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Moringuid Leptocephali in Australasian Waters

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Abstract

EEL-LARVAE of the Moringuidae are about 65mm when full-grown, the intestine is looped at a single place just in advance of the vent, the pectoral and caudal fins are usually well-developed and pigmentation is simple, consisting of a large, dendritic chromatophore on the swelling of the intestine as well as on the midlateral line; myomeres range from 100-170. A collection of 17 specimens examined includes *L. Moringua macrochir* Bleeker, larvae of two other species of *Moringua* and a moringuid which is described as a new species of *Leptocephalus*. *L. diptychus* Eigenmann & Kennedy from the west Atlantic is clearly referable to *Moringua*, suggesting that *Stilbiscus* Jordan & Bollman is a synonym of this genus. Larval life of moringuids is possibly about five or six months.

INTRODUCTION

AMONGST the more conspicuously pigmented leptocephali in the large collection of eel-larvae assembled from the Australasian region and reported on in earlier accounts by the present author is a group which is characterised by having typically a series of about seven large, dendritic chromatophores placed along the midlateral line. The group is further unique among leptocephali in having the intestine looped dorsally (and swollen) in one position only, just in advance of the vent. Leptocephali with similar characters have been described twice before: *Leptocephalus diptychus* Eigenmann & Kennedy, 1900 from the western Central Atlantic (two specimens) and Larva VII Deraniyagala, 1934 from southern India (two specimens). The present material (15 specimens) contains three metamorphic larvae which clearly show the characteristic pigmentation of the larva as well as certain definitive features of the juvenile. On the basis of these specimens, this group of larvae (including *L. diptychus* and Larva VII Deraniyagala) are referred to the Family Moringuidae (and in particular the genus *Moringua* Gray, 1831) confirming the earlier suggestion of Nair (1960) with regard to the familial identity of Deraniyagala's species from Indian waters. The 15 larvae are further separated into three groups on differences in myomere counts, indicating three species. A further two specimens in hand are also referred to this family. They are clearly similar to leptocephali of *Moringua* in having the intestine looped in one position just before the vent but differ markedly in having midlateral pigment restricted to a single chromatophore placed halfway along the caudal region, rather than as a conspicuous series of large chromatophores. At the present time only *Moringua* is referred to the family

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although *Stilbiscus* Jordan & Bollman, 1889 is possibly also a valid moringuid genus (if it is not a synonym of *Moringua* itself). Since the latter two specimens strongly suggest by their pigmentation that they belong in a distinct genus from those of *Moringua-Stilbiscus* I take the course here of naming these as representative of a new species, with the hope that further collections for eels of this family may reveal the final adult identification.

Material examined in the preparation of this account was loaned by the following institutions:—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, Perth. I would again like to thank the authorities of these institutions for kindly placing material on loan.

SYSTEMATIC ACCOUNT

Examination of the four species of moringuid larvae in the present collection shows that leptocephali of the Family Moringuidae can now be characterised as follows:—

Leptocephali of moderate size when full-grown (reaching about 65mm) and not reducing greatly in length on metamorphosis; with a relatively deep body which is elongate-oval in shape; the snout is moderately pointed; the pectoral is present but reduced in size or lost in late metamorphosis; caudal well-developed; vent placed in the second third of the body; intestine narrow except close to the vent where it is swollen and forms a compact loop; level with this loop there is a swelling of the opisthonephros; teeth moderate in number, seldom more than a total of 14 in three series on each side of the jaws; anal origin some distance posterior to vent even in metamorphic larvae; dorsal origin usually slightly behind level of anal origin; pigmentation conspicuous, simple, consisting of a large, dendritic chromatophore dorsal or posterior to the single loop of the gut, as well as either a series of seven or eight equally-spaced, large, surface chromatophores along the midlateral line, those on the left side alternating in position with those on the right, or as a single chromatophore on the mid-lateral line halfway along the caudal region; myomeres numbering 100-170 within the family, but not more than about 12 in each species.

