Reprinted from the "Proceedings of the Indian Academy of Sciences," Vol. LII, 1960

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STUDIES ON THE LEPTOCEPHALI OF BOMBAY WATERS

II. The Metamorphosing Stages of *Muræsox talabon* (Cantor)*

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Received September 1, 1960

(Communicated by Dr. N. K. Panikkar, F.A.SC.)

THE leptocephalus of *Muræsox talabon* generally occurs in the 'dol' net catches along with that of *Muræsox talabonoides* and the collection contains several specimens and 2 elvers (*vide* Introduction, Nair and Mohamed, 1960 *a*). Some of the larvæ showed the full set of larval teeth while in the others they have fallen off indicating the commencement of metamorphosis. A few leptocephali showing intermediate stages of metamorphosis and the elvers present in the collection made it possible to get a more or less connected series of stages in the transformation. It may be pointed out that Stage V described here represents the elver stage and corresponds to Stage VI in the metamorphosis of *Muræsox cinereus* (Nair, 1947) and *Muræsox talabonoides* (Nair and Mohamed, 1960 *a*). The penultimate stage, corresponding to Stage V of these two species, is not present in the collection.

Variations in the size of the leptocephalus have been noticed both in the larval and metamorphosing stages and the largest specimen in the collection measures 102·5 mm. while the smallest is only 70·5 mm. Both these larvæ are edentulous indicating the commencement of metamorphosis. It is likely that ecological and environmental factors, rather than size, influence the metamorphosis of these larvæ. High variation in myotome number is found in this species and it ranges from 142 to 152 with the majority of the specimens showing 146 myotomes.

Stage I (Text-Fig. 1 and Photograph 1).—There are 6 specimens in the collection which come under this stage and all of them possess the full set of larval teeth. The different specimens show slight variations in the myotome number and in the position of the anal opening. This stage represents the full-grown leptocephalus.

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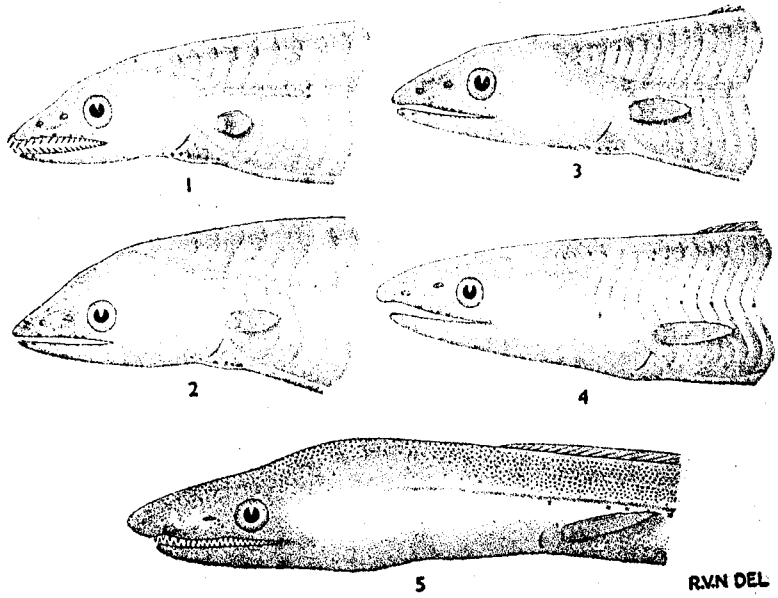
The leptocephalus is of moderate length with a tapering body. The maximum height is in the region of the vent and it measures 7·9 mm. which is 10·9 times in length.



TEXT-FIGS. 1–5. Head region of the metamorphosing stages of the leptocephalus of *Muraenesox talabon*, ×*ca.* 5.

