HUTTON, *Cat. Fish. N.Z.*, p. 66, pl. 11, fig. 105.  
 1892. (non) *Conger vulgaris* CUVIER. THOMSON, *Trans. N.Z. Inst.*, 24: 214.  
 1896. (non) *Conger vulgaris* CUVIER. JORDAN AND EVERMANN, *Bull. U.S. nat. Mus.*, 47: 355.  
 1911. (non) *Leptocephalus conger* (L.). WAITE, *Rec. Canterbury (N.Z.) Mus.*, 1: 164.  
 1921. (non) *Leptocephalus conger* (L.). PHILLIPPS, *N.Z. Jour. Sci. Tech.*, 4: 119 and 125.  
 1921. (non) *Leptocephalus conger* (L.). THOMSON, *Hist. Portobello Fish. Hatch.*, p. 71.  
 1921. (non) *Conger ?wilsoni* (Bl. and Schn.). WAITE, *Rec. S. Aust. Mus.*, 2 (1): 49, fig. 74.  
 1922. (non) *Leptocephalus conger* (L.). PHILLIPPS, *N.Z. Jour. Sci. Tech.*, 5: 94.  
 1923. (non) *Conger ?wilsoni* (Bl. and Schn.). WAITE, *Fishes of S. Aust.*, p. 72.  
 1923. (non) *Leptocephalus conger* (L.). LORD, *Pap. Proc. R. Soc. Tasmania*, p. 64.  
 1929. *Leptocephalus labiatus* (Castelnau). McCULLOCH, *Mem. Aust. Mus.*, 5 (1): 65.  
 1932. *Leptocephalus labiatus* (Castelnau). PHILLIPPS, *N.Z. Jour. Sci. Tech.*, 13: 229.  
 1936. *Leptocephalus verreauxi* (Kaup). GRIFFIN, *Trans. roy. Soc. N.Z.*, 66 (1): 15, pl. 6, figs. 1, 1a.  
 1958. *Conger verreauxi* Kaup. KANAZAWA, *Proc. U.S. nat. Mus.*, 108: 257.  
 1962. *Leptocephalus ?wilsoni* (Bl. and Schn.). SCOTT, *Mar. freshw. fish Sth. Aust.*, p. 75.

**MATERIAL EXAMINED:** One specimen, 261.0mm total length; Bay of Plenty; stomach of groper, *Polyprion oxygeneios* (Bl. and Schn.), caught in 180 fathoms; Dom. Mus. No. 2032. One specimen, 329.1mm; Pegasus Bay, trawl; 27/9/54; Dom. Mus. No. 1617. One specimen, 799.3mm; Porirua Harbour, Wellington; handlined in 3-4 fathoms; 20/3/59. Four specimens, 1056mm-1148mm; Port Levy; commercial trawl in 10 fathoms by *Ikatere*; 29/3/60. One specimen, 1200mm; Big Bay, South Westland; crayfish pot in 5 fathoms; March, 1959. Three specimens, 1316mm-1597mm; off Oaro, Kaikoura; handlined; 17/12/58; Dom. Mus. No. 2672. One specimen, 1317mm; off Castlepoint; trawl; 19/8/53; Dom. Mus. No. 1384. One specimen, 1391mm; three miles south of Titahi Bay, Wellington; handlined in 5 fathoms; 11/6/60. One specimen, 1540mm; Cape Brett, Bay of Islands; handlined in 20 fathoms; 19/2/61. One skull, Dom. Mus. No. 889.

**DESCRIPTION:** Proportional measurements (in per cent of total length) and counts from the above 14 specimens: total lengths 261.0mm-1597mm, standard length 98.6-99.6, head 13.1-16.1, snout 3.0-4.5, eye 1.2-1.9, interorbital 1.5-3.5, upper jaw 4.2-5.8, post-orbital 7.6-10.3, branchial aperture 1.2-2.5, branchial interspace 2.1-6.4, pectoral 4.6-6.3, preanal 36.4-43.5, predorsal 17.2-21.8, depth before eye 2.7-4.9, at pectoral origin 3.8-8.1, at vent 3.6-8.6, at midpoint of caudal region 2.7-5.5. Branchiostegal rays 10-11, pectoral rays 17-18, dorsal rays before level of vent 56-70, dorsal rays 331-347, anal rays 238-265, caudal rays 5 + 4, lateral line pores before level of vent 40-44, vertebrae 157-165.

Body massive in most specimens but distinctly slender in small examples of less than about 600mm; usually growing to about 1500mm but occasionally reaching 2000mm. In

these large specimens the anterior part of the body is broad and powerful, swollen at the belly, but the head is depressed and the eye small. The lips are very thick, the branchial aperture gapes widely and the pectoral is very broad and flap-like. The vent is always in front of the midpoint of the body and the dorsal and anal fins, in large specimens, are very strongly developed to give a bladeliike, compressed caudal region. The colour is variable, usually dull grey-black above, often mottled with light grey or cream and lighter below; small specimens have a black margin to the median fins. This eel usually lives in deep rock crevices, moving out to feed at night although it may be encountered foraging in broad daylight. It is an aggressive creature which may inflict deep gashes with its powerful jaws and sharp teeth.

Head bluntly conical, depressed, not conspicuously differentiated from trunk, short, about 7.0 in total length; snout blunt, flattened dorsally, about 4.0 in head, not projecting in advance of tip of lower jaw; the latter rounded in ventral view, strong, shovel-like; mouth terminal, slightly oblique with cleft extending to below posterior margin of pupil and contained 3.0 times in head; upper lip very well developed, especially along its anterior half, beginning a little behind tip of snout and weaker posteriorly; lower lip thicker, overlapping lower jaw, beginning a little behind tip of lower jaw; tongue strong, pointed, extending to a point halfway between levels of anterior and posterior nostrils.

Teeth relatively small but robust, generally larger anteriorly than those more posteriorly placed; most of them bluntly conical and villiform in small specimens, but a few on premaxillary-ethmoid and anterior part of vomer sharp and recurved, the main teeth on the maxilla and dentary flattened anteroposteriorly with wide bases. Maxillary teeth about 48 in a specimen of 1150mm total length, uniserial, forming a sharp, powerful cutting edge; a row of about 24 minute teeth forming a second longitudinal row medial to this main row; a small triangular patch of about 18 teeth outside the most anterior part of the maxillary row. Premaxillary-ethmoid teeth mostly large, about 20, forming a curved patch, twice as broad as long, which barely shows in advance of lower jaw when mouth is closed; the most anterior teeth of this patch minute. Vomerine teeth large anteriorly but much smaller posteriorly, about 30 in number, forming a tear-shaped patch, less than one-third the length of the maxillary patch with the broad end anterior. Teeth on the dentary essentially in two longitudinal rows of which the lateral row contains about 50 teeth, similar to those on the maxilla; those of the medial row are minute but about the same in number; a few teeth are placed outside the main row in a short row of about five teeth at the anterior tip of the dentary.

Anterior nostril terminal, tubular, with the tube directed forwards and equal in length to about half the pupil. Posterior nostril small, placed close to anterior margin of eye and above the horizontal diameter, usually widely open, oval. Eye oval, small, about 5.5 in postorbital. Fleshy interorbital broad, about twice diameter of eye. Branchial aperture lateral, 1.5 times eye, widely open, with a concave free edge and slightly oblique, its upper extremity near middle of pectoral base. Vent protruding a little into the lateral profile.

Dorsal and anal fins delicate in small specimens but thick and fleshy in large individuals, the dorsal somewhat higher than the anal. Dorsal originating less than the diameter of the pupil behind the level of the pectoral tip, reaching its greatest height in the last quarter of the caudal region where it equals the depth of the body at that point. Anal similar to the dorsal. Caudal fin continuous with the tips of the dorsal and anal fins and pointed. Pectoral fan-like, thick, fleshy and deep in larger specimens, about equal to length of cleft of mouth, its base oblique.

Lateral line ridge inconspicuous, arising high on the head and curving down to meet the midlateral level well behind level of vent. The pores are simple, minute and visible almost to caudal tip. Cephalic sensory pores as in *C. wilsoni*, that is, an occipital pore, five pores on tip of snout and around base of anterior nostril, two pores on maxilla, one behind corner of mouth, three on opercular region and six on lower jaw. Specimens of about 600mm or less may show a pattern of minute surface sensory papillae across the dorsal surface of the head, in front of the pectoral base and around the nostrils.

Colour in life generally dark grey or brown to blue-black above, light grey to white below on the abdomen but specimens may sometimes be mottled grey and white. Small specimens have a narrow black margin to the dorsal and anal fins. Iris dull silver.

**REMARKS:** The specimens of *C. verreauxi* examined above conform well with Kanazawa's redescription (1958, pp. 257-258) of the species from the type and one other specimen in the British Museum. The eye in the present 14 specimens is slightly larger at 1.2-1.9 per cent of total compared with 1.1 in the two specimens examined by Kanazawa. None of the specimens examined above have a small tentacle on either side of the snout as noted by Phillipps (1932, p. 229) but this author may have repeated an observation made by Castelnau (1879, p. 399) on the type of his *Conger ?labiata* from Sydney. There was possibly some confusion



in Castelnau's mind with the projecting, tube-like anterior nostril, if indeed his specimen was a *Conger*. The "belly and fins of a bright yellow" would be an unusual colouration for either *C. verreauxi* or *C. wilsoni*, both of which are known from south-east Australia; the type of *C. labiata* therefore may well belong to some other genus of eels, perhaps *Ophichthus*.

**PROPORTIONAL CHANGES DURING GROWTH:** In *C. verreauxi*, after reaching about 500mm, there is a marked increase in the depth of the body along the trunk so that specimens of about 1500mm may be extremely large in girth. There is at the same time a very great increase in weight and large *C. verreauxi* may be 35lb-40lb. Related to this, the branchial interspace increases much more rapidly than any other proportion of the body. The branchial aperture also lengthens very rapidly. The largest specimen of *C. verreauxi* examined (1597mm) is about six times the length of the smallest specimen (261mm) and comparing the two specimens, the increases in the various proportions are as follows:—head 6.8, snout 7.7, eye 4.6, interorbital 8.5, upper jaw 8.1, postorbital 7.3, branchial aperture 11.3, branchial interspace 11.2, pectoral 7.0, preanal 6.8, predorsal 7.3. The eye therefore decreases in size relative to the length of the body as growth proceeds while the head and preanal length increase at about the same rate relative to the length of the body.