The association of leptocephali having these characters with the Family Moringuidae is here based upon features shown by three metamorphic larvae in the present collection. These larvae, belonging to two species, were collected with metamorphic larvae of other families of eels at Bougainville Island (Solomon Islands) and on the east coast of New Guinea during the C.S.I.R.O. *Fairwind* Expedition in October, 1949. The three specimens all show the single large chromatophore just before the vent as well as the seven chromatophores midlaterally, although these characteristic chromatophores tend to be obscured by the thicker opaque body in these metamorphic specimens. More significantly for their identification with *Moringua* they show the relatively long head, the lower jaw projecting in advance of the tip of the snout, the widely-spaced nostrils of which the anterior is not conspicuously tubular and the reduced pectoral, typical of *Moringua* (see Text-fig. 1, E). In all three the anal originates some distance behind the vent and shows no sign of further development between its origin and the vent. The dorsal originates from 3-15 segments behind the level of the anal origin. The number of preanal segments is more than double that of the postanal segments indicating a probable long preanal length in the juvenile and adult. Dorsal and anal rays are less than 150, suggesting relatively short dorsal and anal fins in the fully metamorphosed larva. These characters are completely consistent with those found in eels of the genus *Moringua*.

The difference in lateral pigmentation is indicative of the two broad divisions of the present material and as in the leptocephali of other families of eels, these divisions, based on pigmentation, probably indicate generic categories. One of these genera is recognisable as *Moringua* but the other has no known counterpart

in this family. In addition to pigmentation the two specimens which belong in the latter as the new species of *Leptocephalus* described here, show a dorsal origin 10-11 segments in advance of the level of the vent. There remains the possibility that this new species belongs elsewhere amongst the various families of eels but the pigmentation and the structure of the intestine (being looped in front of the vent) are so similar to that shown in leptocephali of *Moringua* that I find it difficult not to place it within the Moringuidae.

Vertebral counts from moringuids are unknown except for *Moringua raitaborua* Hamilton-Buchanan, 1822 (recorded by Günther (1870, p. 91) to have 130 vertebrae). Gosline & Strasburg (1956, p. 14, tab. 4) record the vertebral counts of 19 moringuids from Hawaii, the range being 118-130 (with the number greater in females than males). These authors apply the name *M. macrochir* Bleeker, 1855 to this material. Smith (1962, p. 463) refers all his extensive material from the Western Indian Ocean to *M. microchir* Bleeker, 1853, recognising great variation within this species. The basis of the variation noted by Smith is undoubtedly concerned with the degree of sexual maturity of moringuids and this problem is discussed in detail by Gosline & Strasburg (1956, pp. 10-15). I am confident that an examination of vertebral counts of moringuids from various parts of the Indo-Pacific will be a basis upon which to begin a much-needed revision of this family. Schultz (1953, pp. 87-89) records 15 species of *Moringua* from the tropical Indo-Pacific while Munro (1958, p. 130) lists seven species from the New Guinea area.