The head is short and measures 4·8 mm. which is 17·9 times in length. The snout is long and sharply pointed and it is 2·4 times in head. The eye is oval in shape and its diameter is 5·3 times in head. The nostrils have become clearly differentiated and the anterior nostril is situated in the anterior third of the snout while the posterior one is in the middle of the interspace between the anterior nostril and the eye. The cleft of the mouth is straight and extends up to and sometimes slightly behind the posterior border of the eye. Both the jaws are of the same length and are provided with moderately long and pointed teeth which are directed forwards. The teeth formula is $1 + 11 + 6/1 + 16$. Each half of the upper jaw is provided with 18 teeth which are of unequal size. The first one is the grasping tooth which is thin, relatively short and originates slightly above the tip of the snout. This tooth is followed by a group of 11 long teeth of which the first one is the longest and it is larger than the grasping tooth. The other teeth in this group become shorter backwards and the last one is about $\frac{1}{4}$ the length of the first tooth. The second group is composed of the six remaining teeth which are short, conical and of

uniform size. These teeth are compactly arranged near the posterior border of the upper jaw. The lower jaw is provided with 17 teeth in each half and they are regularly arranged and equidistant from one another. The grasping tooth originates slightly below the tip of the lower jaw. It is long, curved and of about the same size as the adjacent teeth in the lower jaw. The other teeth become shorter in size backwards with the last one appearing as a short conical projection only.

TABLE I

Measurements of Muræsox talabon

	Stage I	Stage II	Stage III	Stage IV	Stage V
Total length ..	86·0	87·0	85·5	78·0	84·5
Maximum height ..	7·9 (9·2)	8·1 (9·3)	6·7 (7·8)	5·9 (7·6)	2·8* (3·3)
Predorsal distance ..	21·9 (25·5)	13·0 (14·9)	9·1 (10·6)	9·0 (11·5)	10·5 (12·4)
Preanal distance ..	59·0 (68·6)	45·7 (52·5)	32·4 (37·9)	28·6 (36·7)	28·8 (34·1)
Length of head ..	4·8 (5·6)	5·9 (6·8)	6·2 (7·3)	8·0 (10·3)	11·5 (13·6)
Length of snout ..	2·0 (41·7)	2·2 (37·3)	2·3 (37·1)	2·3 (28·8)	2·9 (25·2)
Diameter of eye ..	0·9 (18·8)	0·8 (13·6)	0·8 (12·9)	0·8 (10·0)	0·9 (7·8)
Total myotomes ..	142	150	147	148	..
Preanal myotomes ..	80	69	52	48	..
Predorsal myotomes ..	30	17	12	10	..

* Height of head is 3·8 mm.

The alimentary canal is moderately long, straight and extends nearly $\frac{2}{3}$ the length of the larva. The type larva shows 142 myotomes with the vent below the 80th myotome. The preanal distance is long and it is 1·5 times in length. The dorsal fin is very long and is about $\frac{3}{4}$ the length of the larva with the predorsal distance 3·9 times in length.

The pectoral fin is oval and shows only indistinct rays. The dorsal and the anal fins are well formed with 252 and 216 rays respectively. The

posteriormost rays of both these fins are longer than the rest and are of about the same length as those of the caudal fin. The caudal fin which is continuous with the other vertical fins shows 12 distinct rays.

The larval pigmentation exhibits characteristic features which are of considerable importance in distinguishing this leptocephalus from those of the other two species of *Muraenesox*. The head pigmentation consists of 4–5 unbranched black chromatophores arranged along the edge of the upper jaw and a row of 6–7 similar large pigment cells in the heart region. In most of the specimens 1–2 highly branching black chromatophores are present at the tip of the lower jaw. The mid-lateral row of chromatophores, situated below the vertebral column, commences usually from the 14th myotome and extends up to the Caudal region. The pigment cells are circular in shape in the anterior region becoming linear in the posterior region of the body. Two to three chromatophores are occasionally present in front of and in a line with this row at intervals of 2–3 myotomes. Slight variations in this general arrangement have been noticed and in a few specimens some of the posterior myotomes are not provided with pigment cells and show occasional breaks in the regularity of their arrangement. The pigmentation of the alimentary canal is very striking and constitutes an important diagnostic feature of the larva and this is observed to persist in the metamorphosing and elver stages. The salient feature of the gut pigmentation is the asymmetrical distribution of the chromatophores. On the ventral side of the gut is a pair of irregular rows of elongated, unbranched black chromatophores extending throughout the posterior $\frac{2}{3}$ of the length of the alimentary canal. In addition to this paired row, there is another prominent row of pigment cells found on the right side of the gut and this row is situated above the right paired row of chromatophores (Photograph 2). This lateral row is composed of compactly arranged, small unbranched chromatophores which become prominent near the anal opening. In some specimens this unpaired row appears as a black line. In most of the specimens this row is seen distinctly as a dotted line extending anteriorly up to the liver diverticulum while the paired rows of pigment cells tend to break up in the anterior region.

