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STUDIES ON THE LEPTOCEPHALI OF  
BOMBAY WATERS

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BY

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### IV. Some Ophichthyid Leptocephali\*

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#### LEPTOCEPHALUS I

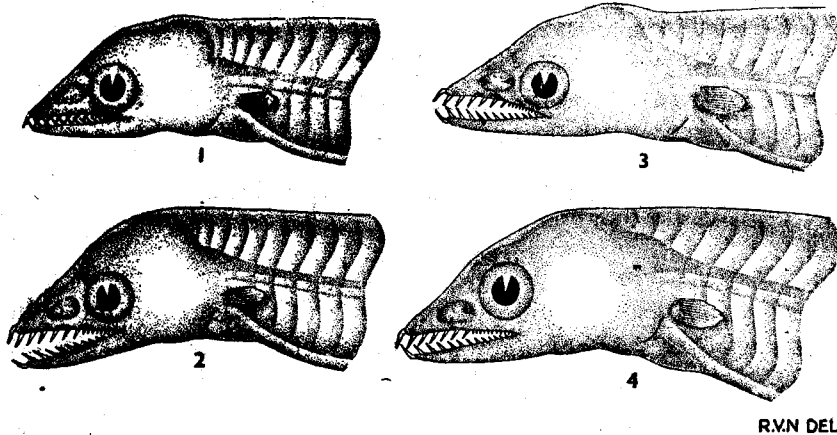
A NUMBER of specimens of this leptocephalus which belongs to the ophichthyid group were obtained from the 'dol' net catches at Versova (*vide* Introduction, Nair and Mohamed, 1960). Examination of these larvæ showed variations in the length and height in the different specimens belonging to the same stage of growth as noticed in *Muraenesox talabonoides*. The collection contains several larvæ in different stages of growth and 3 typical growing stages and the full-grown leptocephalus are described here.

*Stage A* (Text-Fig. 1).—The youngest growing larva is represented in the collection by 4 specimens of which the smallest measures 75 mm. The larva possesses an elongated and compressed body which tapers gradually towards the head and the tail. The height is more or less uniform in the middle portion of the body and the maximum height of 4 mm. is seen in the anal region. The height is 18·8 times in length.

The head is very small and measures 3 mm. and is contained 25 times in length. The nostrils have not differentiated in this stage. The eye is very large and conspicuous with a diameter of 0·8 mm. which is 3·8 times in head. The jaws are of about the same size and the gape of the mouth extends up to the posterior third of the eye. Both the jaws are provided with strong, pointed teeth which are directed forwards and the dental formula is  $1 + 6 + 8/1 + 12$ . Each half of the upper jaw is provided with a strong, curved grasping tooth followed by two groups of teeth. The 6 teeth comprising the first one are uniformly long while the remaining 8 teeth belonging to the second group are conical and short. The teeth of the first group are

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spaced wide apart while those of the second group are compactly arranged. In addition to the grasping tooth, 12 teeth are present in each half of the lower jaw and these are arranged equidistant from one another. The first tooth is the longest and the strongest while the succeeding ones become smaller backwards with the last one the shortest in the series.



TEXT-FIGS. 1-4. Head region of the growing stages of *Leptocephalus I*,  $\times ca. 8$ .



TEXT-FIGS. 5-6. Fig. 5. Head region of *Leptocephalus II*,  $\times ca. 6$ . Fig. 6. Head region of *Leptocephalus III*,  $\times ca. 8$ .

The alimentary canal is fairly long and extends up to about the middle of the larva with the anal opening below the 64th myotome. The preanal distance is 1.9 times in length. The alimentary canal shows 6 ganglion-like swellings situated more or less equidistant from one another and opposite the myotomes 11-15, 20-22, 30-31, 38-39, 47-49 and 54-55. Of these, the first two thickenings are large and prominent while the others become smaller backwards.

The pectoral fin is very small with faint indications of the rays. The dorsal fin, which is situated in the caudal region, is extremely short with the predorsal distance 1.1 times in length. The anal fin commences from about the middle of the larva and the rays are fairly distinct in both these fins. The

preanal distance is 1.9 times in length. The anal fin shows 186 rays while the dorsal fin shows variation in the fin ray count depending on the stage of growth of the larva. The tail fin is absent and the caudal portion ends in a pointed projection.

The pigmentation of the larva is very characteristic and is useful in its identification. The head pigmentation is very feeble and consists of 2-3 oblong black chromatophores near the margin of the upper jaw and 2-3 branching chromatophores in front of the heart and below the gill opening.