A conspicuous change during growth in both *C. verreauxi* and *C. wilsoni* is an increase in number of the compressed teeth along the maxilla and dentary (for comparative data see Kanazawa, 1958, fig. 2). At a length of 261mm, *C. verreauxi* has 35/36 teeth on the maxilla and dentary respectively. The numbers increase regularly with growth and reach a maximum of about 63/65 at 1200mm total length. This increase is illustrated in text-fig. 7 and compared with the numbers of compressed teeth in *C. wilsoni*. The difference in number of teeth on the maxilla or dentary provides a valuable character for the separation of the two species although at lengths up to 200mm there is insufficient difference in the numbers to distinguish examples of the two species on this character alone.

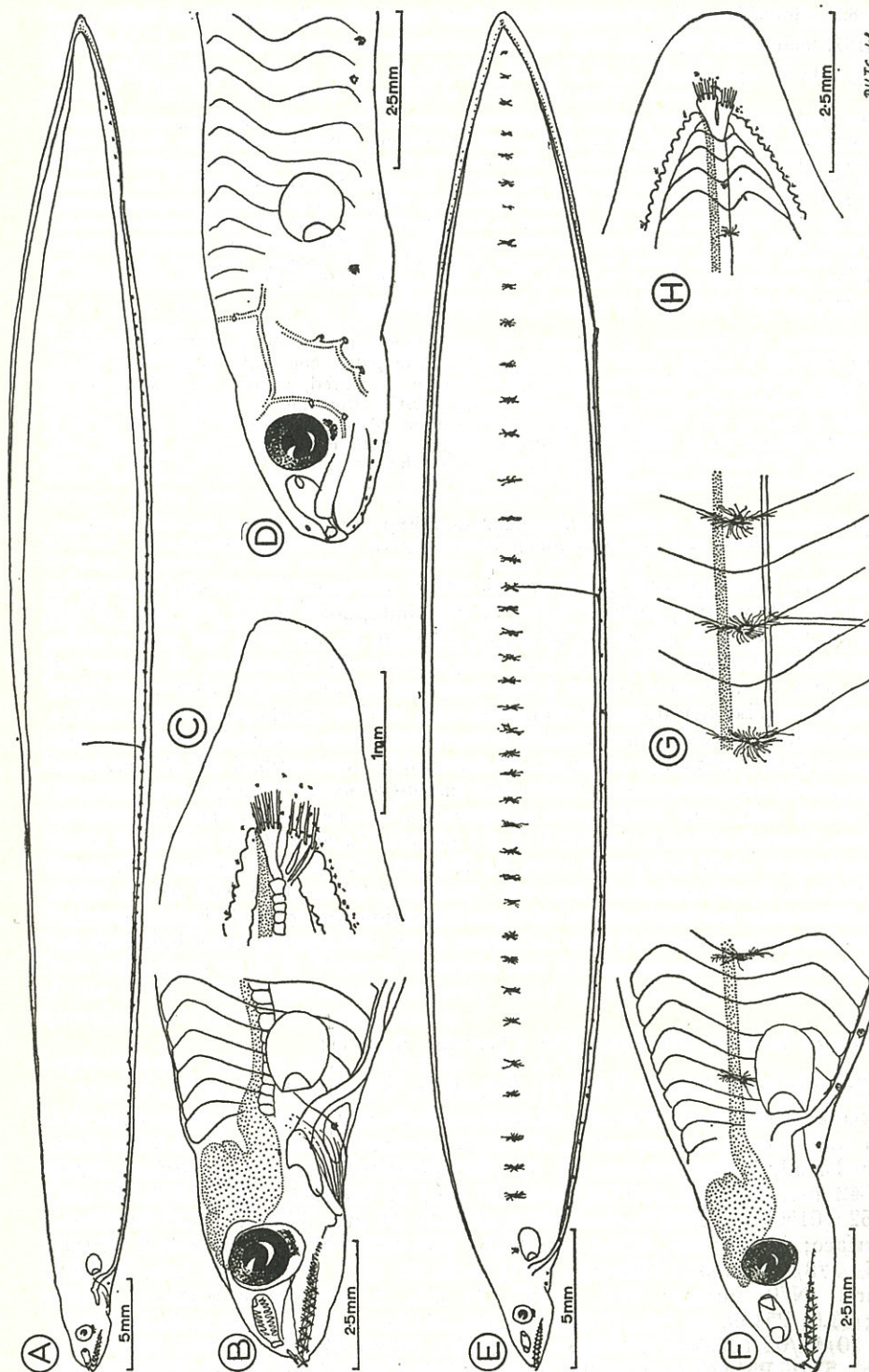
**FOOD:** *C. verreauxi* feeds on a great variety of marine animals including fish, crustacea and cephalopods. The stomach of a specimen taken at Big Bay, South Westland, contained two scarlet parrot-fish, *Pseudolabrus miles* (Bl. and Schn.), a part of a blue-cod, *Paraperis colias* (Forster), part of a crayfish, *Jasus lalandii* and two octopus tentacles. On the west coast of the South Island and around Wellington *C. verreauxi* is known to enter crayfish pots to feed on captured crayfish, as well as to attack crayfish in rocky crevices.

#### *Leptocephalus Conger verreauxi*

**MATERIAL EXAMINED:** *Centre d'Océanographie de l'Institut Français d'Océanie Collection* (5 specimens): 24.1mm total length, IFO Station S.5, 13° 30' S, 162° 00' E, 10/6/62, MWT5, H, ca. 70m; 32.8, St S.3, 18° 10' S, 162° 00' E, 8/6/62, MWT5, H, ca. 95m; 75.2, St 56-5-3, 15° 45' S, 166° 27' E, 31/10/56 (2248hrs), S $\frac{1}{2}$ mO, ca. 150m; 130.5, St 57-6-5, 23° 29' S, 166° 11' E, 11/10/57, S $\frac{1}{2}$ mO, ca. 100m, sample 10; 139.0, St S 1m 1, 10 miles west of Bulari Pass, New Caledonia, 30/10/61, 1.0m plankton net, H, ca. 67m, sample 1.

*C.S.I.R.O. Division of Fisheries and Oceanography (Cronulla) Collection* (1 specimen): 107.5, Warreen Station 105/39, 41° 17' S, 148° 26' E, 10/4/39, N100, H, surface, 30mins.

**DESCRIPTION:** Six specimens: total lengths 24.1mm-139.0mm, myomeres 160-165, dorsal rays 286-317, anal rays 190-261, last vertical blood vessel at myomere 52-56, anterior margin of gall bladder at about myomere 55. Description made from the Warreen Station 105/39 specimen (measurements in mm): total length 107.5, head 6.6, snout 2.0, eye 1.4, cleft of mouth 3.0, postorbital 3.6, pectoral 2.0, snout-vent 85.5, predorsal 58.3, depth just before eye 3.0, at pectoral origin 4.0, at midpoint between pectoral and vent 8.0,



TEXT-FIG. 9.—Figs. A-C, *L. Conger wilsoni*, 74.0mm total length, IFO Station S.4; Fig. A, lateral view; Fig. B, lateral view of head; Fig. C, tip of caudal region. Fig. D, glass-eel of *Conger cinereus* (Ruppell, 1828), 85.7mm total length, DFO (Cronulla) Collection, Kieta, Bougainville Island, Solomon Islands. Figs. E-H, *L. Conger cinereus* lateralis Whitley, 1935, 60.2mm total length, Warreen Station 36/48 (Cronulla); Fig. E, lateral view; Fig. F, lateral view of head; Fig. G, lateral view at about myomere 54; Fig. H, tip of caudal region.



at vent 8.3. Branchiostegal and pectoral rays hard to distinguish, dorsal rays before level of vent 197, total dorsal rays 336, anal rays 263, caudal rays 6 + 5. Teeth  $\frac{1 + VI + 16}{1 + VI + 10}$ . Myomeres 107 + 57 = 164. a-d = 36. Last vertical blood vessel at myomere 54.

Body moderately elongate, much compressed except along head, shallow, its maximum depth near level of vent about 13 in total length, reducing much more rapidly behind vent. Head short, about 16 in total, relatively distinct from trunk; snout very blunt, short, 3.3 in head, its dorsal profile convex; nostrils separated, the anterior one a short tube directed forwards and with a complete rim, the posterior one with a simple raised rim and placed just in front of eye; eye oval, its greatest diameter vertical, but the horizontal diameter 1.4 in snout; cleft of mouth slightly oblique, extending to below posterior margin of pupil; teeth very acute, in three series in the upper jaw and in the lower. Pectoral short, equal to snout in length; dorsal fin relatively well-developed with clearly observable fin-rays; anal similar; caudal with well-developed hypurals and rays.

Pigmentation in formalin as follows:—a small crescentic patch of brownish pigment above the iris and a larger, more conspicuous crescentic patch below the pupil; two small, somatic chromatophores behind the branchial aperture; a paired, ventral, somatic series of rounded chromatophores following the course of the intestine from the 8th segment to the vent, at intervals of one or two segments; this series continues above the base of the anal fin as a rather widely spaced series along the caudal region; a stellate chromatophore on the base of every third or fourth anal ray; a scattering of chromatophores over the base of the caudal fin; chorioid pigment present.

Vertical blood vessels to the viscera numerous, beginning at about the 5th myomere with a barely visible vessel, then continuing irregularly to the 54th myomere.