The pectoral and dorsal fins are unpigmented while the caudal and anal fins are provided with a few scattered black chromatophores at their bases. The anal fin is also provided with numerous, elongated black pigment cells which are uniformly arranged and usually 2–3 chromatophores are found in a line along the anterior border of each of the anal fin rays. A few black chromatophores are also found scattered amidst the caudal fin rays, especially in the lower half of the fin.

Stage II (Text-Fig. 2 and Photograph 1).—This is the edentulous stage ıowing the commencement of metamorphosis and apart from the loss of ıe larval set of teeth a few other changes are also seen in this stage.

There is no change in the general appearance of the larva and the specinen described here is slightly longer than the previous stage and measures 37 mm. in length and 8·1 mm. in height. Consequently the latter is only 10·7 times in the former showing a slightly lower proportion than that of the leptocephalus. The head has elongated and measures 5·9 mm. and it is 14·7 times in length. The snout has also become longer and it is 2·7 times in head. The eye is slightly smaller and its diameter is 7·4 times in head.

The type larva described here shows 150 myotomes of which 69 are preanal in position and the preanal distance is 1·9 times in length. A similar shifting of the origin of the dorsal fin is seen and it is above the 17th myotome in this stage. The predorsal distance is reduced considerably and it is 6·7 times in length.

The pectoral fin is elongated and pointed in this stage. There is no change in the pigmentation of the larva.

Stage III (Text-Fig. 3 and Photograph 1). — The larva has become opaque due to the reduction in the height and the marked increase in the thickness and it measures 85·5 mm. in length. The maximum height of 6·7 mm. is in the middle of the body and it is 12·8 times in length.

The head is long and measures 6·2 mm. which is 13·8 times in length The snout is 2·7 times in head. There is no change in the size of the eye and its proportion has increased to 7·8 times in head.

The myotomes are fairly distinct and the type larva possesses 147 muscle segments of which 52 are preanal in position. The alimentary canal has become shorter and it extends a little more than the anterior third of the larva with the preanal distance 2·6 times in length. The origin of the dorsal fin has also moved forwards and it is situated above the 12th myotome resulting in a further reduction of the predorsal distance which is 9·4 times in length.

The pectoral fin has become longer and shows distinct rays. No change is observed in the vertical fins.

There is no difference in the general pigmentation, but due to the opaqueness of the larva, the pigment cells in the heart region are somewhat indistinct in this stage. Due to the reduction in the length of the alimentary canal, the paired and unpaired rows of chromatophores present on it have become shorter with the pigment cells showing a more compact arrangement. The chromatophores of the unpaired row have accumulated in front of the anus

in an irregular manner giving a stippled appearance to this region. The pigment cells of the paired rows also show a similar tendency to crowd near the anus. The concentration of pigment cells on either side of the anus and in front of it is distinctly seen when the larva is viewed from the ventral side.

Stage IV (Text-Fig. 4 and Photograph 1).—The larva in this stage is perfectly opaque due to further reduction in height and increase in thickness. The leaf-like shape of the larva is almost lost and the cylindrical shape of the elver is attained in this stage. The type specimen measures 78 mm. in length. The maximum height of 5·9 mm. is seen just behind the vent and it is 13·2 times in length.

The head shows considerable elongation in length, particularly in the post-orbital region. The larval shape of the head is lost in this stage and the head resembles that of the adult. The head is 8 mm. long and it is 9·8 times in length. Even though the snout does not show any increase in length, its proportion in head has increased to 3·5 times. The size of the eye remains unchanged and it is 10 times in head. The tip of the snout projects slightly beyond that of the lower jaw and the adult set of teeth has begun to appear in the form of very minute projections on both the jaws.

