

Amphipnous indicus, a new synbranchoid eel from India, with a Redefinition of the genus and a Synopsis to the species of *Amphipnous* Müller¹

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(With two text-figures and two plates)

INTRODUCTION

On 28 July 1957 while collecting fish from a stream passing through Krishnagiri National Park, Bombay, one of us (E. G. Silas) came across a tiny eel-like fish 84 mm. in length. Subsequently a second specimen was obtained just above the main falls at Kanheri Caves about three miles further up. During the last week of September and early in October of the same year, it was once again possible, assisted by a party from the Natural History Section of the Prince of Wales Museum of Western India, Bombay, to collect several specimens of similar eel-like fishes from a streamlet passing through Robbers' Cave, Mahableshwar, Satara District, and one specimen from an adjacent stream at Mahableshwar. A note on the fishes collected on an earlier occasion from the Robbers' Cave together with some ecological observations has appeared elsewhere (Silas, 1953).

A close examination showed that all these eel-like fishes collected at Borivli (elevation between 30 and 75 metres above m.s.l.), and Mahableshwar (elevation about 1400 metres) are identical, belonging to a hitherto undescribed species of the synbranchoid family Amphipnoidae, known thus far from only two species, *A. cuchia* (Hamilton), said to be the most highly evolved air-breathing fish in India, and *A. fossorius* Nair. The new species is designated here as

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Amphipnous indicus sp. nov., based on its systematic description given below. The anatomical details etc. will be dealt with separately.

***Amphipnous indicus* sp. nov.**

Material:

Holotype: 1 specimen 412 mm. in total length.

Type locality: Robbers' Cave, Mahableshwar, Satara District, Maharashtra State, India.

Paratypes: 43 specimens from Robbers' Cave, Mahableshwar; 1 specimen from Dhobi Falls, Mahableshwar; 1 specimen from Davri R., Krishnagiri National Park, Borivli, Bombay; 1 specimen from above Kanheri Falls, Kanheri Caves, Bombay.

The type material will be deposited in the research collection of the Bombay Natural History Society.

Diagnosis:

Body elongate, eel-like, head relatively short, snout bluntly rounded, and occipital region dome-shaped and muscular; scales present in irregular rows on tail and in a narrow streak along dorsum in posterior part of trunk and occasionally in a small isolated patch midventrally in front of vent; palatine teeth anteriorly in three or four rows; branchiostegals five; gills greatly reduced to highly vascularised plate-like structures present on third and fourth branchial arches; suprabranchial accessory respiratory chamber well developed; preanal vertebrae 93 to 99.

DESCRIPTION

Body proportions:

In the following paragraph the body proportions are given in thousandths of the total length as follows. First that of the holotype is given followed in parenthesis by the range and mean for all the specimens examined. For additional details reference may be made to Table IV.

Head 76 (65-84 : 73); eye 5 (4-9 : 5); snout 21 (14-23 : 19); interorbital distance 19 (9-21 : 16); tip of snout to posterior nostril 19 (13-20 : 17); isthmus between gill openings 16 (12-21 : 16); width of gill opening 6 (2-9 : 6); gape of mouth 27 (16-27 : 22); snout to vent 794 (770-830 : 798); greatest height of body 36 (25-41 : 34); width of body 31 (22-35 : 27); snout to occiput 70 (57-78 : 68);

height at occiput 30 (26-38 : 31); distance between anterior nostrils 9 (5-14 : 10); distance between posterior nostrils 12 (7-15 : 12); snout to posterior nostril 19 (13-20 : 17); greatest width of upper lip 9 (4-11 : 8); width of lower lip 4 (3-7 : 5); height of head 38 (25-42 : 35); depth of body at vent 28 (18-32 : 27); depth of body midway between vent and caudal end 22 (16-32 : 24); width of body at vent 20 (16-25 : 21); end of maxilla to tip of snout 40 (26-45 : 37); end of maxilla to tip of lower jaw 34 (21-38 : 31); and length of preanal scaly patch along dorsum 252 (110-392 : 226) in total length.