REMARKS: The leptocephali described above are typical of *Conger* larvae in having a paired, ventral, somatic series of chromatophores along the level of the intestine to the vent, a crescentic patch of pigment on the oval eye and a series of chromatophores above the anal fin. They agree well in number of myomeres, 160–165, with *C. verreauxi* which is the only species of *Conger* with more than 160 vertebrae. The hypurals are elongated and similar in shape to those of the adult, although in the specimen described the caudal rays differ slightly in number from the number normally observed in the adult. Leptocephali of *C. verreauxi* differ essentially from those of *C. wilsoni* in having a greater number of myomeres, in conformity with the difference in myomeres of the adults, i.e. 160–165 in *C. verreauxi* compared with 141–151 in *C. wilsoni*. Larvae of *C. verreauxi* reach a greater length when full-grown than do those of *C. wilsoni* (140mm compared with 100mm). Spawning of *C. verreauxi* probably takes place well to the north of New Caledonia on the evidence of the distribution and size of the leptocephali although this is a remarkably great distance from the geographical limits of the essentially southern *C. verreauxi*.

#### L. *Scalanago lateralis* Whitley, 1935 (Text-fig. 9, E-H)

1935. *Scalanago lateralis* WHITLEY, *Rec. Aust. Mus.*, 19 (4): 218, fig. 2.

MATERIAL EXAMINED: *Western Australian Museum Collection (13 specimens)*: 20.9mm total length, Accession No. P5298, *Lancelin*, 34 miles west of West End, Rottnest Island, Western Australia, 3/7/62 (0030–0100hrs), N70, surface; 38.9, P5282, 42 mls, 21/6/62 (0300hrs), larval net, 37 metres; 39.7, P5538, 45 mls, 10/10/62 (0150hrs), N70, surface; 41.8, P5299, 34 mls, 3/7/62 (0030–0100hrs), N70, surface; 43.2, P5536, 45 mls, 10/10/62 (0010hrs), N70, surface; 44.2, P5180, 49 mls, 1/8/61 (0500–0530hrs), N70, surface; 46.1, P5242, 19 mls, 4/4/62 (0230hrs), N70, surface; 53.0, P5297, 34 mls, 3/7/62 (0300–0100hrs), N70, surface; 53.0, P5159, 50 mls, 11/9/61 (2345–2415hrs), N70, surface; 56.3, P5540, 44 mls, 10/10/62 (0230hrs), N70, surface; 56.7, P5535, 22 mls, 20/9/62 (0215hrs), ln, 37m; 57.0, P5171, 30 mls, 25/10/61 (2250–2320hrs), ln, 27m; 57.5, P5548, 30 mls, 24/10/62 (0320hrs), ln, 110m.

*C.S.I.R.O. Division of Fisheries and Oceanography (Cronulla) Collection (3 specimens)*: 48.2, *Warreen Station 37/48*, 28° 48' S, 113° 36' E, 2/9/48, N70, H, surface, 15mins; 55.2, 60.2, *St 36/48*, 28° 48' S, 113° 47' E, 1/9/48, N70, H, surface, 15mins. All three specimens from Western Australia.

DESCRIPTION: 16 specimens: total lengths 20.9mm–60.2mm, myomeres 112–119, dorsal rays 121–149, anal rays 198–240, a-d = 35–37, last vertical blood vessel at myomere 52–56, anterior margin of gall bladder at myomere 16–18. Description made from the largest specimen which is probably full-grown, *Warreen Station 36/48* (measurements in mm): standard length 59.3, head 4.2, snout 1.9, eye 0.9, cleft of mouth 2.3, postorbital 2.1, pectoral 1.6, snout-vent 45.8, predorsal 24.1, depth before eye 1.9, at pectoral origin 3.2, at midpoint between pectoral and vent 7.8, at vent 7.4. Dorsal rays 233, dorsal rays before level of vent 148, anal rays 144, caudal rays 4 + 3. Teeth  $\frac{1 + VI + 7}{1 + VIII + 5}$ . Myomeres 76 + 38 = 114. a-d = 36. Last vertical blood vessel at myomere 54, anterior margin of gall bladder at myomere 18.

Body moderately elongate, compressed, deep, the maximum depth 7.0 in total, reducing evenly in front of, and behind, midpoint of body. Head relatively long, 12.0 in total, not greatly differentiated from trunk; snout acute, about 3.0 in head, its dorsal profile slightly convex; both nostrils well separated, the anterior nostril carried on the end of a short tube; eye oval, 2.0 in snout; cleft of mouth slightly oblique, extending to below posterior margin of pupil; teeth moderately acute. Pectoral long, a little longer than snout, elongate-oval; dorsal and anal fins well-developed with clearly defined fin-rays, the dorsal origin well in advance of the level of the vent; caudal relatively pointed.

Pigmentation in formalin or alcohol consisting of a paired, regular, ventral series of rounded, somatic chromatophores following the course of the gut from the pectoral every two or three segments to the vent; a crescentic patch of pigment below the iris; rather more widely spaced chromatophores along the base of the dorsal than the more closely set series on the anal base, with a scattering of pigment on the caudal base; a midlateral series of large, constantly dendritic chromatophores (none rounded in any specimen seen) from the pectoral to the tip of the caudal region, spaced at every two or three segments anterior to the level of the vent but more widely spaced posteriorly, each chromatophore with many fine, thread-like branches radiating from a compact centre.

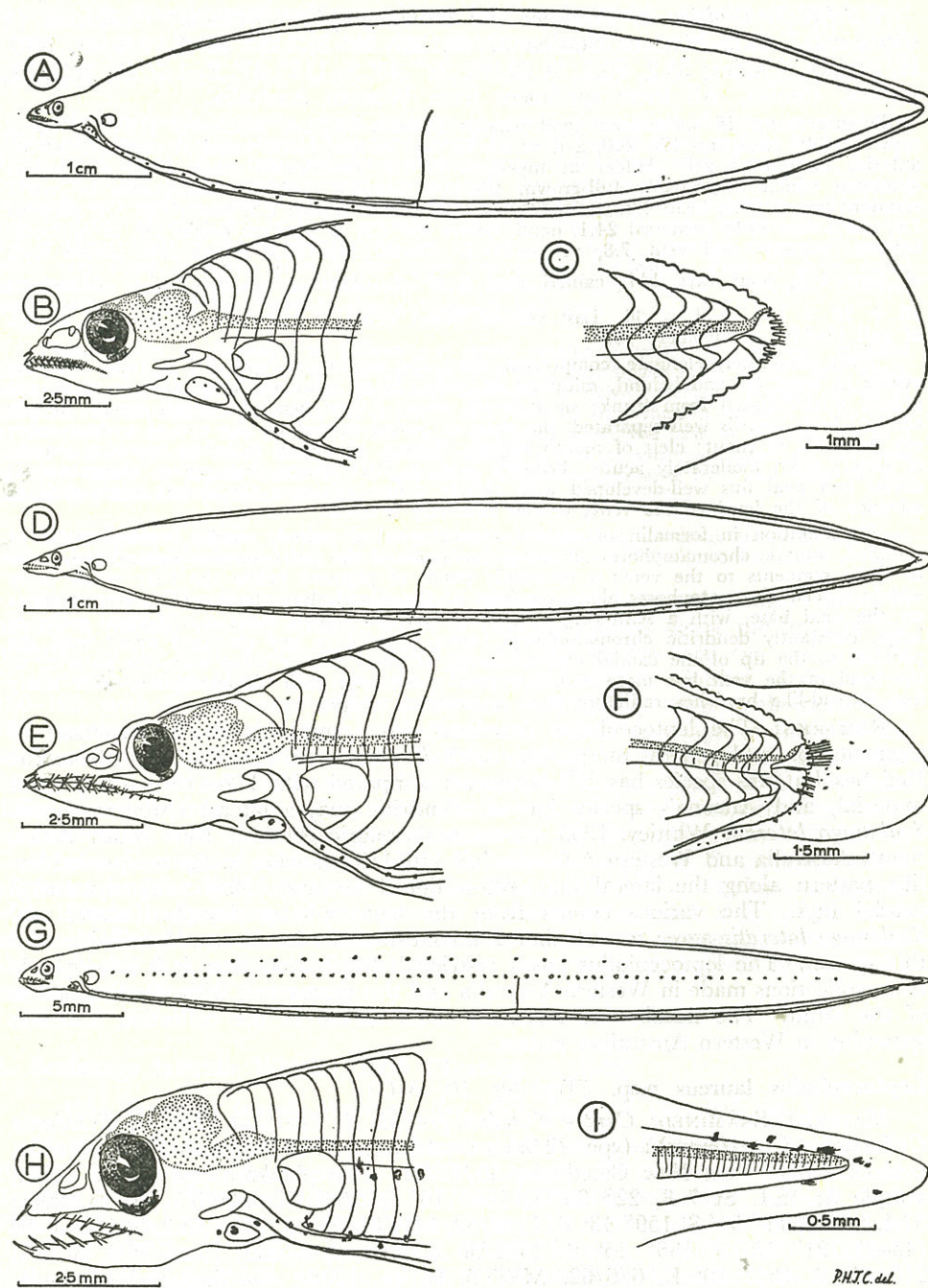
REMARKS: The leptocephalus described above agrees in the arrangement of pigmentation and general morphology with *L. congroides* Ancona, 1928, from the Red Sea but this species has 169 myomeres compared with 112–119 of the present material, and Ancona's species has no dendritic major lateral chromatophores. *Scalanago lateralis* Whitley, 1935, an unusual congrid eel from New South Wales, South Australia and Western Australia has 116–119 branches to the unique ladder-like pattern along the lateral line, 180+ dorsal fin-rays, 150+ anal rays and 8 caudal rays. The various counts from the leptocephalus described above and *Scalanago lateralis* agree so well that I am satisfied the larvae are identifiable with this species. The leptocephalus has a restricted distribution since it is known only from collections made in Western Australia and this agrees well with the distribution of the adult. The number of relatively small larvae in the collection indicates spawning in Western Australian waters.

#### *Leptocephalus laureus* n.sp. (Text-fig. 10, A-C)

MATERIAL EXAMINED: *Centre d'Océanographie de l'Institut Français d'Océanie Collection (6 specimens)*: type, 72.9mm total length, IFO Station S 1m 6, 10 miles west of Bulari Pass, New Caledonia, 30/11/61, 1.0m plankton net, H, ca. 120m, sample 6; 46.1, St 7–8, 22° 35' S, 166° 16' E, 26/7/62, MWT5, H, ca. 20m; 57.4, St S.6, 11° 51' S, 159° 13' E, 11/6/62, MWT5, H, ca. 95m; 63.2, St P58–1–10 (45–2), 21° 10' S, 166° 45' E, 20/1/58 (0045hrs), S $\frac{1}{2}$ mH, 50m; 75.9, St S.1, 21° 45' S, 165° 10' E, 6/6/62, MWT5, H, ca. 120m; one damaged specimen, St LL 61–1–1, 20° 30' S, 163° 23' E, 8/3/61, stomach of lancet fish, *Alepisaurus ferax*.