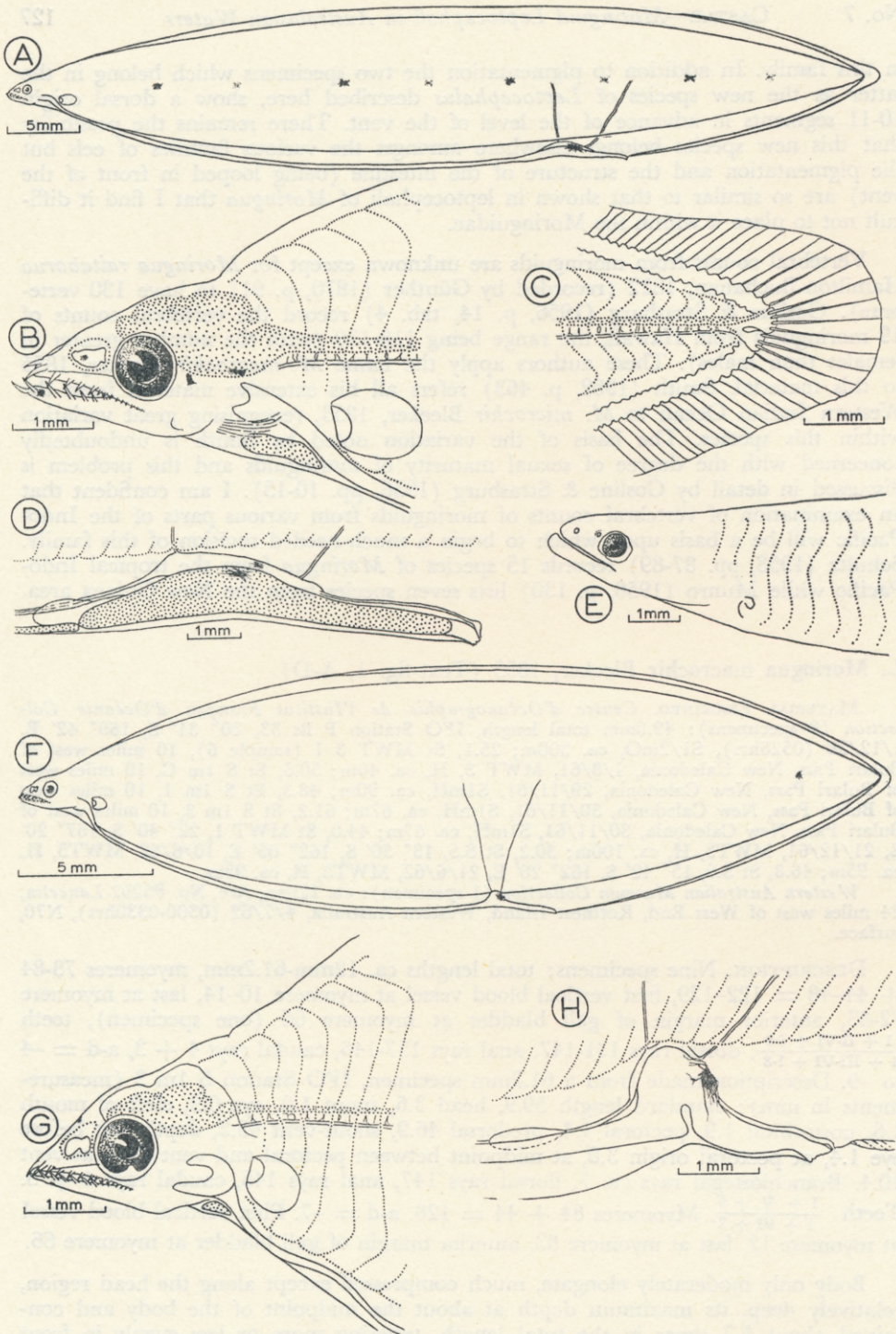
L. *Moringua macrochir* Bleeker, 1855 (Text-fig. 1, A-D).

MATERIAL EXAMINED. *Centre d'Océanographie de l'Institut Français d'Océanie Collection* (8 specimens): 49.8mm total length, IFO Station P Bs 33, 20° 31' S, 169° 42' E, 1/12/58 (0526hrs), S1/2mO, ca. 300m; 25.1, St MWT 3 I (sample 6), 10 miles west of Bulari Pass, New Caledonia, 1/8/61, MWT 3, H, ca. 40m; 50.6, St S 1m C, 10 miles west of Bulari Pass, New Caledonia, 29/11/61, S1mH, ca. 90m; 48.3, St S 1m 1, 10 miles west of Bulari Pass, New Caledonia, 30/11/61, S1mH, ca. 67m; 61.2, St S 1m 3, 10 miles west of Bulari Pass, New Caledonia, 30/11/61, S1mH, ca. 67m; 44.8, St MWT 1, 22° 40' S, 167° 20' E, 21/12/61, MWT3, H, ca. 100m; 30.2, St S.5, 13° 30' S, 162° 05' E, 10/6/62, MWT5, H, ca. 95m; 46.8, St S.9, 15° 42' S, 162° 20' E, 21/6/62, MWT5, H, ca. 95m.