TABLE I  
*Measurements of Leptocephalus I*

	Stage A	Stage B	Stage C	Stage I
Total length ..	75.0	89.5	112.0	128.0
Maximum height ..	4.0 (5.3)	4.2 (4.7)	5.2 (4.6)	5.3 (4.1)
Predorsal distance ..	71.7 (95.6)	84.1 (94.0)	105.0 (93.8)	119.6 (93.4)
Preanal distance ..	40.0 (53.3)	46.8 (52.3)	60.0 (53.6)	69.2 (54.1)
Length of head ..	3.0 (4.0)	3.3 (3.7)	4.0 (3.6)	4.4 (3.4)
Length of snout ..	1.3 (43.3)	1.3 (39.4)	1.4 (35.0)	1.5 (34.1)
Diameter of eye ..	0.8 (26.7)	0.9 (27.3)	0.9 (22.5)	0.9 (20.5)
Total myotomes ..	146	144	144	146
Preanal myotomes ..	64	65	65	67

A row of pigment cells is present along the mid-lateral region just below the vertebral column. The chromatophores of this series begin from the 10th myotome and all the succeeding myotomes with a few exceptions here and there are provided with chromatophores. These pigment cells are unbranched and more or less circular in the anterior region while they are oval in shape in the middle region becoming thin and linear in the posterior region. Occasionally additional chromatophores have been observed to be present

on some of the myotomes of the caudal region. In addition to this normal pigmentation, six prominent postanal groups of black chromatophores are present internally below the vertebral column and opposite myotomes 71, 86, 98, 111, 121 and 134. The mid-lateral chromatophores of these myotomes are also conspicuously larger than the others in the series and the internal pigment groups together with the prominent mid-lateral pigment cells adjoining them give a conspicuous dotted appearance to the larva.

Another distinguishing feature of the pigmentation of the larva is the accumulation of a number of branching black chromatophores above the 6 ganglion-like thickenings of the alimentary canal and on the ventral side near the anal opening. These groups appear to the naked eye as short streaks along the ventral border of the larva. This characteristic pigmentation of the larva, namely, 7 short streaks along the preanal ventral side and 6 large spots along the postanal mid-lateral line, which are arranged more or less at regular intervals, is found to be highly useful for identification.

Some irregularly arranged branching chromatophores are clustered round the tip of the tail. The dorsal fin is unpigmented while a branched chromatophore is present at the base of each of the anal fin rays, excepting a few of the anteriormost rays.

*Stage B* (Text-Fig. 2).—This larva is slightly older than the previous stage and shows general increase in body proportions. The larva measures 89.5 mm. in length and 4.2 mm. in height which is 21.3 times in length.

The length of the head shows slight increase but not proportionate to that of the body. It measures 3.3 mm. which is 27.1 times in length. There is slight increase in the diameter of the eye and it is 3.7 times in head. The snout is 2.5 times in head and the differentiation of the nostrils is not seen in this stage also. The dentition remains unchanged except for the addition of one more tooth in each half of the upper jaw and the teeth formula is  $1 + 6 + 9/1 + 12$ .

The type specimen shows 144 myotomes and the anal opening is situated below the 65th muscle segment. There is no reduction in the predorsal and preanal distances and they continue to be 1.1 and 1.9 respectively in length.

The pectoral fin has become slightly larger in size.

A few changes in the general pigmentation of the larva have been noticed in this stage. Some more chromatophores have appeared in the head region above the oesophagus. The anterior mid-lateral chromatophores which were

circular in the previous stage have assumed an elongated and linear shape. In between the ventral preanal pigment groups other small and inconspicuous groups are occasionally present in this stage. The scattered pigment cells present at the tip of the tail have become localised in their distribution and are seen on the dorsal and ventral sides of the terminal portion of the tail.

*Stage C* (Text-Fig. 3).—This is the penultimate stage in the growth of the leptocephalus and it measures 112 mm. in length. Appreciable increase in the height of the larva is also observed and it is 5.2 mm. which is 21.5 times in length.

The head is moderately long and measures 4 mm. which is 28 times in length. A slight increase in the length of the snout is observed and it is 2.9 times in head. The proportion of the eye has also increased to 4.4 times in head. The nostrils have begun to differentiate in this stage and the anterior one is situated midway between the tip of the snout and the front edge of the eye while the posterior one is in front of the eye. Three more teeth have been added to each half of the upper jaw increasing their number to 19 including the grasping tooth and the dental formula is  $1 + 6 + 12/1 + 12$ .

The type larva shows 144 myotomes and no change in the position of the anus has been observed in this stage and it is below the 65th myotome. Similarly the predorsal and preanal distances also do not show any change in their proportions to length.

The pectoral and caudal fins have become slightly longer than in the previous stage.

There is no change in the colouration of the larva. However, the ventral preanal and the mid-lateral postanal groups of chromatophores have become more prominent in this stage. All the chromatophores of the mid-lateral series including the anterior ones and those situated at the bases of the anal fin rays have assumed an elongated shape.

