

OCCASIONAL PAPER NO. 172

**RECORDS OF THE
ZOOLOGICAL SURVEY OF INDIA**

**Gymnophiona (Amphibia) of India
A Taxonomic Study**

**R. S. PILLAI
AND
M. S. RAVICHANDRAN**

ZOOLOGICAL SURVEY OF INDIA

OCCASIONAL PAPER NO. 172

**RECORDS OF THE
ZOOLOGICAL SURVEY OF INDIA**

**Gymnophiona (Amphibia) of India
A Taxonomic Study**

R. S. PILLAI

*Emeritus Scientist, Zoological Survey of India, Madras
and*

M. S. RAVICHANDRAN

Zoological Survey of India, Madras

Edited by the Director, Zoological Survey of India



सत्यमेव जयते

Zoological Survey of India

Calcutta

1999

CITATION

Pillai, R. S. 1999. *Gymnophiona (Amphibia) of India—A Taxonomic Study* Occ. Paper No. 172 i-vi, 1-117 pp. (Published—Director, ZSI, Calcutta).

Published June, 1999

ISBN 81-85874-13-1

© Government of India, 1999

ALL RIGHTS RESERVED

- No part of this publication may be reproduced stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without the prior permission of the publisher.
- This book is sold subject to the condition that it shall not, by way of trade, be lent, resold hired out or otherwise disposed of without the publisher's consent, in any form of binding or cover other than that in which it is published.
- The correct price of this publication is the price printed on this page. Any revised price indicated by a rubber stamp or by a sticker or by any other means is incorrect and should be unacceptable

PRICE :

Rs. 300.00

\$ 20 £ 15

Published at the Publication Division by the Director, Zoological Survey of India, 234/4, AJC Bose Road, 2nd MSO Building (13th Floor), Nizam Palace, Calcutta-700 020 after laser typesetting by Krishna Printing Works, 106 Vivekananda Road, Calcutta-700 006 and printed at Hooghly Printing Co. Ltd., (A Govt. of India Enterprises), Calcutta.

PREFACE

Gymnophiona are perhaps the least known of all the larger vertebrate groups of the world, with the possible exception of some orders of deep sea fishes. The subterranean mode of life contributes to their rarity. Caecilians have a very restricted world distribution and even within these areas they occur only in small pockets.

Paucity of material is the chief constraint in the study of caecilian taxonomy. Taylor, a world authority on caecilians in his celebrated work "The Caecilians of the World" states "Most of the specimens that have reached museums are those discovered by chance or accident rather than by direct search by a competent collector. A party of four from a major museum recently spent some three months in Panama searching for reptiles and amphibians. Despite the fact that caecilians were one of their major objectives and Panama has three genera and atleast eight species, they obtained only a single specimen. Numerous museums that have sent collectors to various parts of the world have met with similar results. Only in the case of a few species do museums have adequate series. Even when a collector knows an exact geographical locality and an exact habitat of a subterranean species, the digging effort required to discover one may be equivalent to spading up a small garden! I recall numerous times when my own efforts in digging in likely spots have yielded nothing. Rarely enough are specimens to be taken in numbers. The number of species known from one or two specimens is remarkable"

The caecilian fauna of India has never been systematically studied. While information on their taxonomy is inadequate, other aspects including their biology and ecology are very imperfectly known. Only eight species of caecilians were known from India till 1960. Seven were added to these by Taylor from 1960 to 1968; the only subsequent addition was by Pillai in 1968. Thus the total number of species of Indian caecilians stood at 16.

The objectives of this study are three fold : bring together all the taxonomic information available on Indian Gymnophiona by studying the preserved materials that lie scattered in various institutions in India; attempt fresh collections to supplement the rather meagre material that is presently available; describe and illustrate existing species, erect new taxa if necessary, document their distribution, and present a treatise on the Indian Gymnophiona at the alpha-taxonomy level. It is hoped that this work shall serve to inspire further research on this ancient and unique group of apodous amphibians. A chapter on "Morphology and Terminology" outlining the external morphological characters which have a bearing on their taxonomy is included here to assist such work.