The myotomes are not very distinct, however, they could be counted under reflected light and about 148 muscle segments are present in the type specimen. The anus occupies a forward position and it is under the 48th myotome. A proportionate decrease in the postanal distance is seen and it is 2·7 times in length. The origin of the dorsal fin also shows a slight forward movement and it is above the 10th myotome. The predorsal distance is 8·7 times in length.

The pectoral fin has become long and pointed while the median fins do not show any change in their shape.

There is no change in the colouration of the larva. The pigmentation has become somewhat faint, especially the mid-lateral row of chromatophores. The accumulation of pigment cells on either side of the anus is seen conspicuously in this stage.

Stage V (Text-Fig. 5 and Photograph 1).—This is the elver stage comparable to Stage VI in the metamorphosis of *Muræsox cinereus* and *Muræsox talabonoides* and no metamorphosing larva corresponding to Stage V in the metamorphosis of these species is available in the collection. The elvers are represented by two specimens which are of about the same size and appearance. The metamorphosis is almost complete and all the characters of the adult, excepting the colouration, are seen distinctly in the elver.

The body has become perfectly cylindrical and the maximum height is seen in the anterior region and measures 2·8 mm. The height is 30·2 times in length and this proportion is about 3 times that of the larva. It may be mentioned here that the height of the head is greater than that of the body and measures 3·8 mm. In this respect the elver of this species differs from those of the other two species in possessing a large head and a slender body.

The head, which has undergone considerable changes in shape, is very long and resembles the adult head in every detail. The head measures 11·5 mm. and it is only 7·3 times in length. The snout has also become longer and its tip projects considerably beyond that of the lower jaw and the characteristic rostral constriction is seen distinctly. The snout is 4 times in head. The eye has become slightly larger, but its diameter is contained 12·8 times in head and this is due to the lengthening of the head. The anterior nostril is tubulate and is situated at the anterior third of the snout very near the border of the upper jaw while the posterior one appears as slit-like aperture situated in front of the eye by about half its diameter. The gape of the mouth extends beyond the eye. The teeth are well developed in both the jaws and they are pointed, incurved and closely arranged.

The dorsal fin takes its origin far in front of the gill opening. The predorsal distance is greater than in the preceding two stages and it is 8 times in length. The anus is situated at the anterior third of the body and the preanal distance is 2·9 times in length.

The fins are well developed and the pectoral fin is very long and pointed resembling that of the elver of *M. talabonoides*. The dorsal and anal fins have become slightly wider and shows the rays very clearly.

Indications of the adult colouration are seen in the elver and numerous, small, diffusely branching brown pigment cells have appeared on the dorsal side of the head especially in the inter-orbital and post-orbital regions. Similar chromatophores are also present on the dorsal side of the snout, but show a diffuse and scattered arrangement. A few such pigment cells are also present in front of the eye. The pigmentation of the body is confined to the dorsal side only and it extends on the sides up to the lateral line. On the body the chromatophores are arranged uniformly leaving two linear unpigmented zones; one situated at the base of the dorsal fin and the other midway between the dorsal fin and the lateral line. These unpigmented streaks extend throughout the length of the elver and appear as white lines against the brown background. The larval pigmentation persists in the elver and the chromatophores of the mid-lateral series and those of the anal fin are conspicuously seen. The pigmentation of the alimentary canal is also

prominent and appears in the form of an irregular line along the posterior half of the gut and also in the form of a dark line surrounding the anal opening.

The other elver present in the collection shows a deeper pigmentation, even though it is of the same size as the type described here. The pigmentation on the dorsal side of this elver is intense and along the edges of the dorsal and anal fins numerous highly branching, compactly arranged, brown pigment cells have appeared giving a dark-brown colour to their borders.