*Stage I* (Text-Fig. 4 and Photograph 1).—The leptocephalus which represents the final stage in the growth of the larva is characterised by its very long and compressed body which gradually tapers towards the head and the tail. There is very little increase in the height of the larva when compared with the previous stage and it measures 5.3 mm. which is 24.2 times in length.

The head which measures 4.4 mm. in length is relatively small when compared with the body and it is 29.1 times in length. The eye does not show any increase in its diameter, however, its proportion in head has increased to 4.9 times. The snout has become slightly longer but continues to be 2.9 times in head. The nostrils have become clearly differentiated and

there is no change in their relative positions from the condition found in the previous stage. The teeth do not show any change in their number and arrangement and the dental formula of the leptocephalus is the same as that of the preceding stage.

The type specimen shows 146 myotomes with the anal opening below the 67th myotome. The proportion of the preanal distance in length is 1.8 which is slightly less than that of the previous stage while the predorsal distance continues to be 1.1 in length. The position of the vent is observed to be fairly constant in all the specimens, even though the number of myotomes varies from 144 to 147.

There is no change in the general pigmentation of the leptocephalus. The chromatophores on the head have become somewhat diffuse and a few more pigment cells have appeared in the heart region.

#### REMARKS

The four stages described above clearly show the changes undergone during the growth of the larva into the full-grown leptocephalus. There is considerable increase in the total length of the different stages while the height does not register proportionate increase and consequently shows decreasing percentage values as is evident from Table I. On the contrary, the predorsal and preanal distances show progressive increase which is proportionate to that of the length of the larva and on account of this uniform increase their percentage values are more or less constant in the 4 stages. It may be pointed out here, that in the growing phase of the leptocephalus of *Muraenesox talabonoides* (Nair and Mohamed, 1960) both these distances show marked decrease in the successive stages which is caused by the migration of the anus and the origin of the dorsal fin even before the larva reaches the full growth.

The head also grows longer in the different stages, but the growth is not proportionate to that of body and, therefore, a reduction is seen in the percentages. Similarly the snout also does not show proportionate increase in length to that of the head and consequently its percentage also decreases in the successive stages. The opposite condition is found in *M. talabonoides* where the snout shows considerable increase in the different growing stages. The diameter of the eye also does not show any increase in most of the stages and consequently its value decreases in the different stages due to the lengthening of the head. Another feature noticed during the growth of the larva is the addition of new teeth in the second group of the upper jaw; the total number increasing from 15 to 19 in each half while the lower jaw shows

only the same number of 13 teeth in all the stages. In *M. talaboroides* also an additional tooth is formed during the growing phase.

The vent of this larva does not show any significant change in its position in relation to the myotomes during growth and in this respect differs from the condition found in *M. talaboroides* where the anterior migration of the anus takes place even before reaching the full growth of the leptocephalus.

Among the ophichthyid leptocephali recorded so far from Indian waters, *Leptocephalus I* is interesting in showing the maximum length and minimum height as seen from Table II which gives the characters of all the Indian leptocephali of the family Ophichthyidæ. In spite of its unusual length, it shows only 146 myotomes with the vent below the 67th muscle segment. The only known ophichthyid leptocephalus showing a very similar condition is *Leptocephalus II* collected by Jones and Pantulu (1955) from the Travancore coast. This larva shows 141 myotomes with the vent below the 66th myotome. A close similarity is also noticed in the length of the head, predorsal and preanal distances and also in the size of the eye. The length of the snout of the Travancore larva given by the authors is only 0.53 mm. whereas in the description they state that the "snout is twice as long as the orbit" and the diameter of the latter is given as 0.78 mm. Obviously there is an error in the measurement of the snout given in the table and if it is twice the diameter of the eye, then the percentage of the snout length of this larva is found to be fairly close to that of the Bombay larva.

Even though there is general agreement in regard to myotome number and body proportions, it is seen that the height of the Travancore larva is nearly twice that of the Bombay larva. Difference is also noticed in the dentition of the two larvæ. Jones and Pantulu state that "in addition to the prominent median tooth originating a little above the tip of the upper jaw there are 15 pointed teeth on each side" and their reference to a median tooth is not clear. It is likely that they are referring to one of the paired grasping tooth, the other being missing in the single specimen collected by them. On the basis of this assumption, the Travancore specimen has 16/11 teeth while in the Bombay specimen 19/13 teeth are present.