Paucity of knowledge on the systematics, distribution and habitat requirements of Indian caecilians is a major constraint to any intelligent conservation programmes. Although conservation is not the objective here, it is hoped that the present study shall serve as a foundation towards formulation of a conservation policy for Indian Gymnophiona.

This monograph was planned originally to be authored solely by the senior author. However, the contributions made by Dr. M. S. Ravichandran in the compilation of morphological data justifies his inclusion as a co-author. Use of first person singular in the text pertains to the observations of the senior author either during field collections or in museums he has visited for study of caecilian material.

Manuscript of the monograph was submitted for publication in June 1994 and hence subsequent publications, if any, have not been consulted.

Records of The Zoological Survey of India

OCCASIONAL PAPER 172

No. 172

1999

Pages 1 – 117

CONTENTS

PREFACE	iii
INTRODUCTION	1
What are caecilians?	1
Gymnophiona in the Taxonomic System	1
Classification of Gymnophiona	2
The Indian Perspective	3
MATERIAL AND METHODS	4
A REVIEW OF LITERATURE ON THE TAXONOMY OF INDIAN GYMNOPHIONA	6
MORPHOLOGY AND TERMINOLOGY	9
DISTRIBUTION	14
HABITS AND HABITATS	15
LIFE HISTORY	16
ABBREVIATIONS	18
TAXONOMIC TREATMENT	19
Key to Orders of Class Amphibia	19
Order Gymnophiona	19
Classified list of Gymnophiona of India	19
Key to Families of Indian Gymnophiona	20
Family Ichthyophiidae	20
Genus <i>Ichthyophis</i> Fitzinger	21
Key to Species of Genus <i>Ichthyophis</i> of India	21
1. <i>Ichthyophis beddomei</i> Peters	22
2. <i>Ichthyophis bombayensis</i> Taylor	26
3. <i>Ichthyophis garoensis</i> sp. nov.	28
4. <i>Ichthyophis glutinosus</i> (Linnaeus)	32
5. <i>Ichthyophis husaini</i> sp. nov.	36
6. <i>Ichthyophis longicephalus</i> Pillai	39
7. <i>Ichthyophis malabarensis</i> Taylor	42

8.	<i>Ichthyophis peninsularis</i> Taylor	45
9.	<i>Ichthyophis sikkimensis</i> Taylor	49
10.	<i>Ichthyophis subterrestris</i> Taylor	52
11.	<i>Ichthyophis tricolor</i> Annandale	56
	Family Uraeotyphlidae	59
	Genus Uraeotyphlus Peters	59
	Key to Species of Genus <i>Uraeotyphlus</i> of India	60
12.	<i>Uraeotyphlus interruptus</i> sp. nov.	60
13.	<i>Uraeotyphlus malabaricus</i> (Beddome)	64
14.	<i>Uraeotyphlus menoni</i> Annandale	67
15.	<i>Uraeotyphlus narayani</i> Seshachar	70
16.	<i>Uraeotyphlus oxyurus</i> (Dumeril & Bibron)	74
	Family Caeciliidae	77
	Key to Genera of Family Caeciliidae of India	77
	Genus <i>Indotyphlus</i> Taylor	77
17.	<i>Indotyphlus battersbyi</i> Taylor	78
	Genus <i>Gegeneophis</i> Peters	81
	Key to Species of Genus <i>Gegeneophis</i> of India	81
18.	<i>Gegeneophis carnosus</i> (Beddome)	82
19.	<i>Gegeneophis fulleri</i> (Alcock)	85
20.	<i>Gegeneophis krishni</i> sp. nov.	87
21.	<i>Gegeneophis ramaswamii</i> Taylor	90
	SUMMARY AND CONCLUSIONS	92
	ACKNOWLEDGEMENTS	94
	BIBLIOGRAPHY	96
	MAPS	100
	PHOTOGRAPHS	110

INTRODUCTION

What are Caecilians?