Western Australian Museum Collection (1 specimen): ca. 12mm, Acc. No. P5292 *Lancelin*, 24 miles west of West End, Rottnest Island, Western Australia, 4/7/62 (0300-0330hrs), N70, surface.

DESCRIPTION. Nine specimens: total lengths ca. 12mm-61.2mm, myomeres 78-84 + 44-48 = 122-129, first vertical blood vessel at myomere 10-14, last at myomere 72-83, anterior margin of gall bladder at myomere 66 (one specimen), teeth $\frac{1 + \text{II-VI} + 6-9}{1 + \text{III-VI} + 1-3}$, dorsal rays 131-147, anal rays 137-146, caudal rays 4 + 3, a-d = -4 to -9. Description made from a 61.2mm specimen, IFO Station S 1m 3 (measurements in mm): standard length 59.9, head 3.6, snout 1.0, eye 0.9, cleft of mouth 1.6, postorbital 1.9, pectoral 1.4, predorsal 46.9, snout-vent 43.3, depth just before eye 1.4, at pectoral origin 3.0, at midpoint between pectoral and vent 10.8, at vent 10.4. Branchiostegal rays ca. 7, dorsal rays 147, anal rays 146, caudal rays 4 + 3. Teeth $\frac{1 + \text{V} + 9}{1 + \text{VI} + 2}$. Myomeres 84 + 44 = 128. a-d = -7. First vertical blood vessel at myomere 12, last at myomere 83, anterior margin of gall bladder at myomere 66.

Body only moderately elongate, much compressed except along the head region, relatively deep, its maximum depth at about the midpoint of the body and contained about 5.7 times in the total length, tapering more or less evenly in front of, and behind, this point. Head quite short, 17 in total, moderately well differentiated from trunk; snout short, 3.6 in head, conical; nasal organ conspicuous but with nostrils undifferentiated; eye subcircular, its horizontal diameter nearly equal to length of snout or about four times in head; cleft of mouth oblique, reaching



TEXT-FIG. 1.—Figs. A-D—*L. Moringua macrochir* Bleeker, 1855, 61.2mm total length, IFO Station S 1m 3. Fig. D—Lateral view at level of vent to show gall bladder, opisthonephros and pigmentation. Fig. E—*L. Moringua* sp. (109-115 myomeres), 47.8mm total length, C.S.I.R.O. Fairwind Collection, Kieta, Bougainville Island, Solomon Islands:—lateral view of head. Figs. F-H—*Leptocephalus tuberculatus* n.sp., type specimen, 32.7mm total length, Aust. Mus. regd. no. I.A. 2477, Manly Beach, N.S.W., 1907. Fig. F—lateral view; Fig. G—lateral view of head. Fig. H—lateral view at level of vent to show gall bladder, single loop of intestine and pigmentation.

only as far as below middle of pupil; teeth acute, in three clearly distinguishable series on each side of the jaws as follows:—a small, anteriorly-directed tooth on the anterior tip of the snout followed by a series of five rather large teeth and then by a line of nine very small teeth reaching as far as to below middle of pupil, the distribution and size in the lower jaw similar. Branchiostegal rays moderate in number, robust, and curving only moderately around opercular region. Pectoral fin very well developed but delicate, elongate-oval in shape, nearly equal to the cleft of mouth in length; dorsal fin rays and basal structures clearly distinguishable but the origin placed well back along the body, a few segments behind the level of the vent; anal similarly well developed, its origin a short distance behind level of vent; caudal fin long, fan-like, with strong fin-rays and hypurals.

Pigmentation conspicuous, occurring mainly as a series of large midlateral chromatophores with a large chromatophore on the dorsal aspect of the single intestinal swelling, in detail as follows:—a deep chromatophore in the olfactory organ; a rather superficial chromatophore just behind the eye, level with its horizontal diameter; a very deep, dendritic chromatophore level with the floor of the myelencephalon; a conspicuous chromatophore on the anterior tip of the lower jaw; one large, dendritic chromatophore immediately below the opisthonephros (above the intestine and posterior lobe of the liver) at the level of the 74th myomere; along the midlateral line of the left side four large, dendritic, subsurface chromatophores placed at the levels of myomeres 18, 43, 66 and 91; on the right side of the body a similar series placed at myomeres 28, 55, 77 and 108, that is, more or less alternating in position with those of the left side.