Apart from these minor differences, the most important one is in the colouration. In the Bombay larva 7 groups of chromatophores are found in the alimentary canal in the 6 hump-like swellings and the last one near the anal opening and in addition to these, 6 groups of postanal mid-lateral chromatophores are also present. Travancore leptocephalus also shows pigment cell concentrations on the hump-like swellings, but their number



TABLE II  
Measurements of ophichthyid leptocephali

	<i>Leptocephalus vermicularis</i> Southwell and Prashad, 1919	Larva VI Deraniyagala, 1934	<i>Leptocephalus A</i> Gopinath, 1950	<i>Leptocephalus C</i> Gopinath, 1950	<i>Leptocephalus F</i> Gopinath, 1950	<i>Leptocephalus</i> (Madras) Jones and Pantulu, 1955	<i>Leptocephalus I</i> (Travancore) Jones and Pantulu, 1955	<i>Leptocephalus II</i> (Travancore) Jones and Pantulu, 1955	<i>Leptocephalus</i> of <i>Pisodonophis</i> <i>hifala</i> Jones and Pantulu, 1955	<i>Leptocephalus I</i>	<i>Leptocephalus II</i>	<i>Leptocephalus III</i>
Total length ..	61.2	90.0	99.0	82.0	104.0	105.0	82.0	103.5	68.0	128.0	96.0	72.0
Maximum height ..	4.1 (6.7)	8.0 (8.9)	8.5 (8.6)	7.0 (8.5)	7.5 (7.2)	6.3 (6.0)	6.4 (7.8)	7.3 (7.1)	5.1 (7.5)	5.3 (4.1)	7.0 (7.3)	5.0 (6.9)
Predorsal distance ..	44.8* (73.2)	21.7* (24.1)	..	..	..	97.8 (93.1)	77.0 (93.9)	97.1 (93.8)	61.3 (90.1)	119.6 (93.4)	87.2 (90.8)	68.9 (95.7)
Preanal distance ..	23.4† (38.2)	50.0* (55.6)	47.0 (47.5)	34.0 (41.5)	43.5 (41.8)	40.0 (38.1)	54.0 (65.9)	52.5 (50.7)	28.0 (41.2)	69.2 (54.1)	53.4 (55.6)	37.3 (51.8)
Length of head ..	4.3 (7.0)	4.7† (5.2)	4.5 (4.5)	3.4 (4.1)	3.5 (3.4)	4.1 (3.9)	2.9 (3.5)	3.8 (3.7)	3.4 (5.0)	4.4 (3.4)	5.4 (5.6)	3.3 (4.6)
Length of snout ..	1.1 (25.6)	..	..	..	..	1.3 (31.7)	1.0 (34.5)	1.5 (39.5)	1.0 (29.4)	1.5 (34.1)	1.4 (25.9)	1.0 (30.3)
Diameter of eye ..	0.6 (14.0)	..	..	..	..	0.5 (12.2)	0.6 (20.7)	0.8 (21.1)	0.5 (14.7)	0.9 (20.5)	1.1 (20.4)	0.6 (18.2)
Total myotomes ..	122	158	156	206	183	223	174	141	155	146	146	157
Preanal myotomes ..	47	70	63	79	66	80	107	67	60	67	67	65
Teeth ..	..	5/5	22/20	10/14	24/22	12/10	14/10	16/11	nil	19/13	19/13	12/10

\* Calculated from the Text-Figures. † Calculated from the description.

is not given by the authors. However, the post-anal mid-lateral groups of chromatophores are absent in the Travancore larva. This difference in the pattern of pigmentation, taken in conjunction with the other differences, indicates that the two larvæ belong to different species.

LEPTOCEPHALUS II

(Text-Fig. 5 and Photograph 2)

Total length	.. 96.0
Maximum height	.. 7.0 (7.3)
Predorsal distance	.. 87.2 (90.8)
Preanal distance	.. 53.4 (55.6)
Length of head	.. 5.4 (5.6)
Length of snout	.. 1.4 (25.9)
Diameter of eye	.. 1.1 (20.4)
Total myotomes	.. 146
Preanal myotomes	.. 67

This leptocephalus which also belongs to the family Ophichthyidæ is not very common in Bombay waters and the collection contains 14 specimens (*vide* Introduction, Nair and Mohamed, 1960). This larva shows a striking resemblance to *Leptocephalus* I in general appearance, myotome number and pigmentation and at first was thought to belong to the same species, but a critical study showed that the two larvæ differed both in morphometric and meristic characters and it was, therefore, thought desirable to describe it separately, in view of the possibility that it may belong to a very closely related species.

The leptocephalus is completely opaque and is much thicker than the previous larva. It is 96 mm. in length with a more or less uniform height in the postanal region. The anterior portion tapers gradually towards the head while the caudal end tapers abruptly and terminates in a pointed free tail. The height is 7 mm. which is greater than that of *Leptocephalus* I and it is only 13.7 times in length.