Head:

The head is conspicuous from the rest of the body by the dome-shaped muscular occipital region and the bluntly rounded snout. A profuse secretion of mucus, mostly from the anterior part of the body was noticeable soon after the animals were caught and when preserved in formalin this formed into a thick opaque covering all over the body, especially on the head and scaleless part of the trunk. When the mucus layer is cleared, the glandular skin with the pitted surface, especially on the head and nape region is discernible (Plate I, figs. 10 & 11).

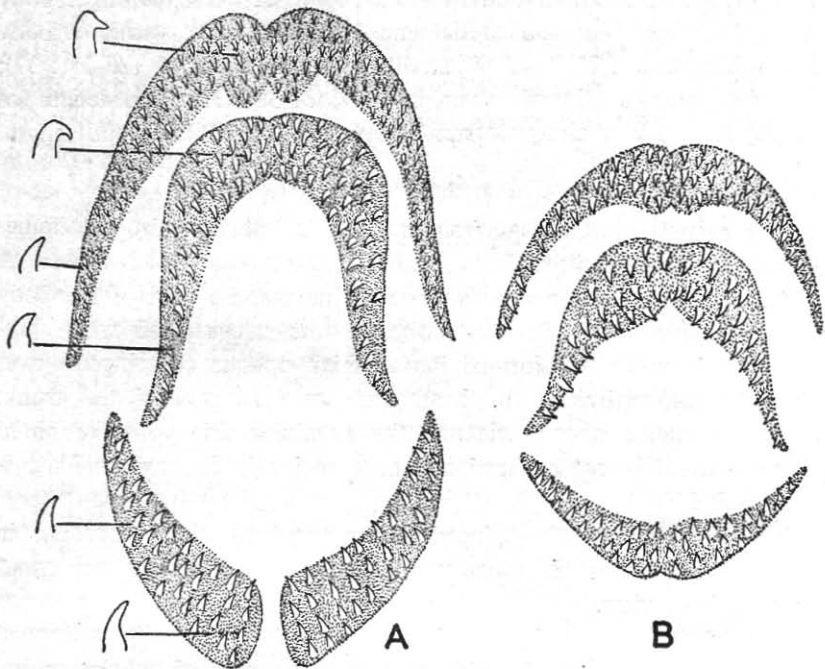
The eyes are greatly reduced and covered by skin. Usually, in preserved specimens the opaque mucus layer completely obliterates the eyes from view.

Part of the snout and upper jaw overhangs the ventrally positioned mouth. The upper lip is thick and overlaps part of the lower lip. Towards the extremity on either side of the symphysis the anterior nostrils appear as two holes. The post-labial groove is not continuous, being interrupted anteriorly at the symphysis of the lower jaw.

Dentition:

While the general pattern is the same both in the young and adults of *A. indicus*, there is a tendency in the larger specimens for an increase in the number of teeth on the maxillary, palatine, and mandibular bands (Text-fig. 1). In a specimen 425 mm. long the palatine band shows four rows of teeth anteriorly which progressively decrease to a single row in the posterior third of the band. The maxillary band has 5 to 6 rows of teeth near the symphysis, but laterally it shows three rows becoming uniserial at the posterior end. When the mouth is closed, in the larger specimens part of the maxillary band of teeth is seen exposed. The mandibular teeth are arranged in three or four rows at the symphysis. The shape of the teeth at different parts of the bands are indicated in Text-fig. 1.

The pattern of the dentition is another important feature distinguishing the new species from its congeners. In *A. cuchia* the palatine and mandibular teeth are uniserial. In the case of *A. fossorius* the maxillary teeth are arranged in two or three rows at the anterior end,