Intestine extremely thin until about myomere 70 where it begins to thicken out slightly; the major portion of the liver and opisthonephros lie at about this level continuing almost to the vent; the liver has an extremely long anterior lobe which reaches forwards to about segment 28. Gall bladder placed far back, almost at the level of the opisthonephros.

REMARKS. This is the most abundant species of *Moringua* in the present collection and in most features is intermediate between the two species described below. It has a range in number of myomeres which is included within the range shown by the 19 specimens of *M. macrochir* from Hawaii examined by Gosline & Strasburg (1956, tab. 4). These authors suggest that *M. bicolor* Kaup, 1856 and *M. macrocephala* (Bleeker, 1863) are synonyms of *M. macrochir*. These three species have been recorded from west New Guinea (Koumans, 1953, p. 196). *M. raitaborua* (Hamilton-Buchanan, 1822) has a vertebral count close to that of *M. macrochir*, i.e., 130 (Gunther, 1870, p. 91) but as this is a typically Indian species and as there may be some doubt as to Gunther's identification I prefer at this point to refer the present species to *M. macrochir*.

L. *Moringua* sp. (109-115 myomeres), Text-fig. 1, E.

1900. ?*L. diptychus* Eigenmann & Kennedy, *Science*, 2(12): 401.

1934. ?Larva VII Deraniyagala, *Ceylon J. Sci.*, B19(1): 95, fig. 9.

MATERIAL EXAMINED. *Centre d'Océanographie de l'Institut Français d'Océanie Collection* (1 specimen): 25.9mm total length, IFO Station 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): 47.8, *Fairwind*, Kieta, Bougainville Island, Solomon Islands, 21/10/49, submarine light and net.

DESCRIPTION AND REMARKS. Two specimens: myomeres 72-81 + 28-43 = 109-115, last vertical blood vessel at myomere 69, teeth 0 (in the larger, metamorphic specimen) and $\frac{1+III+4}{1+III+4}$, a-d = -3 to -6, dorsal rays 140, anal rays 129, caudal rays 3 + 2. Pigmentation essentially as a large, dendritic chromatophore on the

posterior swelling of the intestine and as seven midlateral, subsurface chromatophores, more or less equally spaced, four on the left side and three on the right.

These specimens agree remarkably well with the type and paratype of *L. diptychus* Eigenmann & Kennedy, 1900, from the western Central Atlantic. In the type the myomeres number $73 + 43 = 116$, the pectorals are small, the anterior nostril is on the tip of the snout but is not conspicuously tubular, the lower jaw projects beyond the upper, there is no pigment on the head and teeth are absent. The present species, and in particular the Bougainville metamorphic specimen, agrees so well with *L. diptychus* that normally I would have no hesitation in regarding them to be of the same species. However, I am not aware that the genus *Moringua*, to which *L. diptychus* is clearly referable, has been recorded from the Atlantic. The presence of leptocephali of the *L. diptychus* type in this area nevertheless strongly suggests that moringuid eels occur in the Atlantic. A possible answer is found in the known presence of eels which have been referred to the genus *Stilbiscus* Jordan & Bollman, 1889. The relationship of this genus (and its probable synonym *Anguillichthys* Mowbray, 1927) to the Moringuidae has been discussed by a number of authors including Trewavas (1932, p. 639) who synonymised Parr's family Stilbiscidae (1930, p. 14) with the Moringuidae, a now generally accepted view. Gosline & Strasburg (1956, p. 12) have also discussed the validity of *Anguillichthys* and *Stilbiscus* without a final decision on the matter. There are two alternatives presented by the occurrence of the moringuid leptocephali of the *L. diptychus* type in the western Atlantic: (1) that there is an as yet unrecorded species of *Moringua* in this area or, (2) that *Anguillichthys-Stilbiscus* is a synonym of *Moringua*. With regard to the latter possibility it may be of some value to note here that *L. diptychus* (clearly a *Moringua*) has 114-116 myomeres while the specimen of *Stilbiscus bahamensis* (Mowbray, 1927) examined by Trewavas (1932, pp. 642-645) had 112.