The head is moderately long and measures 5.4 mm. and it is 17.8 times in length. The snout is conical, pointed and very short and is contained 3.9 times in head. The eye is larger than that of *Leptocephalus* I and it is 4.9 times in head. The nostrils are clearly differentiated and the anterior one is situated midway between the tip of the snout and the front edge of the eye

while the posterior nostril is immediately in front of the eye. The jaws are of the same length and the gape of the mouth extends to a level with the centre of the eye. Both the jaws are provided with forwardly directed pointed teeth and the dental formula is  $1 + 6 + 12/1 + 12$ . Each half of the upper jaw carries in addition to the curved grasping tooth, 6 long teeth which become gradually smaller backwards and 12 uniformly sized, regularly arranged short teeth. The lower jaw carries in each half a grasping tooth and 12 teeth of which the anteriormost one is the longest while the succeeding ones become shorter with the last one the smallest in the series.

Most of the larvæ possess 146 myotomes while a few larvæ showed 145 muscle segments. The alimentary canal which is of uniform thickness takes a straight course with the vent opening to the outside below the 67th myotome and shows 6 ganglion-like swellings at regular intervals in all the larvæ in the collection. This obviously shows that there is no shifting of the anus during the growth of the leptocephalus. The preanal distance is 1.8 in length while the predorsal distance which is very long is 1.1 in length.

The pectoral fin is very small with indistinct rays. The anal fin shows only 154 rays which is considerably lower than the count in *Leptocephalus I*. The dorsal fin rays show variation in their number owing to the growth of the fin and formation of new rays in the different specimens present in the collection. The caudal fin is absent in the larva.

The head pigmentation is very simple and along the border of the middle portion of the upper jaw a few small chromatophores are present in a line. A small group of 3-4 large, dendritic chromatophores is present in front of the heart.

The mid-lateral row of chromatophores commences from the 9th myotome and all the succeeding myotomes are provided with a highly elongated black chromatophore with a few exceptions here and there. In the post-anal region 6 prominent mid-lateral groups of pigment cells are clearly seen and these are situated at intervals of 10-12 myotomes. These are formed by the elongation of two consecutive pigment cells of the mid-lateral series and also by the presence of an internal group of chromatophores below the vertebral column. Chromatophores are also concentrated in the form of black patches on the dorsal side of the alimentary canal and altogether 7 such groups are present arranged equidistant from one another. The first six patches are on the ganglion-like swellings of the alimentary canal while the last one is near the anal opening. In some larvæ 2-3 smaller groups of chromatophores have been observed to be present in between some of the posteriormost pigment groups of the alimentary canal. Variations in the

number of pigment cells in each small group as well as in the number and arrangement of these groups have been frequently seen.

The anal fin is provided with a row of long diffuse chromatophores at the base of each of the rays excepting a few of the anteriormost rays. The dorsal fin is free from pigment cells and sometimes one or two dendritic chromatophores are seen on the dorsal side of the caudal extremity of the vertebral column.

#### REMARKS

As pointed out earlier, this larva bears a striking resemblance to *Leptocephalus I* in the size of the eye, dental formula, myotome number, position of the vent and the predorsal and preanal distances. The myotome number varies in this larva from 145 to 146 only while in *Leptocephalus I* a higher variation from 144 to 147 is seen. However, the important differences are in its shorter length and greater height of which the latter is nearly  $1\frac{1}{2}$  times that of *Leptocephalus I*. Further, the head of this larva is longer and is about  $1\frac{1}{2}$  times that of *Leptocephalus I*. These characters which have been found to be stable are very helpful in separating the 2 species.

Among the meristic characters, the anal fin alone is taken into consideration since the dorsal fin is observed to show variation in the fin ray count depending on the stage of growth of the larva. The present larva shows a count of 154 anal fin rays only while a higher count of 186 rays is present in the anal fin of *Leptocephalus I*. It may be mentioned here that Lea (1913) while discussing the importance of myotome number in referring leptocephali to their adults says that "different species of eels have about the same number of segments (vertebræ) and that the number of segments in different individuals of the same species may vary" and, therefore, it is "necessary to include other characters such as the number of rays". In spite of the close similarity, the few differences in the morphometric and meristic characters indicate the possibility that this leptocephalus may belong to a very closely related species or at least to a variety of the same species.

#### LEPTOCEPHALUS III

(Text-Fig. 6)

Total length	..	72.0
Maximum height	..	5.0 (6.9)
Predorsal distance	..	68.9 (95.7)
Preanal distance	..	37.3 (51.8)

Length of head	..	3.3 (4.6)
Length of snout	..	1.0 (30.3)
Diameter of eye	..	0.6 (18.2)
Total myotomes	..	157
Preanal myotomes	..	65

This ophichthyid leptocephalus is represented in the collection by a single specimen which was obtained from the plankton collection made off Bombay on the 1st May 1953 (*vide* Introduction, Nair and Mohamed, 1960). The larva was alive when the collection was brought to the laboratory, but owing to its extreme rarity it was thought best to preserve it rather than allowing it to metamorphose in the laboratory.