Known popularly as caecilians, Gymnophiona, one of the three extant orders of Class Amphibia, comprises a group of limbless, girdleless, burrowing amphibians with an elongate body. They are restricted to certain tropical and subtropical environments of the world and resemble large earthworms in having a well defined body segmentation and practically no tail. Within the body folds are scales concealed under the skin and these are unquestionably an inheritance from the carboniferous Amphibia. The eyes are lidless, visible outside and seems functional in some while it is concealed under the tissues or embedded in the bones of the skull in others. A universal and distinctive character is the presence of a tentacular organ which grows forward along the sides of the brain, and emerges from the skull either at the eye socket or at a point in front of and below the eye. Adults lack gills or gill slits.

Although highly modified and specialised for a subterranean life, caecilians retain many primitive features and it seems certain that they originated from some other group of fossil amphibia than did the frogs and toads (Anura) and salamanders (Caudata), presumably the Lepospondyli. The single recognised caecilian fossil is from the Paleocene of Brazil.

Caecilians are primarily forest animals. Members of one family, Typhlonectidae, live in rivers while the rest are all terrestrial and fossorial living in burrows in damp earth.

Gymnophiona in the Taxonomic System

The first ever published account in herpetological literature, of a caecilian species is that of Seba (1735) who included certain reptiles and amphibians under the name "Caecilia" Linnaeus in 1749 figured and published the description of a new species, *Caecilia tentaculata* which according to him belonged to a new genus of serpent though the possibility of its being related to eel-like fishes was not totally ruled out by him. Thus the Latin name, *Caecilia*, though misplaced, became one of the earliest generic names in the Linnaean system of nomenclature. Linnaeus in 1754 described a second species of caecilian, purported to be from India viz. *Caecilia glutinosa* (= *Ichthyophis glutinosus*). However, for more than half a century, caecilians were considered as reptiles devoid of scales. Some included them in the genus *Mixine* along with lampreys. The ordinal name, Apoda used for caecilians by some, was applied earlier to eel-like fishes and hence is not available for caecilians.

It was Muller (1831) who, on the basis of an example from Java, discovered that despite their resemblance to snakes, caecilians were really amphibians. Gill slits and the nature of the branchial arches in a juvenile specimen gave him the clue, although this was not accepted immediately by other systematists. However, ever since the review of its anatomy by Dumeril and Bibron (1838), caecilians were placed under Amphibia. The present name, Gymnophiona, to the order may be taken to be the result of Muller's earlier suggestion that the first ordinal group of Batrachians be designated as Gymnophides.

Classification of Gymnophiona

Diversity of caecilians was considered to be very low before Taylor started publishing on the systematics of the group from 1960 onwards. Prior to this all caecilians were placed in a single family Caeciliidae which contained 117 species in 21 genera. The monograph published by Taylor in 1968 was a milestone in caecilian systematics. He revised the taxonomy of the caecilians of the world and named two new families viz. Ichthyophiidae and Typhlonectidae and designated 13 new genera and 32 new species, listing a total of 157 world species, 34 genera and 3 families. Scolecomorphidae was named as a new family later by him in 1969 a. Taylor's classification is summarised below

Classification of Gymnophiona according to Taylor (1968, 1969 a)

	No. of families	Genera	Species
Order Gymnophiona	4	34	157
Family Ichthyophiidae		5	
Family Scolecomorphidae		1	
Family Caeciliidae		24	
Family Typhlonectidae		4	

Several publications on caecilian systematics have appeared since then, the more important of which are by Laurant (1984), Duellman and Trueb (1986), and Wake (1986). Wake's classification was largely the one followed by Taylor (1968), as modified by Nussbaum (1977, 1979). Wake recognised five families, 34 genera and 167 species as given below

Higher classification of Gymnophiona according to Wake (1986)

	No. of families	Genera	Species
Order Gymnophiona	5	34	167
Family Ichthyophiidae		3	41
Subfamily Ichthyophiinae		2	37
Subfamily Uraeotyphlinae		1	4
Family Rhinatrematidae		2	9

Family Caeciliidae	24	91
Subfamily Caeciliinae	5	47
Subfamily Dermophiinae	19	44
Family Scolecomorphidae	1	7
Family Typhlonectidae	4	19

However, Nussbaum and Wilkinson (1989) consider all the earlier classification as technically flawed, illfounded and on poorly defined characters and unwarranted assumptions. Reviewing caecilian systematics in detail, they proposed an interim classification of Gymnophiona that “reflects the limited present understanding of caecilian phylogeny” Nussbaum and Wilkinson (1989) recognised six families, 34 genera and 154 nominate species as given below

Classification of Gymnophiona according to Nussbaum & Wilkinson (1989).