REMARKS

The leptocephalus of *Muræsox talabon* exhibits characters which are different from those of the other two species of the genus, namely, *Muræsox cinereus* (Nair, 1947) and *Muræsox talabonoides* (Nair and Mohamed, 1960 *a*). Table II, which gives the characters of the three larvæ, shows that

TABLE II

Measurements of the leptocephali of Muræsox

	Leptocephalus of *Muræsox cinereus* Nair, 1947	Leptocephalus of *Muræsox talabonoides* Nair and Mohamed, 1960 *a*	Leptocephalus of *Muræsox talabon*
Total length	81·0	81·0	86·0
Maximum height	11·0 (13·6)	6·2 (7·7)	7·9 (9·2)
Predorsal distance	20·0 (24·7)	13·8 (17·0)	21·9 (25·5)
Preanal distance	53·0 (65·4)	46·2 (57·0)	59·0 (68·6)
Length of head	5·0 (6·2)	5·3 (6·5)	4·8 (5·6)
Length of snout	2·2* (44·0)	1·9 (35·8)	2·0 (41·7)
Diameter of eye	0·7* (14·0)	0·9 (17·0)	0·9 (18·8)
Total myotomes	138	149	142
Preanal myotomes	78	74	80
Teeth	15/15*	20/17	18/17

* Calculated from the Text-Figures.

the present larva is of medium height only while those of *M. cinereus* and *M. talabonoides* have the maximum and minimum heights respectively. *M. talabon* shows a similar intermediate condition in the length of the snout also which is relatively long in *M. cinereus* and short in *M. talabonoides*. The head is of moderate length in *M. cinereus* while it is long in *M. talabonoides* and short in *M. talabon*. *M. talabon* possesses the largest eye while that of *M. talabonoides* is slightly smaller with that of *M. cinereus* the smallest among the 3 species. It is interesting to point out here that the maximum number of teeth of 20/17 is seen in the shortest species, namely, *M. talabonoides* while the tallest *M. cinereus* possesses only 15/15 teeth with the medium-sized *M. talabon* showing an intermediate number of 18/17 teeth.

M. talabon shows a high myotome variation and the number varies from 142 to 152. *M. talabonoides* shows only a variation of 2 myotomes from 147 to 149 while this is not recorded in the case of *M. cinereus*, which shows the lowest number of 138 myotomes. Corresponding with the differences in the length of the alimentary canal, the position of the vent also shows variations in relation to myotome number and it is located below the 80th, 78th and 74th myotomes in *M. talabon*, *M. cinereus* and *M. talabonoides* respectively. The predorsal and preanal distances of *M. talabon* are longer than those of *M. cinereus* while these are very short in *M. talabonoides*.

The shape of the pectoral fin has some diagnostic significance, and it is circular in *M. cinereus* while it is oval in *M. talabon* and long and pointed in *M. talabonoides*.

Apart from these differences in the general and morphometric characters, the noteworthy difference is seen in the pigmentation of the 3 larvæ. The head pigmentation of these larvæ is more or less uniform; the chromatophores being present in the middle portion of the upper jaw and in the region of the heart. In addition to this normal pigmentation of the head, both *M. talabon* and *M. talabonoides* show pigment cells at the tip of the lower jaw while it is unpigmented in *M. cinereus*. There is close similarity in the pigmentation along the mid-lateral line in *M. cinereus* and *M. talabon* and the row of pigment cells commences from the 17th and 14th myotomes respectively with all the successive myotomes in both the species being provided with chromatophores. On the other hand, in *M. talabonoides* this row commences from the 23rd myotome and the pigment cells are generally distributed at intervals of 3–4 myotomes in the anterior region while posteriorly alternate myotomes alone are provided with chromatophores.

The most striking difference is seen in the pigmentation of the alimentary canal of the 3 species. In *M. talabon*, the chromatophores are arranged in

3 rows in the posterior region of the alimentary canal of which 2 are paired while the third is unpaired and found on the right side of the alimentary canal. This asymmetrical arrangement of the chromatophores in *M. talabon* is found to be constant and serves as an important character in the identification of the larval, metamorphosing and elver stages. *M. talabonoides* also exhibits a highly characteristic pigmentation of the alimentary canal and the pigment cells are grouped at definite intervals to form conspicuous dark patches which persist in the metamorphosing and elver stages. In *M. cinereus*, the pigment cells do not show any pattern in their arrangement and they are distributed along the entire length of the alimentary canal. This study of the colouration of the 3 larval species of the same genus has shown clearly that each species shows a characteristic pattern of pigmentation of taxonomic importance using which the different larvæ, metamorphosing stages and even advanced elvers could be identified easily.