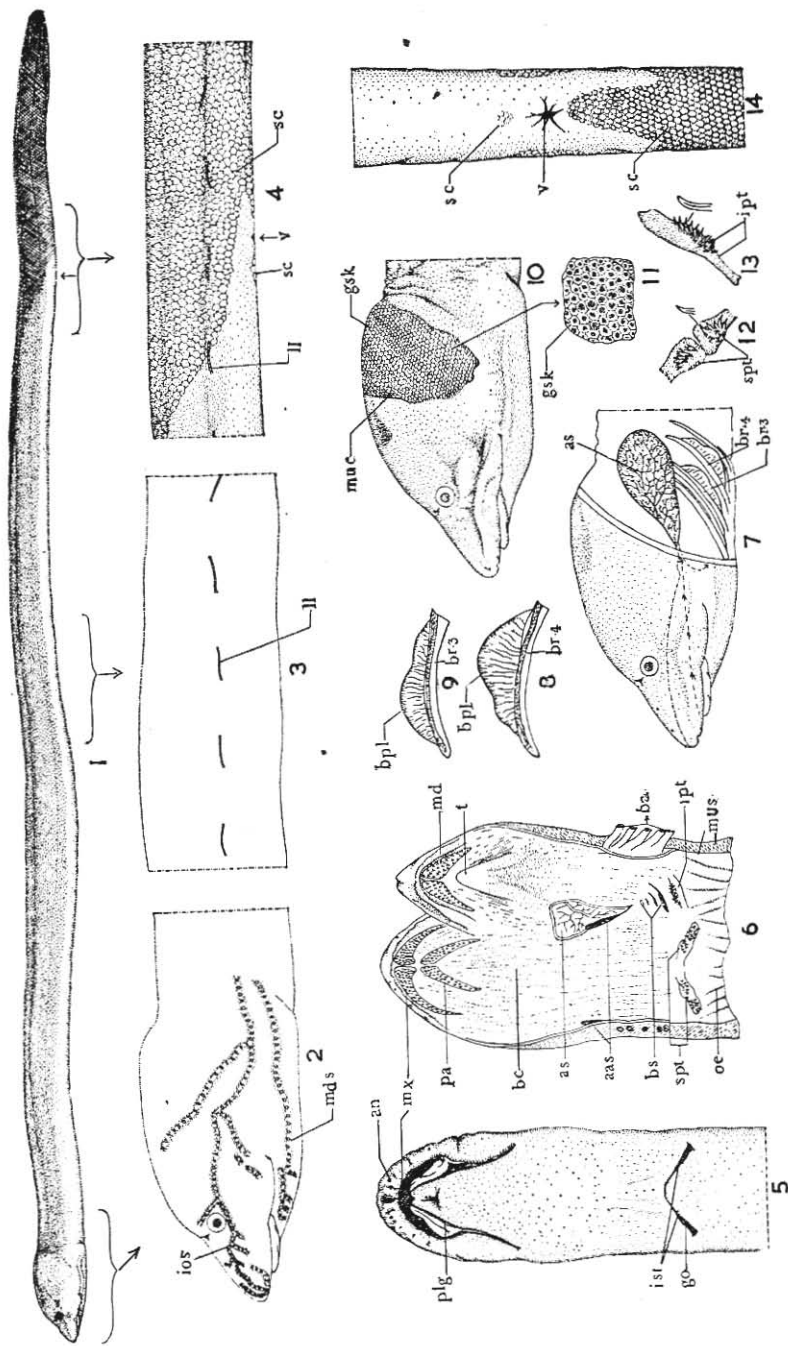
Text-fig. 1. Dentition of *Amphipnous indicus* sp. nov.

A. paratype 425 mm. long, and B. paratype 127 mm. long.

but uniserial in the posterior half and the palatine teeth are biserial anteriorly and uniserial posteriorly; further, the teeth in *A. fossorius* are more pointed and distinctly directed backwards than in *A. indicus*.