	No. of families	Genera	Species
Order Gymnophiona	6	34	154
Family Rhinatrematidae		2	9
Family Ichthyophiidae		2	36
Family Uraeotyphlidae		1	4
Family Scolecomorphidae		2	5
Family Caeciliidae		23	88
Family Typhlonectidae		4	12

The above classification by Nussbaum and Wilkinson is followed here.

The Indian Perspective

Very little was known on the Indian caecilians before 1960 when Taylor started publishing a series of papers on the caecilian fauna of India. His major contributions to the systematics of Indian Gymnophiona include erection of a number of new taxa, resolution of the ambiguity on *Ichthyophis glutinosus* and *Ichthyophis monochrous* and an enumeration of the Indian species while working out the collections available with the Bombay Natural History Society. His monograph on the caecilians of the world (1968) generated considerable interest as a result of which, work on the relationship among the members of the order and to other amphibian orders as well as their pattern of evolution are in progress in many of the major laboratories of the world. However, hardly any work is being pursued in India which could boast of a rich complement of caecilian genera and species. The only single subsequent taxonomic contribution is the discovery of a new species of *Ichthyophis* from Silent Valley (Pillai, 1986).

Caecilian material available with the major taxonomic institutions in India is poor and unrepresentative. *Gegeneophis fulleri* (Alcock) is such an example described from Cachar Hills of Assam in 1904. Taylor could not examine this specimen during his visit to the Zoological Survey of India, Calcutta with the result that this species, described originally as *Herpele fulleri* by Alcock, is still known on the basis of the description made 90 years ago. We have attempted a revised description of the species after a re-examination of the type. The political climate of the type locality not being congenial, collection of fresh specimens of this species could not be attempted.

Caecilian collections are undoubtedly better in museums outside India where most of the type materials are deposited. The types that are available in India today are *Gegeneophis* (= *Herpele*) *fulleri* (Alcock), *Uraeotyphlus menoni* Annandale, *Ichthyophis tricolor* Annandale, *Ichthyophis longicephalus* Pillai and the types of the four new taxa here described viz. *Ichthyophis garoensis*, *Ichthyophis husaini*, *Uraeotyphlus interruptus* and *Gegeneophis krishni*.

MATERIAL AND METHODS

Paucity of preserved material and the difficulty encountered in collecting caecilians have been dwelt upon in the Preface. This is borne out by the fact that only eight specimens of caecilians were available as against more than five thousand anuran examples collected over the past 25 years from the Western Ghats and maintained at the Southern Regional Station, Zoological Survey of India, Madras. 27 specimens have been added during the course of the present study. I have, in addition to these, examined the Gymnophiona collections available with the following institutions in India

Bombay Natural History Society, Bombay

Zoological Survey of India, Calcutta

Zoological Survey of India, Shillong

Zoological Survey of India, Pune

Zoological Survey of India, Kozhikode

Madras Government Museum, Madras

Christian College, Martandam

Modern College, Pune.

In all, 94 specimens belonging to 21 species and 4 families have been studied. Considering the rarity of the group, this represents a respectable number.

There are no special methods of collecting caecilians. Searching for them under logs and stones in humid forests, opening up decomposing vegetable matter, debris or cowdung in farms

and fields is likely to yield them. Digging moist earth with a spade in shaded forest areas, plantations and wetlands is one sure method. Choosing the right spot for digging in likely areas is rather difficult and no caecilian may be discovered even after days of effort. The thrill of discovering one after days of fruitless digging is something to be experienced only. In October, 1976 after a futile search for more than a week in Wynad forests, I kicked at a log out of sheer desperation and lo! under it was a full grown glistening specimen of *Ichthyophis beddomei*. It withdrew quickly and vanished beneath the soil. It was the first ever specimen I have seen alive in the wild and since I was quite ignorant about its conduct, agility or biting propensities, considerable strategy and planning went into its capture which turned out to be much easier than imagined. They do not bite when captured but the slimy body nimbly slides between the fingers with the help of very powerful backward jerks. A specimen of *Ichthyophis peninsularis* from Alamchulai brought to the Christian College laboratory was a little dry and sluggish when taken out of the collection bag. When put in water for cleaning, it suddenly became very alive and active, swimming vigorously like the keelback water snake. I could not manage to catch it even within the confines of the small tray of water, the slimy skin eluding purchase, and had to drain the water off first and then drop it into a jar. I had the same experience with *Gegeneophis carnosus* also.