The larva is transparent and measures 72.0 mm. in length. The height is more or less uniform barring the extremities which gradually taper, the posterior of which terminates in a blunt tail. The height of the larva is 5 mm. and it is 14.4 times in length.

The head is very small and measures 3.3 mm. and is contained 21.8 times in length. The eye which measures only 0.6 mm. in diameter is small in comparison with that of the other two ophichthyid leptocephali described here, and it is 5.5 times in head. The nostrils have become clearly differentiated and the anterior one is situated in the middle of the snout while the posterior one is midway between the anterior nostril and the front margin of the eye. The cleft of the mouth is straight and extends a little beyond the centre of the eye. The jaws are of equal length and are provided with pointed forwardly directed teeth and the dental formula is  $1 + 4 + 7/? + 9$ . Each half of the upper jaw carries a strongly curved and pointed grasping tooth followed by 4 strong and long teeth which become shorter backwards. This group is followed by another set of 7 minute conical teeth. The grasping tooth of the lower jaw is missing while the other teeth are intact and each half of the jaw is provided with 9 teeth of which the anteriormost one is the longest while the succeeding ones become smaller with the last one the smallest in the series.

There are 157 distinct myotomes in the larva and the anus is below the 65th myotome. The alimentary canal is somewhat short and does not extend up to the middle of the larva. It becomes wider posteriorly and it is looped in a characteristic festoon-like manner with 7 sections. The 6 angular portions of the loops are below myotomes 12-13, 20-21, 29-30, 37-38, 46-47 and 54-55. The preanal distance is 1.9 in length while the predorsal distance is nearly 1 owing to the extremely short nature of the dorsal fin.

The pectoral fin is in the form of a small circular flap-like structure without rays. Both the dorsal and anal fins show distinct rays and their number is 46 and 284 respectively. Some of the posteriormost rays, excepting the last few ones, of the dorsal and anal fins are very long and show a beautiful pattern of uniform zig-zag curvature (Photograph 3).

Head pigmentation is very feeble and consists of 3 small pigment cells situated below the nostrils very near the border of the upper jaw and no chromatophores are present in the heart region.

The mid-lateral pigmentation is not very conspicuous and the chromatophores which commence from the 7th myotome are arranged just below the vertebral column. A few of the anteriormost myotomes are provided with only a single round pigment cell while the rest are usually provided with 3 elongated highly branching chromatophores. These chromatophores are arranged end to end and appear as a dark line along the myocommas.

The pigmentation of the alimentary canal is characteristic and a cluster of highly branching black chromatophores is present above the 6 hump-like thickened angles of the loops of the alimentary canal. A similar concentration of pigment cells is present on the dorsal side of the extremity of the alimentary canal near the anal opening. A few chromatophores are also present on the ventral side of the first 4 hump-like thickenings of the alimentary canal. These dark patches at the corners of the loops tend to enhance the festoon-like appearance of the alimentary canal. Four to five unbranched pigment cells are arranged in a line on the ventral side of the first two curved sections of the alimentary canal.

The pectoral and dorsal fins are free from pigment cells while 2-3 chromatophores are present at the base of each of the rays of the anal fin.

#### REMARKS

Quite a few ophichthyid leptocephali have been recorded from Indian waters, but those possessing looped alimentary canal are few in number. Deraniyagala (1934) collected a preleptocephaline larva off Cape Comorin (Larva V) measuring 20 mm. in length and possessing 119 myotomes of which 99 are preanal in position. The figure of the larva shows clearly 9 loops in the alimentary canal. Larva II collected off Tuticorin by Nair and Bhimachar (1950) is also a preleptocephaline stage showing a characteristic pigmentation and the formation of 6-looped portions in the alimentary canal. This larva measures only 7 mm. in length but shows a high myotome number of 180 of which 78 are preanal in position. These preleptocephaline larvae, which have been referred to the family Ophichthyidae by Nair (1960),

and Nair and Dharmamba (1960) respectively, represent very early larval stages in the growth and as such their morphometric characters are not strictly comparable with those of the fully grown leptocephalus and, therefore, they have not been taken into consideration here.

Deraniyagala (1934) recorded another ophichthyid leptocephalus (Larva VI) with looped alimentary canal and in spite of the brief description, the figure shows clearly the looped nature of the alimentary canal with 7 sections in it. This larva possesses 158 myotomes of which 70 are preanal in position. The general characters and pigmentation of the larva have not been given by him. However, from the figure it is seen that the origin of the dorsal fin in this larva is far in front and it is "closer to the snout tip than to the cloaca", indicating that the dorsal fin is long, in contrast to the short nature of this fin in the Bombay larva and normally found in the other ophichthyid leptocephali. It is seen that the larva has begun to metamorphose as shown by the absence of the larval set of teeth and the formation of the adult set which is indicated by "5 short caninoid teeth on each jaw". It is, therefore, possible that with the commencement of metamorphosis, the dorsal fin develops rapidly and assumes the normal size found in the adult.

