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III. The Metamorphosing Stages of *Uroconger lepturus* (Richardson)*

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THE leptocephalus of *Uroconger lepturus* was first described by Nair in 1946 and its occurrence was later recorded from the Gulf of Mannar (Nair, 1948). The present collection consists of several leptocephali and elvers of different sizes, the majority of which was collected from Versova (*vide* Introduction, Nair and Mohamed, 1960). All the stages described here were taken from the collection made on the 9th January 1954. Most of the larvæ in the collection were edentulous and showed high variation in the preanal myotome number and the latter character was also found to vary in the few toothed larvæ present in the collection.

Stage A (Text-Fig. 1).—The collection contains a few specimens belonging to this stage and all of them show the full set of larval teeth including the grasping tooth. This stage, which represents a growing larva, is younger than the leptocephalus described by Nair (1946) and differs from the latter in the possession of the grasping tooth and in the backward position of the vent which indicate that the Madras larva has reached full growth prior to metamorphosis. The growing larva also shows variations in the number of preanal myotomes indicating that the migration of the anus takes place in the growing phase itself. The youngest of the toothed larvæ showing the maximum number of preanal myotomes is described here as the type of this stage.

The larva is transparent and long and measures 110 mm. in length. It is moderately high and the maximum height of 6·2 mm. is seen in the middle region and it is 17·7 times in length. The leptocephalus of this species collected from Madras and Gulf of Mannar were considerably higher and the

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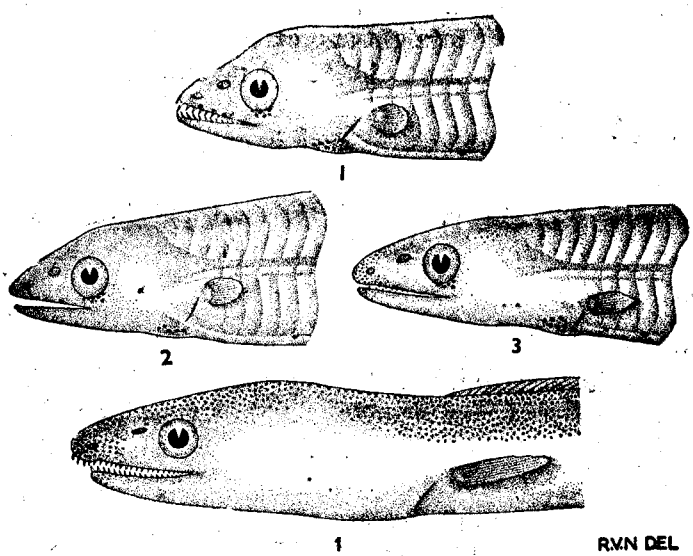
height was 10·2 times in length. This difference in the height of the larva collected from the various places is believed to be caused by the environmental factors. The body tapers gradually towards the head and the tail and the latter is long, pointed and whip-like in appearance. The tail shows a tendency to break off owing to its slender and thread-like nature and the collection contains quite a few larvæ with incomplete tail and some showing its regeneration. Elvers showing regenerated tail have been frequently met with and it was found difficult to distinguish the normal ones from those possessing regenerated tails without staining in alizarin. This partly accounts for the high variation in the vertebral and fin ray counts observed in the elvers and the juveniles of this species.



TEXT-FIGS. 1–4. Head region of the growing and metamorphosing stages of the leptocephalus of *Uroconger lepturus*, ×*ca.* 4·5.

The head is very short and measures 5 mm. which is 22 times in length. The snout is moderately pointed and it is 2·9 times in head. The nostrils are of unequal size and the anterior one is small and situated near the tip of the snout while the posterior one is large and nearer to the front margin of the eye than to the anterior nostril. The eye is large, prominent and slightly oval in shape and its diameter is 3·8 times in head. The jaws are of the same length and the cleft of the mouth extends to a level with the centre of the eye. The jaws are provided with pointed forwardly directed teeth and the dental formula is 1 + 1 + 6 + 15/1 + 14. Each half of the upper jaw carries 23 teeth. The first is the short grasping tooth placed at the tip of the

snout and this is followed by a long and strong tooth. The other teeth are arranged in two groups. The first group is composed of 6 moderately long pointed teeth while the remaining 15 teeth forming the second group are very small and closely arranged in the posterior half of the jaw. The lower jaw possesses in each half a curved grasping tooth placed slightly below its tip and 14 teeth which are placed equidistant from one another. These teeth are fairly long and pointed and become shorter backwards.