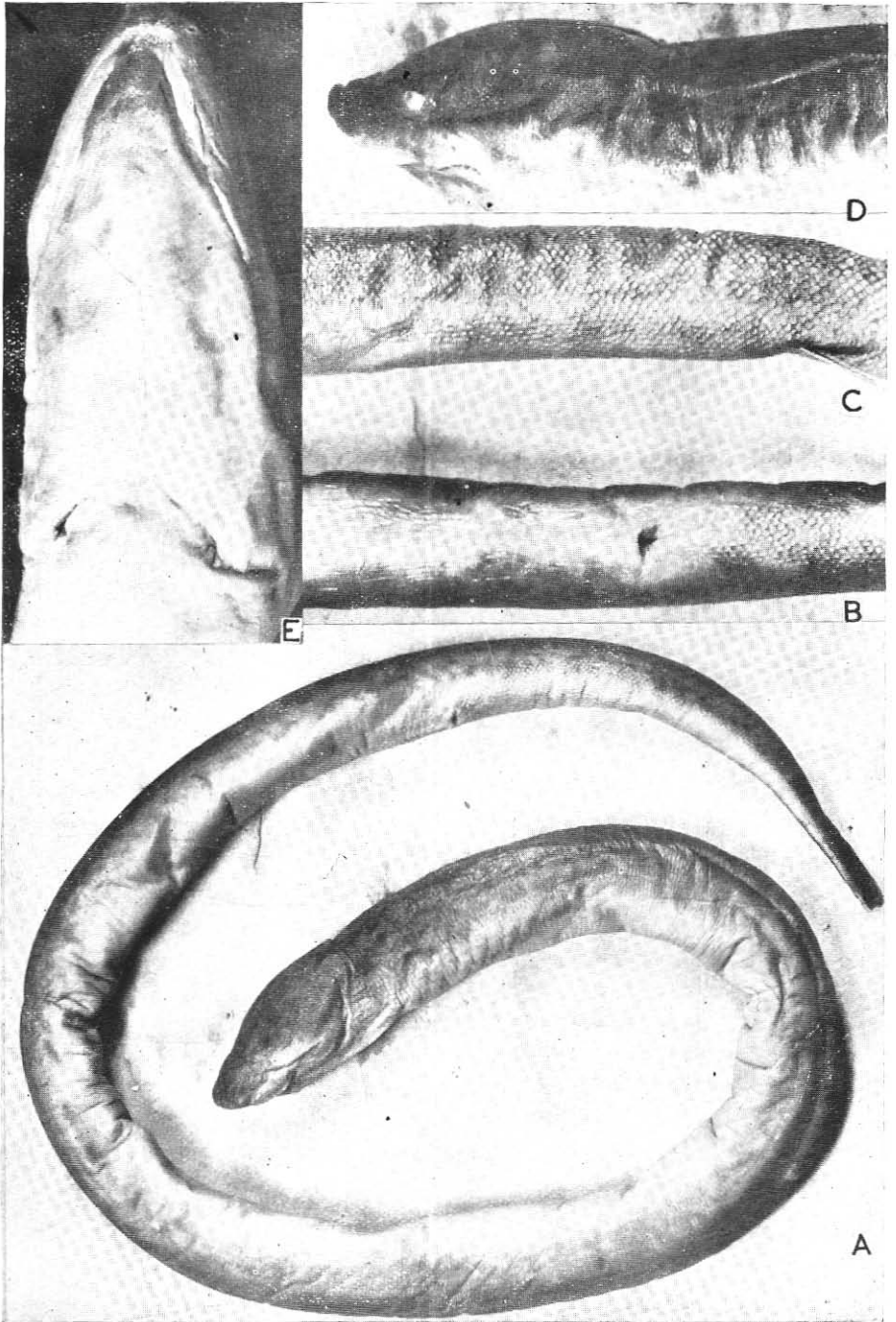
Caudal region:

The dorsal and anal 'fin folds' or ridges vary with age, being more conspicuous in the young. In the latter, the dorsal ridge commences about 0.25 length of head behind level of vent while it can be made out only in the posterior third of the post-anal distance in the adults. The anal ridge commences almost midway between the vent and the end of the caudal in the young, while in the adults it is seen only in the last fourth of the length of the post-anal distance. In *A. cuchia* the dorsal 'fin fold' is said to commence slightly ahead of a vertical line above the vent, while in *A. fossorius* the condition is



Amphippinus indicus sp. nov.

For explanations see p. 378.



Amphipnous indicus sp. nov.
For explanations see p. 378.

more or less as in *A. indicus*, but the anal fold in *A. fossorius* commences from the mid post-anal distance. The caudal tip in *A. indicus* is bluntly rounded.

Scales:

The scales are present in the post-anal part of the body. Anterior to and above the vent they occur as a narrow band along the dorsum extending to some distance in the front, but not surpassing the mid-point of total length. The sides above the vent and slightly behind it are devoid of scales (Pl. I, figs. 4 & 14, and Pl. II, figs. B & C). In a few specimens a small scaly patch is present in front of the vent midventrally.