The two leptocephali from southern India described by Deraniyagala (1934, p. 95) as Larva VII are also unquestionably larvae of *Moringua* having the same general characters of the present group of species and of *L. diptychus*. Deraniyagala's specimens have 103 and 108 ($70 + 38$) myomeres and are therefore possibly referable to the present species although if this were true it would add greatly to the observed range in myomere counts in the present material.

L. Moringua sp. (160-169 myomeres).

MATERIAL EXAMINED. *Centre d'Océanographie de l'Institut Français d'Océanie Collection* (2 specimens): 38.9mm total length, IFO Station S 1m D, 10 miles west of Bulari Pass, New Caledonia, 29/11/61, S1mH, ca. 133m; 61.5, St S 1m 3, 10 miles west of Bulari Pass, New Caledonia, 30/11/61, S1mH, ca. 67m.

C.S.I.R.O. Division of Fisheries and Oceanography (Cronulla) Collection (2 specimens): 58.8, *Fairwind*, Kieta, Bougainville Island, Solomon Islands, 21/10/49, submarine light and net; 63.1, *Fairwind*, Wewak Harbour, New Guinea, 23/9/49, submarine light and net.

DESCRIPTION AND REMARKS. Four specimens: total lengths 38.9mm-61.5mm, myomeres $110-118 + 42-59 = 160-169$, last vertical blood vessel at myomere 112-119, gall bladder not seen, teeth 0 (in the New Guinea metamorphic specimens) and $\frac{1 + III-IV + 5-6}{1 + III-V + 3}$, dorsal rays 128-142, anal rays 128-140, caudal rays $3 + 2-3$, a-d = -12 to -15.

This species is immediately distinguished from the preceding two in having a much higher number of myomeres. The vent is placed at more than 100 segments along the body with the last vertical blood vessel also placed at about this point. There is also a relatively great distance between the levels of the dorsal and anal bases.

Leptocephalus tuberculatus n.sp., Text-fig. 1, F-H.

MATERIAL EXAMINED. *Australian Museum Collection* (2 specimens): 32.7mm total length (type) and 33.5mm (paratype), Aust. Mus. regd. no. IA. 2477, Manly Beach, N.S.W., 1907.

DESCRIPTION. Two specimens: myomeres 53-54 + 46-48 = 100-101, last vertical blood vessel at myomere 51-53, teeth $\frac{1+VI-VII+6-7}{1+V-VI+\frac{2}{3}}$, dorsal rays 180-182, anal rays 147-165, caudal rays ? 4 + 2, a-d = +10 to +11. Description made from the type specimen, 32.7mm total length (measurements in mm): head, 2.8, snout 0.9, eye 0.9, cleft of mouth 1.4, postorbital 1.0, pectoral 0.9, predorsal 11.0, snout-vent 20.1, depth just before eye 1.1, at pectoral origin 2.6, at midpoint between pectoral and vent 8.6, at vent 6.2. Dorsal rays 180, anal rays 147, caudal rays ?4 + 2. Teeth $\frac{1+VII+7}{1+VI+\frac{2}{3}}$. Myomeres 54 + 46 = 100. a-d = +11. Last vertical blood vessel at myomere 53, anterior margin of gall bladder at myomere 41.