Digging where the earth is moist, porous and dark, particularly along the banks of permanent forest streams atleast two to three metres away from the water line or in slushy wetlands around the roots or opening up accumulated decomposing trash is also likely to yield caecilians. Presence of earthworms on which they prey is a fair indicator of their presence to the extent that although they do not occur wherever earthworms are available, earthworms have been found in many of the places where caecilians have been taken from.

How right Edward Taylor was when he recommended a good spade and well-calloused hands as equipments for collecting caecilians. I would supplement it with patience and optimism.

The characters used in the taxonomy of caecilians are mostly superficial and buccal and these could be recognised without dissection or damage to the specimen. The limited number of specimens has not permitted study of internal characters such as visceral organs, cranium or skeleton.

Preserved specimens often tend to be distorted or they are often kept coiled for storing convenience. A fairly accurate estimate of the length of such specimen could be obtained by running a non-elastic thread along the dorsal aspect of the body from the tip of snout to the terminus and measuring it. Other measurements such as the length of head, nuchal collars, distance between eye, nostril, tentacle etc. are taken with the help of dial calipers. Buccal characters are studied by opening the two jaws wide. The number and disposition of teeth are best studied under a stereoscopic binocular microscope. For this the angles of jaws may have to

be cut with a sharp blade for opening the mouth wide. The method of representing the dental formula is given in the chapter on "Morphology and Terminology"

We have chosen for full description a specimen presenting clear characters where there were more than one, and have indicated the data and measurements of the other specimens examined by us. With a view to making this study more meaningful and to bring out clearly the range of variations, the data and measurements of the type and some other example taken from literature are indicated in the Table appended for all the species dealt with.

As is customary in a treatise of this sort, synonymy, type locality, location of types, material studied, diagnosis followed by full description, distribution and remarks wherever necessary, are offered for all the species. Keys are presented for families, genera and for the identification of species. Colour is mostly from preserved specimens, supplemented by live colouration wherever available.

Line drawings of dorsal, ventral and lateral views of head and terminal vent region are provided for all the species. All these have been drawn with the aid of a camera lucida except *Gegeneophis fulleri* and *Ichthyophis subterrestris*, where I had to depend on free hand sketches. Black and white, and colour photographs of some are included.

Maps showing the world distribution of Gymnophiona and the distribution of all the Indian species are also provided.

A REVIEW OF LITERATURE ON THE TAXONOMY OF INDIAN GYMNOPHIONA

The earliest record of a caecilian species from India appears to be *Caecilia glutinosa* (= *Ichthyophis glutinosus*) by Linnaeus in 1754 with a range of distribution from the East Indies through South Western Asia to India. The next record was by Dumeril & Bibron (1841) of *Caecilia oxyura* (= *Uraeotyphlus oxyurus*) from Malabar. *Ichthyophis monochrous* was subsequently described by Bleeker in 1858 and was supposed to extend from Borneo to Sikkim through Java, Sumatra, Malaya, Siam, Ceylon and India. Beddome in 1870 erected *Caecilia Malabarica* (= *Uraeotyphlus malabaricus*) with its type locality designated as "Malabar" Peters (1879) described a species of caecilian from Nilgiris under the name *Ichthyophis beddomei*. Thurston published a catalogue of the available caecilians in the Madras Museum in 1888. Boulenger (1890) included 3 genera and 5 species of caecilians in the Fauna of British India, Reptilia and Batrachia. He recognised only two species in the genus *Ichthyophis* viz. *I. glutinosus* and *I. monochrous*.