Although the scales are not arranged in regular longitudinal rows, they are nevertheless countable. Where they completely encircle the body behind the vent there are on the average about 52 scales as shown by the frequency of their occurrence in 40 specimens detailed in Table I.

TABLE I

Frequency of occurrence of scales round body behind vent in *A. indicus* sp. nov.

No. of scales	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
No. of specimens	—	1	3	3	3	3	3	2	3	7	7	3	1	1	—	—	1	—	—	—	—

The scales are relatively much smaller when compared to those of *A. fossorius*. A typical scale from the side of the tail of a specimen 372 mm. long shows the basal nucleus extending to one-third the length of the scale. The radii are complete, there being 8 apically and 12 or 13 laterally on each side. The circuli are widely spaced apically, numbering 12 in this region. Laterally they are placed more close together and many terminate at the sides of the nuclear area, so much so that only 3 closely placed basal circuli are seen. Variations from this general pattern are seen in scales from different parts of the body and these will be dealt with elsewhere along with a comparative account of the scales of all the three species.

Lateral canal system:

In *A. indicus*, the lateral canal system is well developed and is clearly discernible even in the juveniles. The typical pattern as seen in the larger specimens is shown in Pl. I, figs. 2, 3, & 4. The canal

system on the body appears discontinuous along the mid-lateral part of the body where it is present as short linear streaks each having a number of open pores. The lateral canal system is generally not visible unless the mucus over the body is cleared away.

The nature of the lateral canal system is not known in the case of *A. cuchia* and *A. fossorius*. However, the condition seen in the head region of *A. indicus* differs considerably from that of an allied synbranchoid fish *Monopterus javanensis* Lacépède as described by Yih (1948). The mandibular canal is present in both, but *A. indicus* shows a distinct infraorbital canal (Pl. I, fig. 2), which is absent in *M. javanensis*. The latter instead has the supraorbital canal well developed. It is likely that the nature of the lateral canal system may vary in the different species of the genus *Amphipnous*.

Vertebrae:

X-ray photographs of 32 specimens were taken for vertebral counts. From these, the pre-anal vertebrae could be clearly counted, while those towards the end of the tail were rather indistinct. However, two specimens cleared and stained with alazarin showed 95 and 99 pre-anal and 42 caudal vertebrae respectively.

TABLE II

Frequency of occurrence of pre-anal vertebrae in *A. indicus* sp. nov.

No. of pre-anal vertebrae	90	91	92	93	94	95	96	97	98	99	100
No. of specimens	—	—	—	3	8	10	11	1	—	1	—

The number of pre-anal vertebrae thus range from 93 to 99 (average about 95) while the total number of vertebrae for the species is about 137 to 144.

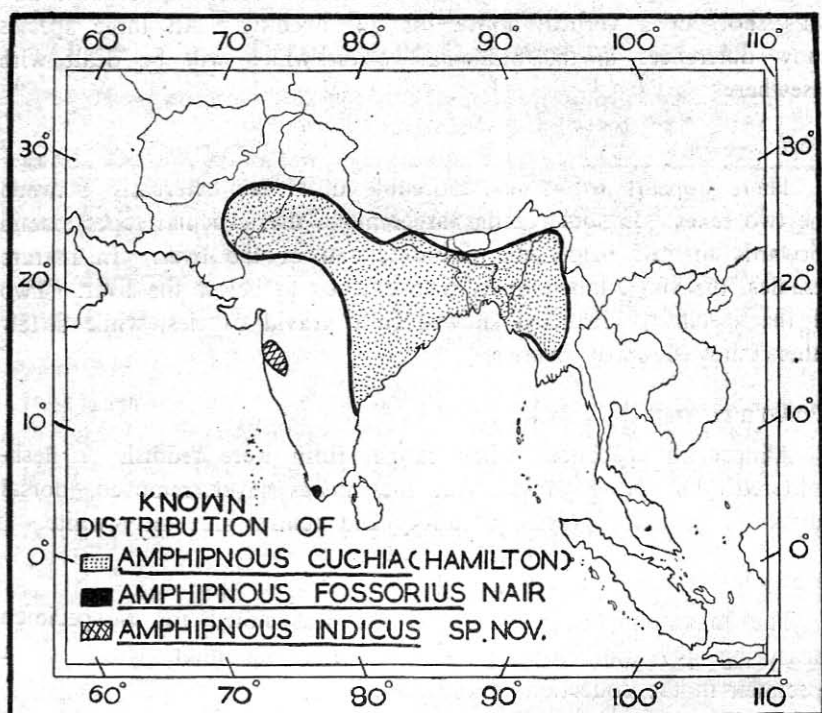
The number of vertebrae differ in the three species of *Amphipnous* as shown in Table III.