Body elongate-oval, much compressed except along head, very deep, its greatest depth at the midpoint of the body and contained about 3.5 times in total length, tapering about equally anteriorly and posteriorly of this point. Head relatively long, nearly 12 in total, clearly differentiated from trunk; snout short, equal to eye length or just less than postorbital; nasal organ well differentiated with the two nostrils not quite separated; eye circular, its diameter a little less than postorbital; cleft of mouth oblique, reaching to below middle of eye; teeth relatively numerous, in three series on each side of upper and lower jaws, in detail as follows:—a minute anteriorly-directed tooth on the anterior tip of the snout followed by a series of seven larger teeth and then by seven much smaller teeth, this series ending below the middle of the eye; a similar pattern on the lower jaw although the posterior series has only three teeth. Pectoral fin relatively long, equal to the length of the eye; dorsal fin well differentiated with its origin about halfway between the levels of the pectoral and the vent; anal fin similar, caudal fin with clearly obvious rays but indistinct hypurals.

Pigmentation restricted entirely to a minute chromatophore on the dorsal surface of the snout above the nasal organ, a similar pigment spot at the base of the third tooth of the upper jaw, a small chromatophore below the tip of the lower jaw; at the level of the 48th myomere a large, dendritic chromatophore over the posterior face of the single upward loop of the intestine; an inconspicuous dendritic chromatophore on the lateral surface at the midlateral level between the 79th and 80th myomeres.

Intestine anteriorly very narrow but swelling out at about myomere 47 and looping upwards conspicuously at this point. Gall bladder posteriorly placed along the intestine, in front of the relatively large mass of the liver which extends in front of the vent. (*L. tuberculum* = a bump or swelling, in reference to the single swelling of the intestine near the vent).

REMARKS. The two features which immediately distinguish the present species from leptocephali of *Moringua* are the presence of only a single large chromatophore on the midlateral line and the anterior origin of the dorsal, between the levels of the pectoral and the vent. If larval moringuids are similar to larvae of other families in their generic differentiation according to conspicuous differences in pigmentation, I would confidently suggest that *L. tuberculatus* is representative of a genus distinct from *Moringua*. It has already been noted here that other genera have been placed in the Moringuidae, namely, *Stilbiscus* and *Anguilllichthys*, but that these are probable synonyms of *Moringua*. In the absence of a genus to which the present species might reasonably be referred I have taken the course of naming the two above specimens from Sydney as representatives of a new species of *Leptocephalus*.

DISCUSSION

The moringuid leptocephali described in this account were collected mainly by the Centre d'Océanographie de l'Institut Français d'Océanie, Nouméa, in the New Caledonia area from about 13°S to 23°S and between 162°E and 169°E. These collections were made during 1958-1962 from the *Orsom III* working depths from the surface to 300m with classical plankton nets and Isaacs-Kidd midwater trawls. Some other specimens, including the important metamorphic larvae from which the generic identification of these leptocephali has been made were collected by the C.S.I.R.O. Division of Fisheries and Oceanography in the New Guinea-Solomon Islands area during late 1949. A single very small larva was collected off Perth, Western Australia and the two specimens of *L. tuberculatus* in the collection of the Australian Museum were found beachcast at Sydney.

Except for the ca. 12mm specimen from Western Australia, the size range in the 17 specimens described is 25.1mm-61.5mm, although individuals of less than 40mm are few. This range occurs in the leptocephali collected not far from Bulari Pass, off Nouméa, New Caledonia and together with the observations that there appears to be little reduction in the length of body during metamorphosis and that there is no great movement of the vent forwards in metamorphosing larvae, is a basis for the suggestion that spawning of moringuids in this area takes place not far from the normal adult habitat. Although there are insufficient larvae in the present collection to place too much reliance on this point, sizes of larvae suggest a spawning in about April-May with rapid growth to a metamorphosis during October-December. Gosline & Strasburg (1956, p. 17) note that while spawning in Marshallese moringuids occurs during the summer and probably all the year round it apparently takes place only during winter in Hawaiian moringuids, as in the present material. Larval life of moringuids is therefore possibly quite short (about five or six months) and in this respect they differ markedly from the anguillids, although as Gosline & Strasburg point out the Moringuidae shows close similarities to the Anguillidae in osteology, in the changes taking place in external morphology at the onset of sexual maturity (giving rise to the taxonomic confusion in the group) and in the partial freshwater habit of these eels.

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