It was in 1904 that Alcock described *Herpele fulleri* from Cachar Hills, Assam on the basis of a single specimen discovered in a collection of snakes. [On comparing this description with

other species known from the two genera viz. *Herpele* and *Gegeneophis*. Taylor (1968) transferred *fulleri* from the genus *Herpele* to *Gegeneophis* and is presently designated as *Gegeneophis fulleri* (Alcock).]

Out of the three contributions made by Annandale on caecilians, the earliest one in 1909 was the record of a new variety of *Ichthyophis glutinosus* viz. *tricolor* from Madathorai at the base of Western Ghats, Kerala. Two more examples of the subspecies were reported by him in 1915 from Parambikulam, Western Ghats. [Basing the striking differences in colouration, Taylor in 1968 bestowed a distinct specific status to this subspecies as *I. tricolor*.] In an earlier publication in 1913, Annandale described a new species, *Uraeotyphlus menoni* on the basis of two examples, one each from Trichur and Kondatti in South Malabar.

While working out the herpetological collections from Nilgiris, Wall (1922) recorded one species of caecilian which he designated as *Ichthyophis glutinosus*. Five years later, Mc Cann (1927) reported a caecilian species from Khandala, Pune District which he identified as *Ichthyophis monochrous* Boul. [These specimens were later described by Taylor (1960 b) as belonging to a new genus and species viz. *Indotyphlus battersbyi*.] This was followed by a record of *I. glutinosus* Boul. from Satara District (Panchgani) by Mullan in 1929.

A fourth species was added to the South Indian genus of *Uraeotyphlus* viz. *U. narayani* by Sheshachar in 1939 from Kanam, near Kottayam, Kerala.

There is a record of a caecilian along with its larvae for the first time from the Eastern Ghats by Ramaswamy in 1947. Identified by him as *Ichthyophis monochrous* (Bleeker), it was subsequently described as *I. peninsularis* by Taylor (1960 a). From the Kanara side of the Gersoppa Falls, Bombay, Abdulali (1954) collected a single specimen which he placed under *Ichthyophis glutinosus*.

Taylor worked out the apodan fauna of India by a series of publications over a period of ten years from 1960 to 1970. In addition to describing a number of new species, he has unravelled the tangle on the controversial *glutinosus* - *monochrous* complex in the Asiatic forms of the genus *Ichthyophis* in a paper he published in 1960 a. As a result of this study the species generally recognised till then as *Ichthyophis glutinosus* and *Ichthyophis monochrous* were each found to consist of several species, many of which were described as new. He recognised *I. monochrous* Bleeker as a species confined to the Island of Borneo while *I. glutinosus* Linnaeus was recognised as an Asiatic species confined to Sri Lanka. *I. tricolor* Annandale and *I. beddomei* which were synonymised by Boulenger and others were also resurrected by him in this publication. In the same year, he established a new caecilian genus and species, *Indotyphlus battersbyi* (Taylor, 1960b) on the basis of the specimens which Mc Cann collected at Khandala and reported earlier (1927) as *I. monochrous* Boul. In yet another publication, Taylor (1961)

worked out the Gymnophiona collections available with the Bombay Natural History Society, Bombay.

Genus *Gegeneophis* was considered monotypic with a single species viz. *carnosus* (Beddome). However, after a study of the material available with the Museum of Comparative Zoology, Harvard College, Cambridge, Taylor (1964) erected a second species viz. *G. ramaswamii* from Tenmalai. "The Caecilians of the World" was published in 1968 wherein Taylor revised the taxonomy of all the known world species. He named two new families, Ichthyophiidae to include all of the primitive taxa of South-east Asia and South America with more than one annulus per segment and Typhlonectidae to receive the aquatic, live-bearing forms of South America. 13 new genera and 32 new species and subspecies were designated. In 1970 he amplified the diagnostic features of his earlier description of *Indotyphlus battersbyi* by including skull characteristics as well.

Daniel (1963) listed 12 species of caecilians from the Western Ghats under four genera. Tikader (1965) recorded several males and females of *Ichthyophis beddomei* Peters at Kotegehar, Chikmagalur District along with a female guarding a cluster of eggs.