DESCRIPTION: Six specimens: total lengths 46.1mm–75.9mm, myomeres 104–111, dorsal rays 133–174, anal rays 92–139, a-d = 13–14, last vertical blood vessel at myomere 34–40, anterior margin of gall bladder at myomere 22–24. Description made from the type, an almost full-grown specimen IFO Station S 1m 6 (measurements in mm): standard length 72.2, head 5.9, snout 2.0, eye 1.0, cleft of mouth 2.3, postorbital 3.0, pectoral 1.3, snout-





TEXT-FIG. 10.—Figs. A-C, *Leptocephalus laureus* n. sp., type, 72.9mm total length, IFO Station S 1m 6: Fig. A, lateral view; Fig. B, lateral view of head; Fig. C, tip of caudal region. Figs. D-F, *Leptocephalus stenorhynchus* n. sp., type, 66.8mm total length, IFO Station S.5: Fig. D, lateral view; Fig. E, lateral view of head; Fig. F, tip of caudal region. Figs. G-I, *Leptocephalus trilineatus* n. sp., type, 44.0mm total length, IFO Station 7-6: Fig. G, lateral view; Fig. H, lateral view of head; Fig. I, tip of caudal region.

vent 59.5, predorsal 51.0, depth before eye 2.4, at pectoral origin 4.8, at midpoint between pectoral and vent 16.4, at vent 10.8. Dorsal rays 174, dorsal rays before level of vent 85, anal rays 139, caudal rays 6 + 4. Teeth  $\frac{1 + 1 + IX + 13}{1 + XI + 5}$  Myomeres 74 + 33 = 107. a-d = 14. Last vertical blood vessel at myomere 38, anterior margin of gall bladder at myomere 24.

Body elongate-oval, much compressed, very deep, the maximum depth 4.1 in total, reducing equally in front of, and behind, the midpoint of the body. Head relatively long, about 12.0 in total, clearly differentiated from trunk; snout bluntish, 3.5 in head, its dorsal profile convex; anterior nostril tubular and directed forwards, well separated from the posterior nostril which is placed just in front of eye; eye oval, 2.0 in snout; cleft of mouth slightly oblique and reaching below middle of pupil; teeth moderately acute. Pectoral oval, equal to snout; dorsal and anal fins well-developed, especially posteriorly; caudal rounded.

Pigmentation consisting of a paired, ventral series of about 12 somatic chromatophores from the level of the pectoral to the level of the last vertical blood vessel which is placed halfway along gut; a line of five spots on the throat; a crescentic patch of pigment below the iris; a few spots on the bases of some anal rays. (*L. laureus* = relating to the laurel, in reference to the laurel-leaf shape of the body.)

REMARKS: The ventral series of pigment spots and the crescentic patch of pigment below the eye suggests that this leptocephalus belongs with the Congrinae, but I cannot further identify the species. Considering that the larvae of the shallow water genera *Gnathophis* and *Conger* are known and that the myomeres are very low in number for a congrid eel, precluding the identification of the species with such long-tailed forms with elongated hypurals as *Uroconger* and *Promyllantor*, I can suggest only that *L. laureus* may belong to an unknown deep-water congrid. The number of myomeres is lower than that recorded for any known congrid eel.

#### *Leptocephalus stenorhynchus* n.sp. (Text-fig. 10, D-F)

MATERIAL EXAMINED: *Centre d'Océanographie de l'Institut Français d'Océanie Collection (8 specimens)*: 23.3mm total length, 47.3, 66.8 (type), 76.0, IFO Station S.5, 13° 30' S, 162° 05' E, 10/6/62, MWT5, H, ca. 95m; 34.5, St 7-2, 22° 35' S, 166° 16' E, 17/7/62, MWT5, H, ca. 70m; 41.0, 45.1, St S.6, 11° 51' S, 159° 13' E, 11/6/62, MWT5, H, ca. 95m; 55.9, St 7-8, 22° 35' S, 166° 16' E, 26/7/62, MWT5, H, ca. 20m.

DESCRIPTION: Eight specimens: total lengths 23.3mm-76.0mm, myomeres 134-152, dorsal rays 167-185, anal rays usually poorly developed, a-d = 43-46, last vertical blood vessel at myomere 47-51, anterior margin of gall bladder at myomere 26-28. Description made from the type, a 66.8mm specimen, IFO Station S.5 (measurements in mm): standard length 65.5, head 4.6, snout 2.0, eye 0.8, cleft of mouth 2.7, postorbital 2.4, pectoral 1.0, snout-vent 63.0, predorsal 50.4, depth before eye 1.6, at pectoral origin 3.1, at midpoint between pectoral and vent 8.6, at vent 2.8. Dorsal rays 175, dorsal rays before level of vent 148, only terminal anal rays developed, caudal rays 4 + 3. Teeth  $\frac{1 + 1 + IV + 8}{1 + V + 5}$ .

Myomeres 130 + 12 = 142. a-d = 45. Last vertical blood vessel at myomere 49, anterior margin of gall bladder at myomere 28.

Body elongate, but not excessively so, compressed, deep, the maximum depth about 7.0 in total length. Head relatively long, about 13.0 in total, distinct from trunk; snout acute, long, 2.5 in head, its dorsal profile slightly concave, never convex; nostrils set closely together immediately in front of eye; eye oval, its horizontal diameter 2.5 in snout; cleft of mouth slightly oblique, relatively long, reaching to below posterior margin of eyeball; teeth acute. Pectoral oval, 1.5 in snout; dorsal weakly developed; anal fin very short; caudal rounded.

Pigmentation in the form of a paired, ventral series of up to 70 compact, somatic chromatophores from below the pectoral origin every segment (anteriorly) or every 3-4 segments (posteriorly) to the vent; a line of five spots on the throat; a crescentic patch of pigment below the iris and a minute patch above the eyeball; scattered spots on the bases of the anal rays and over the base of the caudal. (*Gk. stenos* = narrow, *rhynchos* = snout,

REMARKS: The most characteristic feature of this species is the elongate, acute in reference to the narrow, beak-like snout.) snout which is not found in other congrid leptocephali. The ventral series of chromatophores and crescentic patch below the eye shows that this species belongs



in the Congrinae but again I have no suggestions to make as to the identity of the adult. The broad hypurals and moderate number of vertebrae indicate that the adult would probably not possess a long tail as found in *Uroconger*, *Promyllantor* and other similar genera.

*Leptocephalus trilineatus* n.sp. (Text-fig. 10, G-H)

MATERIAL EXAMINED: *Centre d'Océanographie de l'Institut Français d'Océanie Collection* (2 specimens): type, 44.0mm total length, IFO Station 7-6, 22° 35' S, 166° 16' E, 26/7/62, MWT5, H, ca. 50m; 122.6, St LL 57-5-4, 21° 33' S, 166° 31' E, 11/9/57, stomach of lancet fish, *Alepisaurus ferox*.

C.S.I.R.O. *Division of Fisheries and Oceanography (Cronulla) Collection* (2 specimens): 21.9, Warreen Station 26/40, 32° 34' S, 152° 55' E, 20/4/40, N100, O, 0-200m; 29.3, St 200/39, 30° 19' S, 153° 33' E, 16/7/39, N100, O, 200m.

DESCRIPTION: Four specimens: total lengths 21.9mm-122.6mm, myomeres 186-199, last vertical blood vessel at myomere 57-59. Description made from the type, a 44.0mm specimen, IFO Station 7-6 (measurements in mm): standard length 43.8, head 2.9, snout 1.0, eye 0.7, cleft of mouth 1.1, postorbital 1.1, pectoral 1.2, snout-vent 42.1, predorsal 33.5, depth before eye 1.6, at pectoral 2.1, at midpoint between pectoral and vent 4.1, at vent 0.7. Fin-rays not developed. Teeth  $\frac{1+0+VII}{1+IV}$ . Myomeres 163 + 36 = 199. Last vertical blood vessel at myomere 59.

Body elongate, compressed, depth 10.0 in total. Head relatively long, 14.0 in total, not conspicuously differentiated from trunk; snout short, 3.5 in head, its dorsal profile slightly convex; nostrils not yet differentiated but the olfactory organ set in the middle of snout; eye oval, 2.0 in postorbital or 1.3 in snout; cleft of mouth oblique, reaching to below middle of pupil, teeth acute. Pectoral fin round to oval, 1.5 in snout, median fins inconspicuous.

Pigmentation consisting of a paired ventral series of rather diffuse somatic chromatophores from the pectoral region to the vent; about three pigment spots on the throat; a minute patch of pigment above the eyeball and a crescentic patch below it; a regular series of large, diffuse chromatophores following the midlateral level from the pectoral to the tip of the caudal region, spaced at about every two to three segments; an irregular line of diffuse chromatophores above and below this midlateral line; a scattering of larger chromatophores on the caudal tip. (*L. tres* = three, *linea* = a line, in reference to the three lines of chromatophores on the lateral surface.)

REMARKS: This larva is immediately distinguishable from all other congrid leptocephali in having three longitudinal lateral rows of chromatophores. It also has a high number of myomeres for congrid larvae as well as a narrow caudal (although the three specimens described are clearly not full-grown) which would probably possess elongated, narrow hypurals. This suggests that the adult would be a long-tailed congrid but further identification is at present not possible.

*Leptocephalus geminus* n.sp.