Jones and Pantulu (1952) gave an account of the metamorphosing stages of the talabon eel, *Muræsox talabon* collected from the Burhabulong estuary, Chandipore, on the 27th May 1951 from the stake-net catches. They described 6 stages in the metamorphosis of the larvæ and a comparison of the different stages shows that they do not conform to the stages proposed by Schmidt (1906) and Jespersen (1942). The different stages described by them do not correspond with the metamorphosing stages of *M. cinereus* (Nair, 1947). Consequently a rearrangement of the stages is found necessary for a comparison with those of *M. cinereus* and *M. talabonoides* (Nair and Mohamed, 1960 *a*). Stage I described by Jones and Pantulu is edentulous and is comparable to Stage II of *M. cinereus* while the larva collected from Visakhapatnam and described in the addendum approaches Stage I of *M. cinereus*, even though the larva has not reached full growth as shown by the undifferentiated nostril. Stages II and III generally conform with Stages III and IV of *M. cinereus* while Stages IV and V are really elvers with very little difference either in body proportions or in colouration. There is no decrease in the depth of the body and the same height of 2·07 mm. is given for both the stages. These stages correspond to Stage VI of *M. cinereus*. It is well known that the metamorphosis of leptocephalus is accompanied by considerable reduction in length and therefore the 6th stage described by them which is a juvenile eel is not considered here.

A comparison of the measurements and their percentages of the different stages as revised above given in Table III with those of the corresponding stages of *M. cinereus* (Nair and Mohamed, 1960 *a*) shows the close agreement in the morphometric characters of the larva as well as the metamorphosing stages.

TABLE III

Measurements of Muræsox talabon (*Jones and Pantulu*, 1952)

	Larva (I)	Stage I (II)	Stage II (III)	Stage III (IV)	Stage IV (VI)	Stage V (VI)	Stage VI (Juvenile)
Total length ..	64·0	65·0	69·0	61·0	72·0	71·0	216·0
Maximum height (excluding fins)	10·5 (16·4)	5·9 (9·1)	5·9 (8·6)	3·6 (5·9)	2·1 (2·9)	2·1 (3·0)	8·5 (3·9)
Predorsal distance ..	15·5 (24·2)	9·0 (13·8)	9·5 (13·8)	7·4 (12·1)	9·9 (13·8)	9·5 (13·4)	25·5 (11·8)
Preanal distance ..	41·0 (64·1)	32·5 (50·0)	25·0 (36·2)	22·0 (36·1)	22·0 (30·6)	21·0 (29·6)	74·0 (34·3)
Length of head ..	5·0 (7·8)	5·6 (8·6)	7·8 (11·3)	7·0 (11·5)	10·5 (14·6)	10·7 (15·1)	31·0 (14·4)
Length of snout ..	2·0 (40·0)	2·1 (37·5)	2·2 (28·2)	2·3 (32·9)	2·7 (25·7)	2·7 (25·2)	7·0 (22·6)
Diameter of eye ..	0·6 (12·0)	0·6 (10·7)	0·7 (9·0)	0·6 (8·6)	0·9 (8·6)	0·9 (8·4)	2·5 (8·1)
Total myotomes ..	136	136	136	..	..	136*	136*
Preanal myotomes ..	75	58	43	..	..	34*	32*

* Vertebrae.

and this resemblance makes it necessary to examine the characters on which Jones and Pantulu have distinguished the talabon larva from that of *M. cinereus*.