The myotomes are distinct except in the whip-like portion of the tail where they are somewhat faint and could be made out satisfactorily after staining with eosin. Altogether 218 myotomes are present in the type specimen and variation from 204–223 has been observed in this species. The alimentary canal is very long, straight and extends nearly $\frac{3}{4}$ the length of the larva with the anus situated below the 122nd myotome. The origin of the dorsal is nearer to the snout than to the caudal and the predorsal distance is 2·4 times in length. The preanal distance is only 1·3 times in length.

The anal fin is very short and both the anal and dorsal fins are continuous with the caudal and the rays of the caudal fin are about double the size of those of the other fins. The pectoral fin is circular in shape with indistinct fin rays.

Even though the pigmentation of the larva is very feeble, the chromatophores are very large and conspicuous and they are observed to persist in the metamorphosing and elver stages. Along the edge of the upper jaw 3–4 circular, unbranched, chromatophores are arranged in a line. A group of black branching chromatophores are present just below the eye and this pigmentation, as pointed out by Nair (1946), is a distinguishing feature of the larva of this eel. Near the heart 4–7 large black pigment cells are found scattered without any definite arrangement.

The mid-lateral row of chromatophores usually commences from the 12th myotome and the pigment cells which are large, black and unbranched are regularly distributed in each of the succeeding myotomes and occasionally at intervals of 1–4 muscle segments. This row does not extend up to the whip-like portion of the tail. A row of closely arranged black pigment cells is found along the dorsal side of the alimentary canal and this series extends beyond the vent with the chromatophores arranged along the base of the anal fin. The post-anal chromatophores of this row are linear and show a scattered distribution and are not found in the tail region. The other fins do not show any pigmentation.

Stage I (Text-Fig. 2 and Photograph 1).—Since the stage described in 1946 represents the full-grown leptocephalus comparable to Stage I in the metamorphosis of *Muræsox cinereus* (Nair, 1947) and as no significant difference has been observed in similar stages present in the Bombay collection, the leptocephalus stage is not described here. For comparison, the general and morphometric characters of the Madras larva are also included in Table I along with those of the different stages described here.

TABLE I

Measurements of Uroconger lepturus

	Stage A	Stage I	Stage II	Stage III	Larva Nair, 1946
Total length ..	110·0	103·0	98·0	88·0	112·0
Maximum height ..	6·2	6·7	4·6	3·8	11·0
	(5·6)	(6·5)	(4·7)	(4·3)	(9·8)
Predorsal distance ..	45·0	27·6	11·0	11·5	43·0
	(40·9)	(26·8)	(11·2)	(13·1)	(38·4)
Preanal distance ..	82·2	55·0	32·0	27·5	82·0
	(74·7)	(53·4)	(32·7)	(31·3)	(73·2)
Length of head ..	5·0	5·4	6·9	10·8	6·0
	(4·5)	(5·2)	(7·0)	(12·3)	(5·4)
Length of snout ..	1·7	1·9	2·1	2·8	2·1*
	(34·0)	(35·2)	(30·4)	(25·9)	(35·0)
Diameter of eye ..	1·3	1·3	1·3	1·3	1·6*
	(26·0)	(24·1)	(18·8)	(12·0)	(26·7)
Total myotomes ..	218	206	204	212†	216
Preanal myotomes ..	122	79	52	44†	116
Predorsal myotomes ..	57	40	14	10	..

* Calculated from the Text-Figure.
† Vertebra(e).

This stage represents the edentulous condition in the metamorphosis of the larva and it is comparable to Stage II of *M. cinereus*. The larva measures 103 mm. in length. The maximum height is seen in the middle region and it measures 6·7 mm. which is 15·4 times in length. The height gradually decreases at the two extremities and this is more pronounced in the posterior region which ends in a finely pointed thread-like tail.

The head has grown longer and measures 5·4 mm. and it is 19·1 times in length. A slight increase in the length of the snout is seen and it is 2·8 times in head. There is no change in the size or shape of the eye and it is 4·2 times in head. In almost all the specimens belonging to this stage, the tail was found to be regenerated and as such it was found impossible to get the correct number of muscle segments and the fin rays. The type specimen shows only 206 myotomes. The important difference seen in the edentulous stage is the shifting of the origin of the dorsal fin and the anus. The origin of the dorsal fin is situated above the 40th myotome in this stage and consequently the predorsal space is reduced considerably and it is 3·7 times in length. Marked reduction in the length of the alimentary canal is also noticed and the anus is situated just behind the middle of the larva below the 79th myotome. The preanal distance is 1·9 times in length.