Satyamurthi (1967) updated and elaborated Thurston's (1888) Catalogue of the caecilians available at the Madras Government Museum. The South Indian species listed by him were *Ichthyophis glutinosus*, *I. monochrous*, *Uraeotyphlus menoni* and *U. narayani*.

Jaisingh (1978) recorded *Ichthyophis peninsularis* from Alamchulai, Kanyakumari District, outside the known range of its earlier distribution which was "Malabar". In the same year, two juveniles of *Ichthyophis beddomei* were recorded from the Netravathi River, South Canara by Rahman and Rajagopal (1978).

Nussbaum (1979) discussed the taxonomic status of the genus *Uraeotyphlus*. Disregarding the inclusion of the genus in family Caeciliidae by Taylor (1968) and establishing that the description of the skull of *Uraeotyphlus oxyurus* by Taylor (1969) was erroneous, Nussbaum transferred Genus *Uraeotyphlus* from family Caeciliidae to Ichthyophiidae, *inter alia*, describing a new subfamily, Uraeotyphlinae and redefining the family Ichthyophiidae.

A revival of interest on caecilian studies earlier initiated by Prof. B.R. Sheshachar in the 1930's was seen in Karnataka, particularly on their ecology. Gundappa, Balakrishna and Katre Shakuntala (1981) studied the characteristics of the soil in which *Ichthyophis glutinosus* lives. This was followed by a note on the soil characteristics and hatching features in respect of two species available at Sringeri viz. *Ichthyophis beddomei* and *Uraeotyphlus narayani* by Balakrishna, Gundappa and Katre Shakuntala (1982). The specific identities of four species of apodans, *Ichthyophis glutinosus*, *I. beddomei*, *I. bombayensis* and *Uraeotyphlus narayani* were confirmed biochemically by electrophoretic myogen patterns by Balakrishna, Katre Shakuntala and Gundappa

(1982). More studies on egg-laying and reproduction in *I. malabarensis* were made by Sheshachar, Balakrishna, Katre Shakuntala and Gundappa in the same year at Sringeri. Some more information on the eggs and embryo of the same species was provided by Balakrishna, Gundappa and Katre Shakuntala in 1983.

Inger et al (1984) reported two species of caecilians viz. *Gegeneophis carnosus* and *Ichthyophis beddomei* from the Ponmudi Hills, Kerala. In an overview of the Amphibian fauna of India, Inger and Dutta (1986) listed 15 species of Gymnophiona under four genera.

A new species of *Ichthyophis* viz. *I. longicephalus* was described by Pillai (1986) from Silent Valley, Nilgiri Biosphere Reserve.

In the absence of enough knowledge on Gymnophiona to allow establishment of a robust, phylogenetic classification of caecilians, Nussbaum and Wilkinson (1989) presented an interim classification of the caecilians of the world with diagnoses to generic level. They recognised six families and 34 genera. Uraeotyphlidae was given the status of a family. They recognised no categories of Gymnophiona other than families, genera and species and admit that the present knowledge does not allow the establishment of a robust, phylogenetic classification of caecilians.

MORPHOLOGY AND TERMINOLOGY

A caecilian is a slim, worm-like amphibian with no limbs or limb girdles. They vary in length from species of 50 mm to species of 1500 mm. The skin is naked, devoid of external scales. Scales may cover part or most of the body, but are concealed under the skin. The head is followed by two nuchal collars delineated by three nuchal grooves. Behind the collars the body is divided into segments by a series of folds in the skin. The vent is on the ventral side close to the posterior end of the body. Eyes when present are minute and without lids. A tentacle is present in all caecilians between the eye and nostril, most frequently at a point below the level of these organs.

Given below are the major morphological features in the standard terminology used in caecilian taxonomy. The characters are such that they could be recognised externally without involving dissection. Paucity of material and the difficulty in procuring them would make the study of internal characters, skull or vertebrae not feasible. Such studies however, are desirable since a number of external characters currently used in caecilian taxonomy are not fully reliable and liable to variation depending upon age, size etc.