TABLE III

Characters	<i>A. indicus</i> sp. nov.	<i>A. cuchia</i> (Ham.) (after Günther, 1870)	<i>A. fossorius</i> Nair (after Nair, 1951)
No. of pre-anal vertebrae	93-99	106	73
No. of caudal vertebrae	42-45	65	53-56
Total No. of vertebrae	137-144	171	126-129

In this connection it is interesting to note that Nair (1951) found the pre-anal vertebrae in *A. fossorius* to be constant (73), while the

caudal vertebrae were found to vary in number. The range for *A. cuchia* is not known, but the figures given indicate a much higher count for that species. The vertebral counts in the three species also indicate another interesting trend of an increase from the southern to the northern latitudes as seen in the lowest counts in



Text-fig. 2. Map showing the distribution of species of the genus *Amphipnous* Müller

A. fossorius from the southernmost part of India to the highest counts in *A. cuchia* in the northernmost parts of India. Text-fig. 2 shows the natural distribution of the three species.

Branchial region:

The gill filaments of the third and fourth branchial arches are reduced and fused to form plate-like organs which are highly vascular. The first two branchial arches are placed close together, so much so that, instead of a branchial slit there is only a shallow blind pocket indicating the position in the wall of the bucco-pharyngeal cavity. Behind this are three narrow branchial slits, the posteriormost one being the broadest (Pl. I, fig. 6). The gill opening on either side is narrow and is separated by a wide isthmus. The gill membranes

unite with each other to form a slight ridge below the isthmus, but the latter can be distinctly made out.

The walls of the accessory air chamber are also highly vascular but, unlike *A. cuchia* where the accessory air chamber is much elongate and shown by Das (1927) as surpassing posteriorly a line above the gill opening, in *A. indicus* the chamber is relatively broader and falls short of a vertical above the gill opening. All three species show differences in the branchial region which will be dealt with elsewhere.

Sex:

There appears to be no noticeable difference externally between the two sexes. In some of the larger males the testicular lobes extend forwards to just below the posterior end of the liver. In mature females, the single-lobed ovary also extends to below the liver. Two of the specimens dissected showed fully gravid ovaries, while a few others showed spent ovaries.

Colour:

Almost all specimens when caught fresh were reddish or flesh-coloured. On preservation, with the mucus layer removed, dorsal surface is generally greyish or dusky and ventral side dirty white.

Weight and size:

The maximum weight of 72.1 gm. was noted for a specimen measuring 447 mm. in total length. The maximum length of a specimen in the collection is 480 mm.

Altitudinal distribution:

The collection of *A. indicus* from about 1400 metres above m.s.l., at Mahableshwar, is interesting, and shows the distribution of the species as occurring from just above sea-level to the colder waters of the hill streams of the Western Ghats of Bombay. The smallest specimen from Mahableshwar measures 82 mm. and this combined with the condition of the ripe ovaries of two of the specimens examined and the spent ovaries of a few others suggests the possibility of the fish breeding inside the cave or in the marshy areas in the vicinity of Robbers' Cave. That the fish could be a resident in the cooler waters at that altitude is also suggested by the recent discovery of its congener, *A. cuchia*, from the Kathmandu Valley, Nepal (DeWitt, 1960). In view of this, it will not be surprising if *A. fossorius*, at present known only from the

low-lying areas near Trivandrum, is also found to occur in marshy places along the courses of hill streams in the Western Ghats of Kerala. In any case, the spatial distribution of *A. indicus* and *A. cuchia* shows their adaptability to relatively cooler waters also.