MATERIAL EXAMINED: *Centre d'Océanographie de l'Institut Français d'Océanie Collection* (5 specimens): type, 40.9mm total length, IFO Station D1b, 20° 56' S, 163° 46' E, 11/5/60 (2033hrs), S $\frac{1}{2}$ mO, 0-300m; 115.3, St LL 61-1-2, 20° 50' S, 163° 38' E, 8/3/61, stomach of lancet fish, *Alepisaurus ferox*; 64.9, St S 1m B, 10 miles west of Bulari Pass, New Caledonia, 28/11/61, 1.0m plankton net, H, ca. 90m, sample 5; 69.2, St MWT B, 10 miles west of Bulari Pass, New Caledonia, 28/11/61, MWT3, H, ca. 67m, sample 4; 29.0, St S.5, 13° 30' S, 162° 05' E, 10/6/62, MWT5, H, ca. 95m.

C.S.I.R.O. *Division of Fisheries and Oceanography (Cronulla) Collection* (1 specimen): 29.2, Warreen Station 16/38, 33° 40' 20" S, 151° 27' 30" E, 2/9/38, N200H, 25m, 30mins.

DESCRIPTION: Six specimens: 29.0mm-115.3mm total lengths, myomeres 160-174, last vertical blood vessel at myomere 49-56, anterior margin of gall bladder at myomere 35-36. Description from the type, a 40.9mm specimen, IFO Station D1b (measurements in mm): head 3.3, snout 1.4, eye 0.8, cleft of mouth 1.6, postorbital 1.6, pectoral 1.2, snout-vent 39.8, predorsal ca. 29.3, depth before eye 1.9, at pectoral origin 2.3, at midpoint between pectoral and vent 5.3, at vent 1.1. Dorsal rays 224, other rays not developed. Teeth  $\frac{1+1+I+8}{1+I+6}$ . Myomeres ca. 136 + 31 = ca. 167. a-d = ca. 48. Last vertical blood vessel at myomere 52. Anterior margin of gall bladder at myomere 35.

Body moderately elongate, much compressed, a little deeper behind the midpoint where the depth is 7.7 in total length and from here tapering gradually towards snout, more rapidly towards caudal tip, the latter turned downwards; vent subterminal in this specimen; pigmentation mainly as a paired series of chromatophores along the level of intestine and three longitudinal rows of chromatophores on the lateral surface.

Head short, 12 in total, not clearly differentiated from trunk; snout short, 2.4 in head, its dorsal profile concave, the nasal organ conspicuous but the nostrils as yet undeveloped; eye oval, 1.6 in snout; cleft of mouth oblique, extending to below middle of pupil. Teeth acute but generally short; the first on each jaw a forwardly-directed needle-like fang, that of the upper jaw placed on anterodorsal aspect of snout; the second of upper jaw very small, less acute, flatly triangular in section with the apex lateral; the third tooth much larger but similar in shape to the second; the remaining eight teeth similar, small, gradually increasing in size towards angle of mouth; those of the lower jaw decreasing slightly in size from the second to the last but generally larger than those of upper jaw. Pectoral a large, fleshy flap, 1.5 times longer than eye; dorsal fin with faint but nevertheless countable basal structures, originating well in advance of vent.

Pigmentation as follows:—a narrow, crescentic patch of pigment above iris and a larger, more conspicuous but also more diffuse patch below iris; three round, compact chromatophores in a line on the lateral aspect of throat; a paired, ventral series of rather diffuse, rounded, somatic chromatophores from below pectoral base along level of intestine as far as vent, a little fewer than one per segment; a series of more diffuse somatic chromatophores slightly below middle angle of myomeres from the 5th segment to the tip of caudal region, spaced at about one chromatophore per 2-4 segments (but rather irregularly spaced); a second longitudinal, lateral series of diffuse, somatic chromatophores between this midlateral row and the dorsal flexure of the myomeres, much more infrequently placed than those of the midlateral row; a similar but still more infrequently spaced row of chromatophores along the ventral flexure of the myomeres; pigment in the chorioid. (*L. geminus* = a twin, in reference to the close similarity of this species to *Leptocephalus trilineatus*.)

REMARKS: The group of specimens described here is clearly very similar to the previous species in pigmentation, that is, in the possession of three longitudinal rows of chromatophores on the lateral surface of the body. Other pigmentation is typical of the larvae of various congrid eels (the ventral series along the level of the intestine and the presence of iris pigment). The present specimens, however, have fewer myomeres (160-174) than the previous species and the last vertical blood vessel is placed a little further forwards (at myomere 49-56 compared with myomere 59 in the previous species). I am satisfied that these specimens represent a distinct species, especially in view of similar distinctions between the leptocephali of say, *Ariosoma scheelei* and *A. mauritianum*. There are two species to which *L. geminus* may possibly be referred, if only on the basis of myomere counts and the structure of the caudal. These are *Pseudoxenomystax bulbiceps* (Whitley, 1948) known from Tasmania to the Chatham Islands in deep water and *P. hirsutus* Castle, 1960, known from Kaikoura and Cook Strait, New Zealand (see Castle, 1960, pp. 465 and 467). Both of these species have about 160 vertebrae and a relatively narrow tail the hypurals of which are elongated and support about eight caudal rays, similar to the condition in *L. geminus*. Dorsal rays in these two species are between 300 and 350 in number, an appreciably higher number than in the largest specimen of *L. geminus*. However, in this specimen the dorsal rays are poorly developed and would clearly be more numerous in the metamorphosed eel. In a single, very large specimen of *L. geminus* from the northeast Indian Ocean which I have examined, the dorsal fin-rays have reached their full number (indicated by the abrupt origin of the dorsal fin) of about 260 but unfortunately in



this specimen the tail tip is missing and a correct count cannot be made. Nevertheless, I would estimate that there would be a full complement of not less than 300 fin-rays in the undamaged larva and consequently I would tentatively suggest *L. geminus* to be the young of one of the above species of *Pseudoxenomystax*. If this were the case then a second species of this genus, as represented by *L. trilineatus* with more numerous myomeres is also suggested.

**Leptocephalus mediopunctatus** n.sp. (Text-fig. 11, A-C)

**MATERIAL EXAMINED:** *Centre d'Océanographie de l'Institut Français d'Océanie Collection* (3 specimens): type, 73.0mm total length, IFO Station 57-4-3, 20° 50' S, 166° 50' E, 31/7/57 (0045hrs), S $\frac{1}{2}$ mH, ca. 50m; damaged specimen, St 56-4-3b, 18° 07' S, 168° 22' E, 18/5/56 (2310hrs), S $\frac{1}{2}$ mH, ca. 90m; ca. 118 (damaged), St LL 59-1-3, 22° 45' S, 162° 44' E, 30/1/59, stomach of lancet fish, *Alepisaurus ferox*.

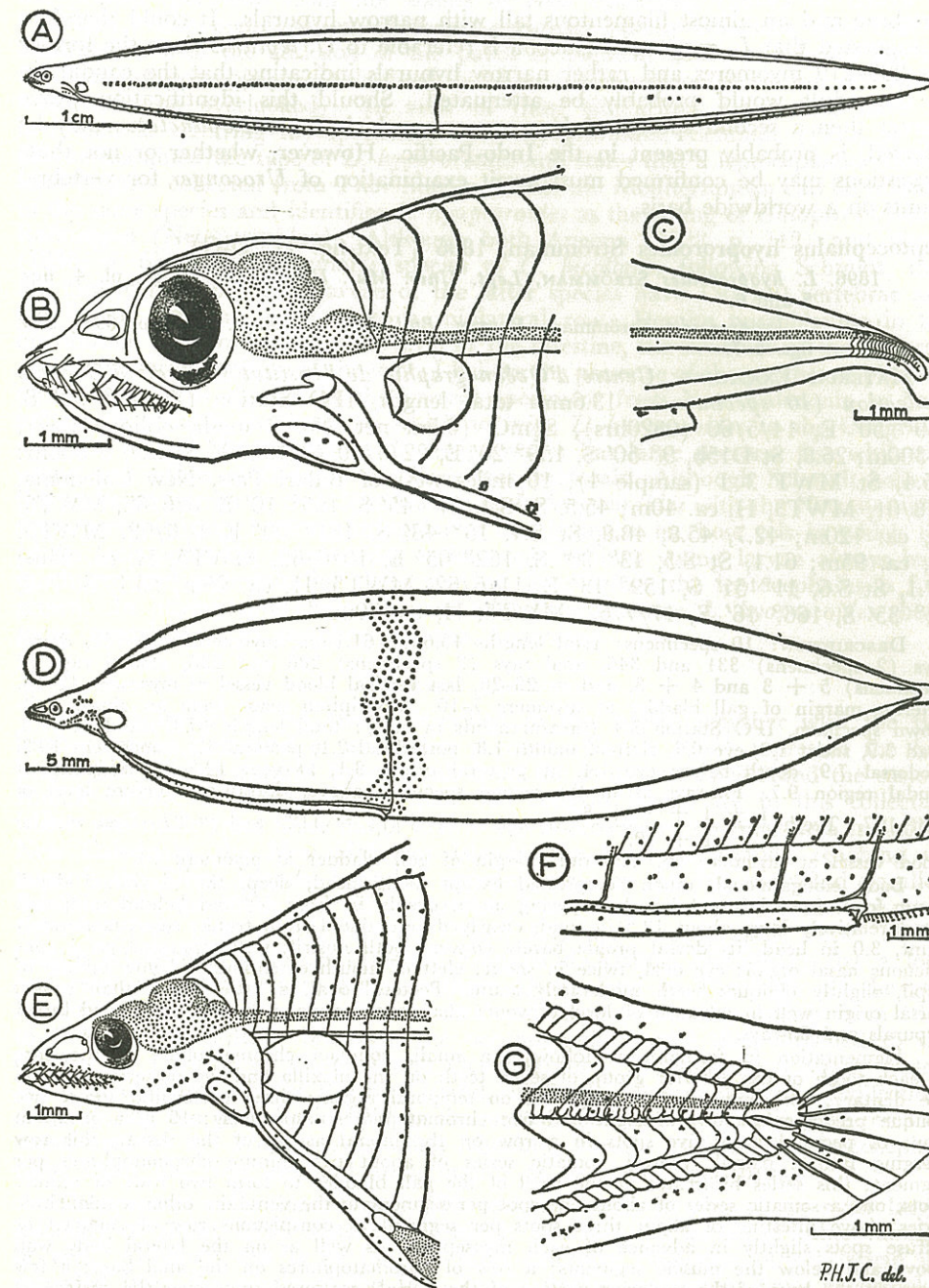
**DESCRIPTION:** From the type, a 73.0mm specimen (measurements in mm): standard length 72.7, head 4.1, snout 1.2, eye 0.9, cleft of mouth 1.9, postorbital 2.0, pectoral 1.0, snout-vent 70.2, predorsal 27.1, depth before eye 1.9, at pectoral origin 3.2, at midpoint between pectoral and vent 8.2, at vent 1.6. Fin-rays not developed. Teeth  $\frac{1 + 1 + III + 8}{1 + IV + 5}$ . Myomeres 189 + 54 = 239. a-d = 142. Last vertical blood vessel at myomere 62. Anterior margin of gall bladder at myomere 60.