The fin rays are distinctly seen in the vertical fins and their number as stated earlier is found to be highly variable.

There is no change in the pigmentation of the larva in this stage.

Stage II (Text-Fig. 3 and Photograph 1).—This stage which corresponds to Stage III of *Muræsox cinereus* is represented in the collection by a single specimen. The larva has becom eopaque and shows reduction in height and moderate increase in thickness. The larva measures 98 mm. and the height which is 4·6 mm. is 21·3 times in length. The reduction in the height is very conspicuous in the posterior half of the larva while the anterior half is more or less uniform in height.

The head has elongated considerably, especially in the post-orbital region and measures 6·9 mm. which is 14·2 times in length. The snout has also become longer and it is 3·3 times in head. The eye in this stage does not show any change in size and it is 5·3 times in head. The adult set of teeth has begun to develop and they are seen as small pointed projections which are seen better in the lower jaw.

The myotomes have become almost indistinct in the posterior region due to the reduction in the height and the thickening of the larva, while those of the anterior region could be made out faintly. The type specimen possesses 204 myotomes. The anus has shifted further anteriorly and it is opposite the 52nd myotome with the preanal distance 3·1 times in length. The origin of the dorsal fin has also shifted considerably forwards and it is above the 14th myotome with the predorsal distance 8·9 times in length.

Changes in the pigmentation of the larva indicating the gradual assumption of the adult colouration is seen in this stage. The tips of the snout

and the lower jaw have become powdered with minute black chromatophores. On the dorsal side of the post-orbital region a group of small black chromatophores is present. The body pigmentation does not show any change. The chromatophores of the mid-lateral series have become very prominent with ramifying branches. The pigment cells along the alimentary canal and the base of the anal fin have also become larger and dendritic and this row extends up to the tip of the tail in this stage.

Stage III (Text-Fig. 4 and Photograph 1).—This is the final elver stage in the metamorphosis of the larva comparable to Stage VI of *Muræsox cinereus*. The elver is perfectly cylindrical and measures only 88 mm. in length. The height is considerably reduced and it is 3·8 mm. which is 23·2 times in length. The maximum height is seen just behind the gill opening and the body gradually tapers from this point to terminate in the finely pointed tail.

The length of the head has increased to 10·8 mm. and it is only 8·1 times in length. The snout, which resembles that of the adult, is long and projects beyond the tip of the lower jaw and it is 3·9 times in head. The eye has become perfectly circular and it is 8·3 times in head. Most of the adult teeth have appeared in the elver and both the jaws show rows of small, sharply pointed and incurved teeth.

Alizarin preparation of the elver shows the presence of 212 vertebræ. Further reduction in the length of the alimentary canal has taken place and the anus is situated below the 44th vertebra with the preanal distance 3·2 times in length. The origin of the dorsal fin is above the 10th vertebra and slightly behind that of the pectoral fin. In spite of the anterior shifting of the origin of the dorsal fin, the predorsal distance is greater than that of the previous stage and this is due to the marked elongation of the head of the elver which is 7·7 times in length.

Important changes in the pigmentation have taken place in the elver which still retains the larval pigmentation, especially the mid-lateral row of chromatophores. The ventral pigmentation, on the other hand, has become somewhat faint due to the opacity of the elver. Numerous, small, dendritic uniformly sized and closely arranged chromatophores have appeared on the dorsal side of the head and the body giving a uniform brown colour to the dorsal side of the elver. On the head, the pigmentation is confined to the inter-orbital region while on the body, it extends laterally up to the middle of the space between the base of the dorsal fin and the lateral line. In the posterior region, the body pigmentation extends below the lateral line also and it is intense near the caudal region. An unpigmented narrow zone,

which appears as a white line to the naked eye, is present on either side of the anterior $\frac{2}{3}$ of the dorsal fin.

Along the border of the dorsal and anal fins, numerous dark brown pigment cells have appeared giving it a dark brown colour which is deeper in the tail region.

Several elvers in different stages of growth are present in the collection and they do not show any appreciable change in the morphometric characters. Intensification of the pigmentation is noticed during the growth of the elver and its body assumes a uniform brown colour while the edges of the vertical fins are black in colour.