The authors found that the 'metamorphosing stages of the talabon present a close similarity to those of *M. cinereus*' and pointed out a few differences between the two species. One of the characters mentioned by them is in regard to the cleft of the mouth and they state that "the cleft of the mouth in *M. cinereus* extends up to the posterior border of the eye whereas in talabon it reaches well beyond the orbit". But in the description of the Visakhapatnam larva they have stated that the "cleft of the mouth reaches the posterior border of the obrit". Even though this character has no taxonomic significance it is seen that the cleft of the mouth of the larva of talabon eel does not show any difference from that of *M. cinereus*. The second character is in regard to the myotome number which is 138 in *M. cinereus* and 136 in the talabon larva and as shown in a subsequent part of this series (Nair and Mohamed, 1960 *b*) this difference in the myotome number is not significant enough to exclude the normal variation found within a species. The third point of difference relates to the mid-lateral row of pigment cells which in the larva described by them commences from the 10th myotome while in *M. cinereus* it begins regularly from the 17th myotome only. Even though this difference is only by a few myotomes, it may be pointed out that in *M. cinereus* 3–4 chromatophores have been noticed in the preceding myotomes also and in a line with the pigment cells of the mid-lateral series. Slight individual variations have also been observed in regard to the mid-lateral pigmentation making it of doubtful utility in identification, especially when the difference is only by a few myotomes. The other differences mentioned by Jones and Pantulu are the prominent rostral constriction and the tubulate nature of the anterior nostril of the talabon larva. These characters are not dealt with in the description of the different metamorphosing stages of *M. cinereus*; however, the figures of the head region of the different metamorphosing stages show these characters clearly. The rostral constriction in *M. cinereus* is seen distinctly in the advanced metamorphosing stages, especially in Stage V while the tubular nature of the anterior nostril is also shown clearly in the figure of the head of the elver.

It is seen from the above discussion that the larva and metamorphosing stages of *M. talabon* described by Jones and Pantulu belong to *M. cinereus* in view of the almost perfect agreement in the different characters. Additional evidence in support of this assumption is given by the fact that the pectoral fin is circular in the talabon larva also and it becomes oval in the metamorphosing and elver stages and this condition is found only in

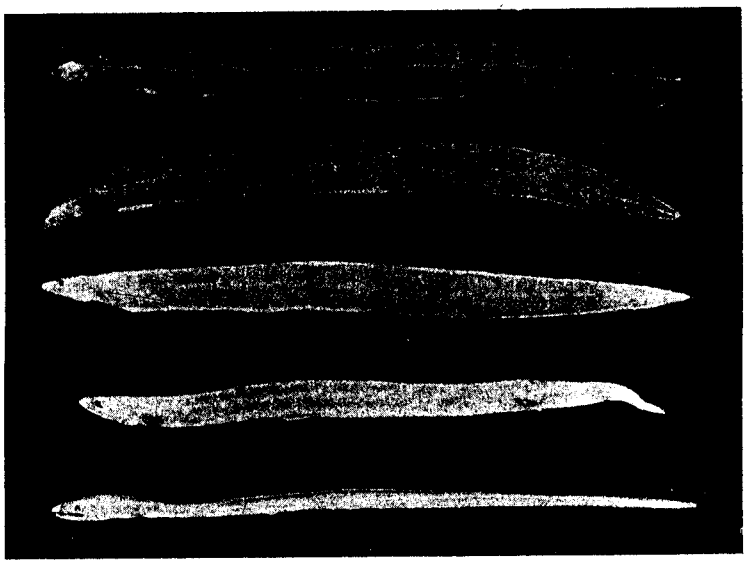


PHOTO. 1

PHOTO. 2

M. cinereus. Further, the larva described by them resembles that of *M. cinereus* in the early acquisition of the adult colouration of the body during the metamorphosis itself while in the other two species this is seen only in the elver stage. Lastly it may be pointed out here that according to Jones and Pantulu, the adult of *M. cinereus* is fairly common along the Orissa and Bengal coasts.

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EXPLANATION OF PLATE

PHOTOGRAPH 1. The five stages in the metamorphosis of *Muræsox talabon*. About natural size.

PHOTOGRAPH 2. A portion of the asymmetrical row of pigment cells on the alimentary canal of *Muræsox talabon*.