Body relatively elongate, much compressed, its maximum depth 8.9 in total length; vent subterminal in this specimen; pigmentation inconspicuous, restricted mainly to a line of small, somatic chromatophores on the midlateral line and another along the level of the intestine from the pectoral to the vent.

Head short, about 18 in total, not conspicuously differentiated from trunk; snout blunt, 3.4 in head, its dorsal profile convex and the nasal organ well developed; eye oval, 1.3 in snout; cleft of mouth oblique, reaching to below middle of pupil; teeth moderately acute, conspicuous. Pectoral round, relatively short, about equal to eye; dorsal origin well in advance of level of vent at the level of the 47th myomere; rays of dorsal and anal fins not well enough developed to be counted but probably about 300; caudal fin weak with the hypurals and rays undifferentiated.

Pigmentation consisting of a curved, narrow patch above iris and a larger, more readily noticeable crescentic patch below iris on its posteroventral corner; a line of five, small, compact spots on the lateral wall of the throat, lateral to the heart; a paired ventral series of small, somatic chromatophores spaced at about one per segment at the level of the intestine from the 6th myomere to the vent (although these spots are much less frequent near the vent); a midlateral series of small, diffuse or compact, somatic chromatophores, about one per segment, from the 8th segment to about the level of vent; three minute spots slightly in advance of the caudal tip; chorioid pigment present. (*L. medius* = the middle, *punctum*, = a point, in reference to the longitudinal row of chromatophores along the middle of the body.)

**REMARKS:** The present species bears close resemblances to the leptocephali of *Conger conger* (L.) and *C. cinereus* Rüppell in having a midlateral line of chromatophores, one per segment, as well as an intestinal series and a patch of pigment below the iris (these last two also being typical characters of members of the Congrinae). However, the number of myomeres in the present species is much greater than in any known species of *Conger* (the highest being that found in *C. verreauxi* Kaup, 165-172). I find only one species of *Leptocephalus* which approaches the present material in number of myomeres, pigmentation and other characters; this is *L. magnaghii* Ancona, 1928, from the Red Sea, having 209-219 myomeres and lateral chromatophores spaced at every two segments. While I do not place great emphasis on the latter difference, I am satisfied that the difference in number of myomeres between the present specimens (the two other New Caledonia larvae have about 235 myomeres) and *L. magnaghii* is great enough to indicate a second species. With regard to the identity of the adult of *L. mediopunctatus*, only one congrid eel is recorded to have more than 200 vertebrae; this is *Uroconger lepturus* (Richardson, 1844), an elongated congrid eel which is known from Japan to South Africa and which has recently been redescribed by Asano (1962, pp. 114-117, fig. 49). This species has 203-204



TEXT-FIG. 11.—Figs. A-C, *Leptocephalus mediopunctatus* n.sp., type, 73.0mm total length, IFO Station 57-4-3: Fig. A, lateral view; Fig. B, lateral view of head; Fig. C, tip of caudal region. Figs. D-G, *L. hyoprорoides* Strömman, 1896, 48.8mm total length, IFO Station S.4: Fig. D, lateral view; Fig. E, lateral view of head; Fig. F, lateral view of posterior portion of intestine to show kidney and pigmentation; Fig. G, tip of caudal region.



vertebrae and an almost filamentous tail with narrow hypurals. It could therefore be suggested that *L. magnaghi* Ancona is referable to *U. lepturus* since the former has 209–219 myomeres and rather narrow hypurals indicating that the caudal tip in the adult would probably be attenuated. Should this identification prove correct then a second species of *Uroconger*, to which *L. mediopunctatus* may be referred, is probably present in the Indo-Pacific. However, whether or not these suggestions may be confirmed must await examination of *Uroconger* for vertebral counts on a worldwide basis.

**Leptocephalus hyoprroides** Strömman, 1896 (Text-fig. 11, D-G)

1896. *L. hyoprroides* STRÖMMAN, *Lept. Univ. Mus. Upsala*, pp. 39–41, pl. 4, figs. 5 and 6.

1936. *L. hyoprroides* Strömman. BERTIN, *Bull. Inst. océanogr. Monaco*, 694: 5–6, figs. 5–7.

MATERIAL EXAMINED: *Centre d'Océanographie de l'Institut Français d'Océanie Collection (10 specimens)*: 13.6mm total length, IFO Station D5, 18° 32' S, 159° 50' E, 14/5/60 (0820hrs), S $\frac{1}{2}$ mO (0.5m net, No. 2 mesh, oblique tow), 0–300m; 26.8, St D15b, 9° 50' S, 159° 20' E, 22/5/60 (0219hrs), S $\frac{1}{2}$ mO, 0–300m; 55.4, St MWT 3 I (sample 4), 10 miles west of Bulari Pass, New Caledonia, 1/8/61, MWT3, H, ca. 40m; 45.5, St S.1, 21° 45' S, 165° 10' E, 6/6/62, MWT5, H, ca. 120m; 42.7, 45.8, 48.8, St S.4, 15° 48' S, 161° 00' E, 9/6/62, MWT5, H, ca. 95m; 61.1, St S.5, 13° 30' S, 162° 05' E, 10/6/62, MWT5, H, ca. 95m; 37.1, St S.6, 11° 51' S, 159° 13' E, 11/6/62, MWT5, H, ca. 95m; 55.1, St 7–2, 22° 35' S, 166° 16' E, 17/7/62, MWT5, H, ca. 70m.

DESCRIPTION: 10 specimens: total lengths 13.6mm–61.1mm, myomeres 110–122, dorsal rays (2 specimens) 331 and 346, anal rays (2 specimens) 286 and 236, caudal rays (2 specimens) 5 + 3 and 4 + 3, a–d = 23–28, last vertical blood vessel at myomere 42–48, anterior margin of gall bladder at myomere 7–10. Description made from an almost full-grown specimen, IFO Station S.4 (measurements in mm): total length 48.8, standard 47.8, head 3.9, snout 1.3, eye 0.6, cleft of mouth 1.8, postorbital 2.1, pectoral 1.5, snout-vent 19.2, predorsal 7.9, depth before eye 1.4, at pectoral origin 3.1, at vent 12.2, at midpoint of caudal region 9.7. Fin-rays as in the second specimen above, dorsal rays before level of vent 107. Teeth  $\frac{1+1+V+8}{1+10}$  Myomeres 41 + 71 = 112. a–d = 27. Last vertical

blood vessel at myomere 46. Anterior margin of gall bladder at myomere 10.

Body elongate-oval, much compressed except along head, deep, the maximum depth about four times in total length, tapering about evenly in front of, and behind midpoint. Head relatively long, about 12.5 in total, clearly differentiated from trunk; snout moderately blunt, 3.0 in head, its dorsal profile barely convex; both nostrils well separated on a conspicuous nasal organ; eye oval, twice in snout; cleft of mouth extending to below middle of pupil, slightly oblique; teeth moderately acute. Pectoral oval, a little longer than snout; dorsal origin well in advance of level of vent; anal long; caudal with well developed broad hypurals and fin-rays.

Pigmentation in formalin as follows:—a small, compact chromatophore at the base of each tooth of the anterior group of seven teeth on the maxilla and the posterior nine on the dentary; six compact chromatophores on temporal region; three postorbital spots; two oblique preopercular rows of eight and five chromatophores respectively; 10 in a group in front of pectoral base; five spots in a row on the lateral aspect of the throat, this row merging into a paired, ventral, somatic series of about two minute chromatophores per segment; this series bifurcates at the level of the gall bladder to form two rows of minute spots, one a somatic series of about one spot per segment to the vent, the other a splanchnic series above intestine of about three spots per segment; a conspicuous row of compact or diffuse spots slightly in advance of each myoseptum, as well as on the lateral body wall above and below the muscle segments; a row of chromatophores on the anal base; a few spots on the base of the posterior portion of the dorsal; scattered spots over the surface of the caudal; a small, crescentic patch of pigment below the posteroventral corner of the iris; a minute patch above the anterodorsal corner of the iris; pigment in the chorioid.

REMARKS: The ten specimens of the distinctive leptocephalus described above show remarkably close resemblances to the single specimen of *L. hyoprroides* described by Strömman (1896, p. 39) from southwest of Bermuda. In his redescription of Strömman's type specimen, Bertin (1936, p. 5) gives a myomere count of 38 + 76 = 114 and these figures are within the range of myomeres in

the present specimens from the waters of New Caledonia (38–45 + 65–79 = 110–120). The pigmentation of these specimens exactly coincides with that of Strömman's with the addition of the patch of pigment above and below the iris (a character not apparently observed by either Strömman or Bertin but one which may easily be overlooked). In view of these similarities I therefore have no hesitation in referring my specimens to *L. hyoprroides*. Schmidt (1913, p. 55) also re-examined the type of *L. hyoprroides* and states that a leptocephalid (58mm total length) collected from Thor Station 156 in the Mediterranean can be referred to the same species and identifies *L. hyoprroides* as the young of *Chlopsis bicollaris* Rafinesque (Nettastomidae). Although both Ancona (1928, p. 112) and Bertin (1936, p. 6) refer Strömman's species to *C. bicollaris*, following Schmidt, they are clearly in error, since larvae of the latter species have 130–140 vertebrae and the lateral pigment restricted to a midlateral row. Despite resemblances in the distribution of pigment along the level of the intestine, the structure of the hypurals and the anterior position of the vent, I believe the presence of the patches of pigment above and below the iris in the present specimens from New Caledonia to be a sufficiently reliable character by which to refer *L. hyoprroides* to the Congridae and not to the Nettastomidae. *L. hyoprroides* has large pectoral fins while the young and adults of *Chlopsis bicollaris* lack pectorals. Although Schmidt believes this to be no barrier to the identification of *L. hyoprroides* with the Nettastomidae since pectorals may be lost during larval development, in those eels in which the adults lack pectorals (muraenids, various ophichthids) young larvae always have much reduced pectorals but these are lost long before the leptocephalus is full-grown. In having splanchnic pigment above the intestine *L. hyoprroides* shows some resemblance to members of the Anagoinae.