TABLE IV
DETAILS OF BODY PROPORTIONS

(No. of specimens followed by range in thousandths of total length : the averages are given in parentheses)

Species	<i>A. indicus</i> sp. nov.					<i>A. fossorinus</i> Nair
	0 - 100 mm.	101 - 200 mm.	201 - 300 mm.	301 - 400 mm.	401 - 500 mm.	
Total length						192 mm.
Head length	5 : 73-80 (76.5)	3 : 66-71 (68.5)	3 : 65-69 (66.6)	15 : 66-78 (72.8)	20 : 74-84 (78.4)	83
Diameter of eye	5 : 5-9 (6.8)	3 : 5-8 (7.0)	3 : 4-5 (4.6)	15 : 4-6 (4.8)	20 : 4-6 (5.0)	6
Length of snout	5 : 16-22 (18.8)	3 : 16-18 (17.0)	3 : 14-17 (15.3)	15 : 16-22 (19.3)	19 : 18-23 (20.4)	20
Height of body	5 : 28-33 (29.6)	3 : 25-37 (30.3)	3 : 31-34 (32.3)	15 : 31-40 (35.3)	20 : 30-41 (35.4)	29
Width of body	5 : 22-30 (25.2)	3 : 25-31 (28.0)	3 : 24-29 (27.0)	15 : 25-35 (27.8)	20 : 24-35 (29.0)	23
Height of head	4 : 26-29 (28.0)	3 : 25-31 (27.6)	3 : 30-34 (32.0)	15 : 33-39 (35.7)	20 : 33-42 (37.8)	33
Depth at vent	4 : 23-29 (26.2)	2 : 24-28 (26.0)	3 : 28 (28)	15 : 25-32 (28.3)	20 : 18-32 (26.4)	19
Angle of mouth to tip of snout	4 : 26-39 (33.0)	2 : 31-33 (32.0)	3 : 30-34 (32.6)	15 : 31-40 (36.1)	19 : 35-45 (41.6)	42
Dist. bet. upper angles of gill openings	5 : 18-24 (20.2)	2 : 20 (20.0)	3 : 20-21 (20.6)	15 : 19-21 (21.4)	20 : 18-23 (21.7)	13
Snout to vent	5 : 762-791 (776.2)	3 : 734-784 (768.3)	3 : 796-803 (800.3)	14 : 775-814 (811.1)	20 : 784-830 (810.0)	779
Length of pre-anal scaly patch	4 : 110-167 (148.5)	—	3 : 258-341 (286.1)	15 : 137-311 (244.4)	20 : 144-290 (208.5)	*167?

* In this specimen examined, the scales are absent in the anterior part of the trunk.

REDEFINITION OF THE GENUS *Amphipnous* MÜLLER 1839

The last definition of the genus *Amphipnous* Müller given by Day (1878) reads as follows:

'Branchiostegals six. Gill membranes almost entirely grown to the isthmus, and having a single transverse opening. Three branchial arches with the laminae rudimentary, divided by narrow slits. A respiratory air sac exists on the neck behind the head communicating with the gill cavity. Palatine teeth in a single well-developed row. Scales present and arranged in longitudinal rows.'

With the discovery of *A. fossorius* and *A. indicus* from peninsular India, a redefinition of the genus is necessary and this is given below:

Genus *Amphipnous* Müller

Amphipnous Müller, 1839, *Adh. Akad. Wiss. Berlin*, p. 244 (Orthotype: *Unibranchapertura cuchia* Hamilton).

Pneumobranchus McClelland, 1844, *Calcutta Journ. Nat. Hist.* 5: 192 [Logotype: *P. striatus* McClelland = *A. cuchia* (Hamilton)].

Branchiostegals five or six; body elongate, cylindrical anteriorly and tail compressed laterally; body partly or wholly covered with small cycloid scales; posterior nostrils placed interorbitally; anterior nostrils placed near end of snout in upper lip; fins totally absent, but short dorsal and anal rayless folds of skin present on tail, confluent at tip; suprabranchial accessory respiratory chamber present on either side; gills greatly reduced and fused to form highly vascular plate-like structures on two or three branchial arches; two or three branchial slits leading from buccopharyngeal cavity to branchial chamber; a pair of gill openings partly or well concealed by the fold of the united gill membranes; teeth uniserial or multiserial on jaws and palate; vertebrae 121 to 171, pre-anal vertebrae numbering 73 to 106.