Gopinath (1950) recorded another ophichthyid larva (*Leptocephalus*) A with looped alimentary canal which shows 156 myotomes with the vent below the 63rd myotome. The larva shows 8 distinct loops with pigment concentrations over the ganglion-like swellings at the angles between the two successive loops and in addition shows 9-10 postanal mid-lateral groups of chromatophores.

The larva described in this paper shows a striking similarity to those described by Deraniyagala (1934) and Gopinath (1950) especially in the myotome number which is 157, 158 and 156 respectively. The position of the vent shows some variation and it is below the 70th myotome in the Ceylon larva while it is below the 63rd and 65th myotomes in the Trivandrum and Bombay larvæ respectively. These 3 larvæ also differ in the number of loops found in the alimentary canal and the Trivandrum larva shows 8 loops while only 7 loops are present in the Ceylon and Bombay larvæ.

A comparison of the colouration of these larvæ is not possible since there is no mention about the pigmentation of the Ceylon larva. The Trivandrum larva shows a characteristic pigmentation and chromatophore concentrations are present in the ganglion-like swellings at the angles of the loops and also on the sides of the postanal portion of the body very much resembling the pigmentation of *Leptocephalus* I and II described earlier. The Bombay larva also shows similar accumulation of pigment cells at the

angles of the loops of the alimentary canal, but the postanal mid-lateral black patches are not present in this larva.

In spite of the close similarity in the total and preanal myotomes between these 3 larvæ recorded from the coastal waters, the Trivandrum larva is distinct in showing 8 loops in the alimentary canal and also in the characteristic postanal pigmentation. The Ceylon larva and the present one show similarity in the number of loops and differ only in minor details like height, length of head, predorsal distance, etc. A comparison of the colouration is not possible without a re-examination of the Ceylon larva. If a similar colouration is present in the Ceylon larva also, then it is highly probable that they belong to the same species.

*Leptocephalus vermicularis* (Southwell and Prashad, 1919) collected from Doorakara, Sunderbans (Gangetic Delta) is the first ophichthyid leptocephalus recorded from Indian waters (Nair, 1960). Deraniyagala (1934) described 2 larvæ, Larva V and Larva VI and he referred the latter only to the family Ophichthyidæ due to the absence of the caudal fin. The ophichthyid characters of Larva V (Deraniyagala, 1934) and Larva II (Nair and Bhimachar, 1950) have been pointed out by Nair (1960) and Nair and Dharmamba (1960) respectively. Gopinath (1950) described *Leptocephalus* A and *Leptocephalus* C collected from the Trivandrum coast and assigned them to the ophichthyid group. *Leptocephalus* F described by him is also an ophichthyid larva (Nair, 1960). Jones and Pantulu (1955) described a few ophichthyid preleptocephaline stages and 4 ophichthyid leptocephali collected from Madras, Travancore and Orissa coasts and referred the last one to *Pisoodonophis hijala* based on the myotome and vertebral counts. Recently Nair and Dharmamba described the early life-history of an ophichthyid egg collected from the Lawsons' Bay, Waltair (1960).

Including the 3 larvæ described here, 16 ophichthyid leptocephali have so far been recorded from Indian waters of which 4 are in the early preleptocephaline stages. The important characters of all the leptocephali are given in Table II which shows clearly the wide variation encountered among the different larvæ in regard to size, morphometric characters, myotome number and to some extent in pigmentation.

As pointed out earlier, *Leptocephalus* I described here is peculiar in showing the maximum length of 128 mm. and minimum height, of 4.1% while the minimum length of 61.2 mm. and maximum height of 8.9% are seen in *Leptocephalus vermicularis* and Larva VI (Deraniyagala, 1934) respectively.



The length of head and snout and the diameter of eye do not show any significant difference among the different ophichthyid leptocephali. Leptocephalus I and II collected from Bombay show the maximum number of teeth namely 19/13. Deraniyagala (1934) mentions the presence of the lowest number of "5 short caninoid teeth on each jaw" in Larva VI, but they appear to be the rudiments of the growing adult set of teeth only. Gopinath (1950) gives 22/20 and 24/22 teeth for Leptocephalus A and F which obviously represent the total number of teeth present in each jaw and not the number found in each half of the jaw, the latter of which is the customary way of expressing the number of teeth in leptocephali. This assumption is found to be correct in the case of *Muranesox cinereus* for which he gives 32/30 teeth while each half of the jaws carries 15/15 as shown in the figure (Nair, 1947). It is believed that he has followed the same procedure in regard to the number of teeth in the other larvæ also and Leptocephalus C described by him shows a low number of 5/7 (10/14 as given by Gopinath) which as pointed out by him, does not represent the full set of larval teeth. In regard to Leptocephalus II from Travancore coast Jones and Pantulu (1955) mentions the presence of a prominent median tooth which as pointed out earlier could only be one of the paired grasping tooth.