#### GENERAL DISCUSSION

The 15 species of eel larvae described in this paper, together with the two further species described in an earlier account (Castle, 1963) represent the first major assembly of congrid leptocephali from the southwest Pacific and the eastern Indian Ocean. Altogether more than 500 congrid larvae are in this collection which was made from three major areas: (a) a broadly rectangular area including New Caledonia, the New Hebrides Islands, the Solomon Islands, reaching up towards the Ellice Islands, bounded approximately by the 7th and 22nd parallels South and by the 158th and 172nd parallels East (collections in this area were made from 1956 to 1962 mainly by the *Orsom III*, the oceanographic vessel of the Centre d'Océanographie de l'Institut Français d'Océanie, Nouméa); (b) a long and relatively narrow area from southern Queensland to Tasmania off the east Australian coast over the continental shelf and slope (collections mainly from 1938 to 1942 by the F.R.V. *Warreen*, the oceanographic vessel then attached to the C.S.I.R.O., Division of Fisheries and Oceanography, Cronulla, New South Wales; (c) a smaller area west of Rottnest Island, off Perth, Western Australia (collections made during the period mid-1961 to the end of 1962 by the *Lancelin*, the research vessel used by the Western Australian Museum, Perth). A few other leptocephali came from the New Zealand area, mainly as beachcast specimens.

The present collection of over 500 congrid larvae is part of an even larger assembly of about 1,100 leptocephali which also includes larvae of other families of eels. Although this is by far the most extensive collection of eel larvae yet recorded from the whole of the Indo-Pacific smaller collections have nevertheless been examined. The most important of these (500 specimens) is recorded by Ancona (1928) from the Red Sea and includes about 50 congrid leptocephali belonging to eight species. The 1928–30 *Dana* collection from this area was large but the congrid larvae in the collection have not been examined. Other notable collections have been made from the Indo-Malayan archipelago (Strömman, 1896) and from off Ceylon (Gopinath, 1949).



In the initial sorting of the present collection of eel larvae the leptocephali described in this paper were separated from all other groups of larvae in having a pectoral fin at all stages of development, a caudal fin which is not reduced in length in full-grown specimens, the gut is not festooned or swollen at any point and pigment always occurs as a regular, ventral series of chromatophores. The myomeres are never extremely numerous, that is, they are never more than 250 and the body is never filamentous. This combination of characters is not found in other groups of leptocephali.

Many eel larvae with this combination of characters have been described and a few of these have been referred to the family Congridae on the basis of transitional, metamorphosing specimens which show characters of both the larva and the young congrid eel (e.g. *Conger conger*, *Ariosoma balearica* and *Gnathophis habenatus*). Indeed, the characters which identify leptocephali to the familial level are now in general well established so that there are no serious difficulties in the broad sorting of collections of eel larvae.

Within the family Congridae leptocephali fall quite readily into two major divisions. The first of these, subfamily Anagoinae Asano, 1962, is characterised by leptocephali which have essentially a round eye without iris pigment, a series of compact somatic chromatophores in a line on each myoseptum immediately below the midlateral line, ventral pigment as a series of chromatophores along the ventral midline and as a double series of splanchnic chromatophores along the kidney ducts to the vent, and a subterminal vent with the dorsal and anal fins confined to the extremity of the body until just before the onset of metamorphosis. One of the most well-known examples of this group is *L. Ariosoma balearica* (De Laroche) from the Central Atlantic and the Mediterranean. Five species described in the present paper are referred to the Anagoinae. The second division, subfamily Congrinae, has leptocephali which possess an oval eye with iris pigment, a paired series of somatic chromatophores along the ventral midline from the pectoral region to the vent or not as far, and the vent usually appreciably in advance of caudal tip. Typical representatives of this group are *L. Conger conger* (L.) and *L. Gnathophis habenatus* (Richardson).

Although one species in the present collection, *L. hyoproridae* Strömman, 1896, has at least one feature which is intermediate between those shown for leptocephali of the Anagoinae and the Congrinae, I am of the opinion that the difference between these two groups of leptocephali strongly and reliably support the distinctions shown mainly in osteological characters in Asano's recent separation of the two congrid subfamilies. As I propose to show, larval characters (and in particular, larval pigmentation), in the one major family of eels which I have as yet investigated (Congridae) are of considerable systematic value and should provide in the future, a useful adjunct to osteological characters in the separation of eel genera at least in this family. Whitley (1935, p. 216) has subdivided the Congridae into the two subfamilies Scalanagoinae, type genus *Scalanago* Whitley, 1935, and the Leptocephalinae. *Scalanago* (type species, *S. lateralis* Whitley, 1935) is unique amongst congrid eels in having the lateral line with numerous lateral branches, a preorbital bone with downward projections into the upper lip and a relatively long tail. In addition, its leptocephalus has the oval eye, iris pigment and ventral pigment typical of members of the Congrinae. I have no hesitation therefore in transferring *Scalanago* to the Congrinae (which replaces the Leptocephalinae because of Direction 87 of the International Commission on Zoological Nomenclature, February, 1958, recognising *Conger* Oken, 1817, as the genus for conger eels).

Below the subfamily level the leptocephali described above show clear distinctions mainly in body shape and pigmentation. Further subdivisions are based on such numerical characters as the number of myomeres, the relative position of the gall

bladder and of the vertical blood vessels and the number of fin-rays. These characters are of the type which commonly distinguish adult eel species (e.g., the species of *Conger* and *Gnathophis*). I therefore propose that the subdivisions of the congrid leptocephali described here, which are based mainly on amount and distribution of chromatophores, actually represent generic divisions. This agrees with my findings in the examination of larvae of other families of eels in the present collection. A disturbing feature of eels in general is that the limits of many genera of adults within a particular family have not always been clearly defined, due to the essential monotony of external characters. Generic differences as suggested above in the leptocephali may well contribute to the resolution of such confusion wherever it should arise.

Including the two species of *Gnathophis* already described (Castle, 1963) there are 17 species of congrids in the present collection, referred to 11 genera. As far as can be determined from the literature there are about eight genera and 16 species of congrid eels in the southwest Pacific and eastern Indian Ocean. These numbers are only approximate since many of the species, especially those described in earlier accounts, are in need of re-examination. In particular, the generic status of many of those of the *Ariosoma*-group and the *Bathycongrus*-complex of Ogilby has scarcely been critically examined. As a contrast, the congrid eels of the Japanese region have been carefully studied in detail by Asano (1962) and this author finds 10 genera and 14 species in the area, even though this area is small compared with that considered here. The more recent large collections of leptocephali from the eastern Indian Ocean by the Centre d'Océanographie de l'Institut Français d'Océanie which have been sorted but not included in this report contains possibly no more than one genus additional to those described here. It is therefore a strong possibility that the present collection represents a fairly complete picture of the number of congrid genera and species in the area of study, agreeing well with the position in the waters of Japan.

The congrid larvae in the collection range in size from about 5mm to about 300mm (although the majority are between 25mm and 200mm in length) and include a small number which are in stages of metamorphosis. The length of a full-grown congrid leptocephalus depends mainly on the species to which it belongs but in general those of the Anagoinae are much longer (reaching more than 300mm in *Ariosoma anago*) and deeper than those of the Congrinae (which reach 140mm in *Conger verreauxi*) but are more often less than 100mm. However, in at least one species (*Gnathophis habenatus*) evidence was previously given (Castle, 1963, p. 37) that an increase in length to beyond the "normal" maximum may occur if the stimulus to metamorphosis does not arise, whatever this stimulus may eventually prove to be.

Most collections in the three areas suggest that leptocephali of any particular species may remain for some time in the vicinity of the spawning area so that it is only the presence of very small larvae which can be taken as a reliable indication of the location of the spawning area. Small larvae of the various species indicate that there are two broad areas in the southwest Pacific in which spawning of these congrid eels may take place. The more northerly one lies between New Caledonia and the Solomon Islands over a depth of between 3,000m and 5,000m; the other lies off the New South Wales coast at about the latitude of Sydney over similar depths. At least *Gnathophis habenatus*, *G. incognitus* Castle, 1963, and *Ariosoma mauritianum* spawn in the latter area but the majority of the remainder probably spawn north of New Caledonia. The third spawning area indicated by the present collection is off Rottneest Island, Western Australia, again over relatively great depths of 3,000m–5,000m where spawning of *A. mauritianum* and *Scalanago lateralis* takes place. Spawning in most cases appears to occur in relatively shallow depths of about 50m–100m and dispersal of the young larvae does not clearly follow the prevailing surface currents. In one species at least (*Gnathophis*



*habenatus*) the larvae are found northwards to the New Caledonia region, a dispersal movement contrary to the south-flowing East Australian Current.

Most of the larvae were collected with plankton nets of up to 200cm in diameter in horizontal and oblique hauls, a larval fish net or by 3ft or 5ft Isaacs-Kidd midwater trawls. These latter nets proved to be admirable for collecting larger leptocephali. A few specimens from the New Caledonia region were found in the stomachs of skipjack, yellowfin tuna and lancet fish (*Katsuwonus pelamis* (L.), *Neothunnus macropterus* (Temm. and Schleg.), and *Alepisaurus ferox* Lowe, respectively) taken on troll lines and longlines in the off-shore waters of New Caledonia.