The genus is distributed along parts of India, Pakistan, Nepal, and Burma.

SYNOPSIS TO THE SPECIES OF THE GENUS *AMPHIPNOUS* MÜLLER

1. Palatine and mandibular teeth in two or more rows; vertebrae 126 to 144, pre-anal vertebrae being 73 to 99 3
2. Palatine and mandibular teeth uniserial; vertebrae about 171, pre-anal vertebrae 106 (longitudinally arranged scales present throughout body; branchiostegals 6) *Amphipnous cuchia* (Hamilton)

Note:

No attempt has so far been made to study the variations in the vertebral counts of this species. Material from Burma should be specially examined in the context.

Amphipnous fossorius Nair

Amphipnous fossorius Nair, 1951, *Proc. Indian Acad. Sci.* 34(B) (6): 311-316, 321, 326-327, figs. 1,7. (Type locality: Marshy areas in the paddy fields and banana plantations adjoining Karamanai River, Karamanai, Trivandrum, Kerala State)

Note:

The single specimen of *A. fossorius* that we have examined is devoid of scales in the anterior part of the body; the scales are arranged in distinct longitudinal rows in the posterior half. The skin in the anterior part of the body is smooth without any indication of scale pockets. According to Nair (1951) 'the body is covered by very minute cycloid scales . . .'; we feel that this character needs rechecking in the type material also. Unlike in *A. indicus*, the gill openings and the crescent-like opening is greatly arched. The longitudinal furrows on the ventral side of the branchial region of the head as in some of the true eels (e.g. *Moringua* etc.) are very characteristic of this species.

ACKNOWLEDGEMENTS

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(Only those not listed under the synonyms to the species are given below.)

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EXPLANATION OF PLATES

PLATE I

Amphipnous indicus sp. nov.

1. Lateral view of holotype 412 mm. long ; 2. Head region showing lateral sensory canal system ; 3. Middle of body showing scaleless condition as well as discontinuous sensory canal system along the midlateral part of the body ; 4. Part of trunk and tail showing disposition of scales and discontinuous lateral sensory canal system along midlateral part of body ; 5. Ventral view of head and anterior part of body ; 6. Dissection showing both roof and floor of buccal cavity and pharynx and indicating the position of the aperture to the air chamber and its relation to the branchial slits ; 7. Lateral dissection showing the position of the accessory air chamber ; 8. Fourth branchial arch and attached plate-like organ composed of fused gill filaments ; 9. Third branchial arch showing same structure as 8 ; 10. Lateral view of head with part of mucus coating removed to show glandular skin ; 11. Patch of skin of head magnified to show pitted glandular nature ; 12. Suprapharyngeal bone and its teeth ; 13. Infrapharyngeal bone and its teeth ; 14. Ventral view of part of trunk and tail showing disposition of scales.

Abbreviations : *aas* aperture of accessory air chamber ; *an* anterior nostril ; *as* accessory air chamber ; *ba* cut ends of branchial arches ; *bc* buccal cavity ; *bpl* gill filaments fused to form gill plates ; *br* branchial arches ; *bs* branchial slits ; *go* gill opening on one side ; *gsk* glandular skin ; *ios* infraorbital sensory canal ; *ipt* infrapharyngeal bone and teeth ; *ist* isthmus between gill openings ; *ll* discontinuous lateral canal system on side of body ; *md* mandibular band of teeth ; *mds* mandibular sensory canal ; *muc* layer of mucus covering on head ; *mus* muscular body wall cut across ; *mx* maxillary band of teeth ; *oe* oesophagus ; *pa* palatine band of teeth ; *plg* post labial groove ; *sc* scales ; *spt* suprapharyngeal bone and teeth ; *t* tongue ; *v* vent.

PLATE II

Amphipnous indicus sp. nov.

A. Holotype, 412 mm. long ; B. Ventral view of part of trunk and tail showing arrangement of scales ; C. Lateral view of same, but showing more of the tail portion and complete encirclement of scales in the posterior part ; D. Lateral view of head of paratype showing characteristic dorsal profile ; E. Ventral view of same, with the skin cut to enable counting of branchiostegal rays.