REMARKS

It was pointed out that Stage A described here is an advanced growing stage, while the larva described by Nair in 1946 represents the full-grown leptocephalus of *Uroconger lepturus*. Three stages in the metamorphosis of the leptocephalus alone are available in the Bombay collection. For studying the changes undergone during the growing phase, a comparison of the growing Stage A with the full-grown leptocephalus described in 1946 is not attempted here, since there is only one stage belonging to the former category. Further, these larvæ are collected from widely separated places like Madras and Bombay which present different ecological conditions and, therefore, a comparison of the morphometric characters is not considered desirable. However, it is significant to note that in *U. lepturus* also the migration of the anus and the shifting of the origin of the dorsal fin take place in the larva even before it reaches the full growth, thus resembling the condition found in *Muræsox talabonoides* (Nair and Mohamed, 1960).

Most of the larvæ in the collection are without teeth and while describing the Madras larva Nair pointed out that "in the majority of the examples collected the larval set of teeth has dropped off and indications of the adult set are seen as minute conical projections". A similar condition was noted in the leptocephalus collected from the Gulf of Mannar and Nair (1948) stated that "all the larvæ in the present collection are edentulous with great reduction in the length of the alimentary canal". The abundance of the edentulous stage in these centres like Madras, Gulf of Mannar and Bombay suggests that the leptocephalus of *U. lepturus* generally enters the foreshore waters after the commencement of metamorphosis which is indicated by the loss of the larval set of teeth and preceded by anal migration.

It may be mentioned here that the transforming stages of this eel have been found to be extremely rare in the 'dol' net catches, even though the

larvæ and the elvers have been collected in large numbers. Similarly the collections made at Madras and the Gulf of Mannar also do not contain any metamorphosing or elver stages. It is likely that the metamorphosing stages are found in the relatively deeper waters and they also manage to dodge the net effectively because of their greater agility. The occurrence of the elvers in large numbers in the Bombay collection is perhaps due to the fact that they are voracious feeders and go after prey like *Acetes* and shrimps which occur in enormous numbers in the Bombay waters during this period and are trapped in the 'dol' nets along with them.

The metamorphosis of *U. lepturus* shows the usual changes observed during the metamorphosis of the other Indian leptocephali. The reduction in the height observed in this species is by 56·1% of the larval height while the predorsal and preanal distances are reduced by 65·9% and 57·2% respectively. The length of the head of the elver is more than 2¼ times the length of the head of the leptocephalus. Due to this increase in the head length, the percentage values of the snout and the eye are reduced considerably. The formation of the adult colouration is seen even in Stage II while in the elver, the dorsal side is uniformly brown and the fins have a dark brown border.

The resemblance in the general shape of the leptocephalus of *U. lepturus* to *Leptocephalus acuticaudatus* (Kaup, 1856) was pointed out by Nair (1946). Kaup's description of the larva is based on a single specimen collected by Dussumier from the Malabar coast. Bertin (1935) who re-examined the types of leptocephali described by Kaup states that 2 specimens sent by Dussumier in 1830 from the Coromandel coast are present in the Paris Museum. Apparently there is some confusion about the number and place of collection of *L. acuticaudatus*. However, according to Bertin's redescription the 2 specimens measure 137 and 135 mm. in length with a maximum height of 10 mm. The origin of the dorsal fin is nearer the snout with a preanal distance of 25 and 20 mm. respectively while the anal fin occupies half the length of the body. The larvæ possess slightly more than 200 myotomes. The tail is pointed and ends in the pointed caudal fin. Chromatophores are present along the ventral side irregularly distributed up to the base of the tail and also along the lateral line. These characters given by Bertin show that in general shape, body proportions, myotome number and also in pigmentation *L. acuticaudatus* resembles the larva of *U. lepturus* and justifies the assumption that the former is the larva of the latter which is one of the common eels of the coastal waters.

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EXPLANATION OF PLATE

PHOTOGRAPH 1. The three stages in the metamorphosis of *Uroconger lepturus*, $\times ca.\ \frac{3}{4}$.

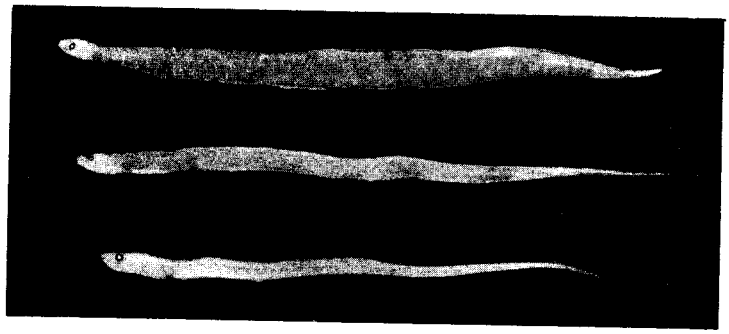

PHOTO. 1