The myotome number shows high variation among the different leptocephali and in this respect the larva described by Jones and Pantulu (1955) from Madras shows the highest number of 223 myotomes while *L. vermicularis* shows the lowest number of 122 myotomes. It is seen that the predorsal distance in most of the species is more than 90% of the length except in *L. vermicularis* and Larva VI of Deraniyagala (1934) where the lower percentage is caused by the elongation of the dorsal fin due to the commencement of metamorphosis. On the contrary, the preanal distance does not show much variation among the different ophichthyid leptocephali. The position of the vent shows considerable divergence and it is below the 107th myotome in Leptocephalus I collected from Travancore coast (Jones and Pantulu, 1955) while it is below the 47th myotome in *L. vermicularis*.

The alimentary canal of most of the ophichthyid larvæ is straight except in Larva VI of Deraniyagala (1934), Leptocephalus A of Gopinath (1950) and Leptocephalus III from Bombay in which it shows a looped nature. The gut of the other larvæ shows hump-like thickenings at regular intervals. There is no information on this point about the alimentary canal of *L. vermicularis* (Southwell and Prashad, 1919) and Larva VI of Deraniyagala (1934), the descriptions of which are very brief. Gopinath (1950) recorded 8-9 and 6 distinct humps for Leptocephali C and F respectively. A similar condition has been noted by Jones and Pantulu (1955) in all the ophichthyid

larvæ described by them. They have recorded the presence of 6 and 12 hump-like thickenings for the leptocephalus of *Pisoodonophis hijala* and the Leptocephalus from Madras respectively while they mention the presence of similar thickenings in the alimentary canal of the other two larvæ collected from Travancore coast without giving their number. Leptocephali I and II from Bombay waters also show this character distinctly and 6 such thickenings are present in both the larvæ. Such hump-like thickenings of the alimentary canal have also been noticed in the leptocephali with looped alimentary canal and they are found at the angles of the loops. It may be pointed out here that such hump-like thickenings of the alimentary canal have so far been recorded only in the ophichthyid leptocephali and as such this feature can be regarded as a diagnostic character of the larvæ of this family.

The different ophichthyid leptocephali show a fair amount of uniformity in regard to pigmentation with slight variations which perhaps indicate specific differences. From the available information, it is seen that in almost all the larvæ, the head pigmentation is normal and consists of a group of chromatophores in the middle portion of the upper jaw and in the region of the heart. The mid-lateral row of chromatophores is distinctly seen in all the larvæ below the vertebral column with only slight variations in the arrangement of the pigment cells. In all the larvæ, the anal fin is pigmented and the chromatophores are found at the bases of the fin rays. The dorsal fin, on the other hand, is unpigmented in all the leptocephali except in Leptocephalus F of Gopinath (1950). The most important feature of the pigmentation is the concentration of pigment cells in the form of dark patches in the hump-like thickenings of the alimentary canal and also occasionally in between them. A similar conspicuous group of chromatophores is also present in some larvæ near the anal opening. In addition to this pigmentation, Leptocephalus A of Gopinath (1950) and Leptocephali I and II from Bombay waters show additional conspicuous postanal groups of chromatophores situated internally at regular intervals below the vertebral column.

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## EXPLANATION OF PLATE

- PHOTOGRAPH 1. *Leptocephalus* I,  $\times ca. \frac{1}{2}$ .
- PHOTOGRAPH 2. *Leptocephalus* II. About natural size.
- PHOTOGRAPH 3. Caudal region of *Leptocephalus* III showing the zig-zag curvature of the dorsal and anal fin rays.

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PHOTO. 1



PHOTO. 2

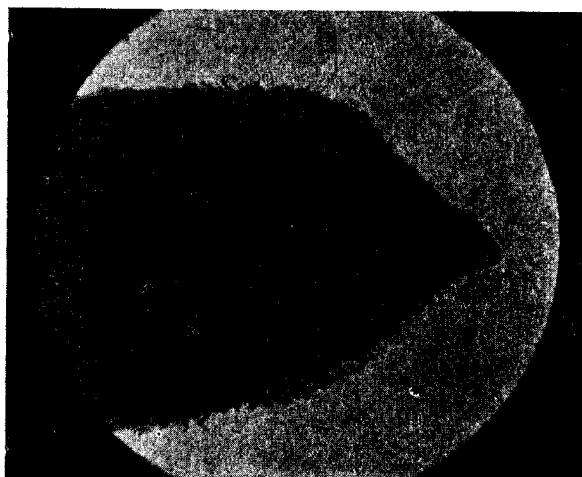


PHOTO. 3