KEY TO THE ADULT CONGRID EELS OF NEW ZEALAND

- Body usually moderately elongate, without scales, tip of tail with a well-developed caudal fin, posterior nostril always in front of eye, pectoral present, branchial aperture usually semicircular, lateral, in front of pectoral base; tongue free; origin of dorsal always near level of pectoral; lips usually well-developed but upper sometimes reduced, lateral line conspicuous
- 1 (4) Upper lip turned upwards as a thick, fleshy flap; preorbital bone without ventral projections into upper lip; teeth on the jaws in one or two longitudinal rows, those of the outer row much larger and compressed to form a sharp cutting edge; dorsal fin originating near or behind level of pectoral tip ..... *Conger* Oken, 1817,
  - 2 (3) Body slender, seldom reaching more than 1,000mm; eye relatively large, 1.9-3.9 per cent of total; 36-41 pores before level of vent, 141-149 vertebrae; dorsal rays 298-330, branchiostegal rays 8-9; origin of dorsal seldom less than half the length of the pectoral behind pectoral tip ..... *C. wilsoni* (Bloch and Schneider, 1801), known from shallow waters of northern New Zealand, Southern Queensland to Tasmania and Western Australia.
  - 3 (2) Body usually robust and reaching 1,500mm or more; eye small, 1.2-1.9 per cent of total; 40-44 pores before level of vent, 157-165 vertebrae; dorsal rays 331-347, branchiostegal rays 10-11; origin of dorsal about the diameter of the pupil within level of pectoral tip ..... *C. verreauxi* Kaup, 1856, known in shallow waters from New Zealand to southeast Australia.
  - 4 (1) Upper lip thin, very weak; preorbital bone with ventral projections into upper lip; teeth cardiform on jaws; dorsal always originating in front of level of pectoral tip,
  - 5 (8) Dorsal origin over branchial aperture; anterior nostril a simple tube directed forwards; specimens of more than about 300mm with minute finger-like epidermal papillae; preorbital bone single with three ventral projections ..... *Pseudoxenomystax* Breder, 1927,
  - 6 (7) Dorsal rays 327-353, anal rays 240-258, pectoral rays 16, vertebrae about 160, reaching 500mm in length ..... *P. bulbiceps* (Whitley, 1948), known in 150-600 fathoms from Chatham Islands, New Zealand and Tasmania.

- 7 (6) Dorsal rays 306-314, anal rays 204-226, pectoral rays 14-15, vertebrae about 156, reaching 1,000mm in length ..... *P. hirsutus* Castle, 1960, known in about 450-600 fathoms from Kaitiaki, New Zealand.
- 8 (5) Dorsal origin about halfway along pectoral; anterior nostril tube-like with an indented or scroll-like rim, directed ventrally; no epidermal papillae except for a few on the head; preorbital bones two ..... *Gnathophis* Kaup, 1856,
- 9 (10) Vertebrae 120-127; anterior nostril with a scroll-like rim; small, triangular premaxillary-ethmoid patch of teeth not conspicuous outside the mouth from the ventral aspect known in shallow water from New Zealand, Lord Howe Island, New South Wales to Western Australia and possibly St Paul's Island, South Indian Ocean. *G. habenatus* (Richardson, 1848),
- 10 (9) Vertebrae 139-147; anterior nostril with an indented rim; round premaxillary-ethmoid patch of teeth extending conspicuously in advance of maxillary teeth ..... *G. incognitus* Castle, 1963, known in about 30 fathoms from New Zealand, the elvers from the Kermadec Islands.

KEY TO THE CONGRID LEPTOCEPHALI KNOWN FROM THE SOUTHWEST PACIFIC AND WESTERN AUSTRALIA

- Body elongate-oval to long but never filamentous, relatively deep, its maximum depth 4-10 times in total length, vent usually near caudal tip throughout major part of growth; caudal fin not reduced in length; pectoral fin present at all stages of development; intestine straight, not swollen or festooned at any point. Pigment always present ventrally and sometimes laterally as well as in the chorioid. Myomere range in each species seldom more than 20, but number in any species may be from 100 to 250
- 1 (10) Eye round; ventral pigment in the form of a series of small somatic chromatophores along the ventral midline from the throat to the level of the gall bladder; as a series of closely-set, round, compact splanchnic chromatophores along each kidney duct above the intestine from the gall bladder to the vent; an oblique series of minute, compact, elongated somatic chromatophores on each myoseptum immediately below the midlateral line; a series along the dorsal midline present or absent; scattered chromatophores on the bases of the anal rays and over the surface of the caudal; vent sub-terminal, the dorsal and anal fins confined to the extremity of the body until the onset of metamorphosis ..... Subfam. ANAGOINAE Asano, 1962,
  - 2 (7) No other lateral pigment present ..... *Ariosoma* Swainson, 1838,
  - 3 (4) Myomeres 110-119, last vertical blood vessel at about myomere 58, body reaching 160mm in length ..... *L. Ariosoma scheelei* (Strömman, 1896).
  - 4 (3) Myomeres greater than 120,



- 5 (6) Myomeres 134-153, last vertical blood vessel at about myomere 69, body reaching 278mm in length .....  
*L. Ariosoma mauritianum*  
 (Pappenheim, 1914)
- 6 (5) Myomeres 157-172, last vertical blood vessel at about myomere 80, body reaching 314mm in length .....  
*L. Ariosoma anago*  
 (Temm. and Schleg., 1842).
- 7 (2) Additional lateral pigment present,
- 8 (9) Additional lateral pigment as small, numerous chromatophores scattered over the whole of the lateral surface of the body, myomeres 138, last vertical blood vessel at about myomere 68 .....  
*L. ?Alloconger anagoides*  
 (Bleeker, 1864).
- 9 (8) Additional lateral pigment as an oblique line of minute, compact chromatophores on the second flexure of each myoseptum above the lateral line and on the end of the first flexure below the lateral line, myomeres 147-151, last vertical blood vessel at about myomere 92 .....  
*L. scalaris* n. sp.
- 10 (1) Eye oval; ventral pigment in the form of a paired series of small, somatic chromatophores at the level of the intestine from the throat to the vent or not as far; scattered chromatophores on the bases of the anal rays and over the surface of the caudal; usually a narrow, curved patch of pigment above iris and a larger crescentic patch below iris; vent usually somewhat in advance of the caudal tip; dorsal origin in advance of level of vent .....  
 Subfam. CONGRINAE,
- 11 (12) Body elongate-oval; vent at about midpoint of body; pigmentation on head in the form of a chromatophore at the base of each tooth, on the opercular, temporal and prepectoral regions; body pigmentation as a paired ventral, somatic series of chromatophores which bifurcates at level of gall bladder to form two rows, one a somatic ventral series to vent, the other a splanchnic series above intestine also to vent; a conspicuous row of widely-spaced chromatophores in advance of each myoseptum from dorsal to ventral margins of body wall; myomeres 110-122, last vertical blood vessel at myomere 42-48 .....  
*L. hyoproroides* Strömman, 1896.
- 12 (11) Body usually elongate but sometimes elongate-oval; vent usually some distance in advance of caudal tip; no pigment on lateral surface of head, although very small larvae sometimes have pigment spots on tips of jaws; ventral pigment only at level of intestine and always somatic; lateral pigment never scattered over whole lateral surface but sometimes in one to three longitudinal rows,
- 13 (32) Ventral pigment along whole length of intestine,
- 14 (31) Snout short and occasionally blunt, especially in those larvae which are approaching metamorphosis,

- 15 (24) Chromatophores present on lateral body wall,
- 16 (21) A single midlateral row of chromatophores from about level of pectoral to at least level of vent,
- 17 (20) Midlateral row of chromatophores compact, nondendritic,
- 18 (19) Midlateral row spaced at about one chromatophore per segment; myomeres greater than 200 .....  
*L. mediopunctatus* n. sp.
- 19 (18) Midlateral row spaced at least at intervals of 2-3 myomeres; myomeres 139-152 .....  
*L. Conger cinereus* Ruppell, 1828.
- 20 (17) Midlateral row of chromatophores large, constantly dendritic, placed at about every 2-3 myomeres; myomeres 112-119, last vertical blood vessel at myomere 52-56 .....  
*L. Scalanago lateralis* Whitley, 1933.
- 21 (16) Three longitudinal lateral rows, including a midlateral row of chromatophores, those of the upper and lower rows much less numerous,
- 22 (23) Myomeres 165-174, last vertical blood vessel at myomere 49-56 ..... possibly referable to *Pseudoxenomystax bulbiceps* (Whitley, 1948) or to *P. hirsutus* Castle, 1960.  
*L. geminus* n. sp.,
- 23 (22) Myomeres 186-199, last vertical blood vessel at myomere 57-59 ..... possibly also referable to *Pseudoxenomystax* Breder.  
*L. trilineatus* n. sp.,
- 24 (15) No lateral pigment (except on caudal tip in very small specimens of about 10mm-15mm),
- 25 (28) Chromatophores usually present on lateral body wall above anal fin as a continuation of the ventral series to the vent,
- 26 (27) Myomeres 141-151, last vertical blood vessel at myomere 52-56, body reaching 100mm in length .....  
*L. Conger wilsoni*  
 (Bl. and Schn., 1801).
- 27 (26) Myomeres 160-165, last vertical blood vessel at myomere 54-60, body reaching 140mm in length .....  
*L. Conger verreauxi* Kaup, 1856.
- 28 (25) Chromatophores absent from above anal fin .....  
*Gnathophis* Kaup, 1856,
- 29 (30) Myomeres 116-131, preanal about 100, last vertical blood vessel at about myomere 41 .....  
*L. Gnathophis habenatus*  
 (Richardson, 1848).
- 30 (29) Myomeres 134-150, preanal about 112, last vertical blood vessel at about myomere 46 .....  
*L. Gnathophis incognitus*  
 Castle, 1963.
- 31 (14) Snout long and beak-like, myomeres 134-152, last vertical blood vessel at about myomere 49 .....  
*L. stenorrhynchus* n. sp.
- 32 (13) Ventral chromatophores reaching only to halfway along intestine, myomeres 104-111, last vertical blood vessel at myomere 34-40 .....  
*L. scalaris* n.sp.



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