Body Size

The smallest caecilian species as yet known is *Idiocranium russeli* Parker from Cameroons, Africa which has no trace of larval characters on attaining a body length of 51 mm. Females of

90 mm have been found brooding developing eggs. The maximum known length of this species is 144 mm. The largest is a variety of *Caecilia thompsoni* Boulenger from Columbia with a recorded length of 1515 mm.

The shortest and thinnest of the Indian species appears to be *Gegeneophis krishni*, a species described here as new. *Indotyphlus battersbyi* also is a short and thin species. Contrasting with these, the longest and stoutest is *Ichthyophis malabarensis* which grows to over half a metre in length (545 mm).

The ratio of length to breadth although usually indicated in descriptions, varies between sexes, ages and stages of life and seemingly is without taxonomic significance.

Eye

Caecilians mostly lead a subterranean life where the need for a visual organ like the eye is restricted. Various degrees of development of the eye are seen. The eye may be capable of a visual function in some and is placed superficially as in some species of Ichthyophiidae. In some others eyes are not visible externally being covered by skin and subdermal tissues as in *Indotyphlus battersbyi*. In some others as in species of *Gegeneophis*, it remains buried under the bones of the skull. The eye maintains a fairly constant position in relation to the angle of the mouth and nostril. A whitish areola often surrounds it. Its dimensions or relative size are not of much use in the segregation of species.

Though the eye would appear to be virtually non-functional, recent comparative morphological studies indicate that there is a trend toward increased covering of the eye, and concomitant reduction and loss of lens and modification of the retina. But significantly there appears to be an intact retina and an optic nerve which suggest that the eyes are functional atleast as photoreceptors in those species that have been studied.

Tentacle

The tentacle, a chemosensory organ unique to caecilians, is present invariably in all. Its location is indicated by a tiny pit between the eye and the nostril. The tentacle may emerge directly below the nostril or at nearly any point between the eye and the nostril. Position of the tentacle in relation to the eye and nostril is generally useful in defining the genera, though its size and shape are rarely useful since they are distorted and retracted in preserved material. In the absence of any external auditory organs and in the largely subterranean habitats where eyes would be of little use and the immovable tongue of little help in the sense of taste, it is presumed that the tentacle serves a variety of functions such as chemosensory, tactile and other basic

functions such as sex recognition, mate and food finding, recognition of ambient temperature, moisture and pH and possibly detection of predators as well. In life the tentacles are seen constantly protruding and retracting.

Nostril

The size, shape and position of the nostril are variable. Nostrils may be located at the very tip, on the dorsal or lateral side of the snout, clearly or barely visible when viewed from above. In shape they may be circular, elongate or angular. The opening of the internal nares or choanae on the palate varies in relation to the vomerine teeth in different genera.

Mouth and Tongue

While a few caecilians have a terminal mouth, others have a projecting snout with a recessed mouth. A terminal mouth is considered primitive.

The tongue is comparatively large but being fastened on its middle, it is movable only on its anterior and lateral margins. It may or may not cover the splenial teeth. Narial plugs which are elevations which fit into the choanae to close them, may be absent, moderately developed or teat-like. The normal shape and structure of the tongue is often distorted in preservation, depriving its diagnostic utility in the separation of genera or species. Still, detailed comparative studies on the morphology of the tongue may offer assistance in taxonomy.

Teeth

Typically there are four series of teeth (Fig. 1). The upper jaw carries a continuous 'U'-shaped outer premaxillary-maxillary series and an inner row of prevomeropalatine series, the latter often with a gap between the prevomers and palatines. The lower jaw has a corresponding outer dentary series and an inner row of splenials. The splenials may be few in number or even absent in some genera.

The number of teeth in each series may vary with age, teeth are added on the hind end. With some teeth being lost and some concealed under the gum there is considerable difficulty in making an accurate count. One tooth often assumes a median position in the premaxillary-maxillary and prevomeropalatine series and the dental formula is then indicated as 20-1-20 or as 20-21.

The number of teeth in each series varies in different species and genera. The dentition is best studied in cleaned skulls but the difficulty in procuring enough number of specimens for osteological and dentition studies may deter such procedures. A fairly accurate count could be obtained by opening the jaws wide, drying the tissues surrounding the teeth, probing teeth with

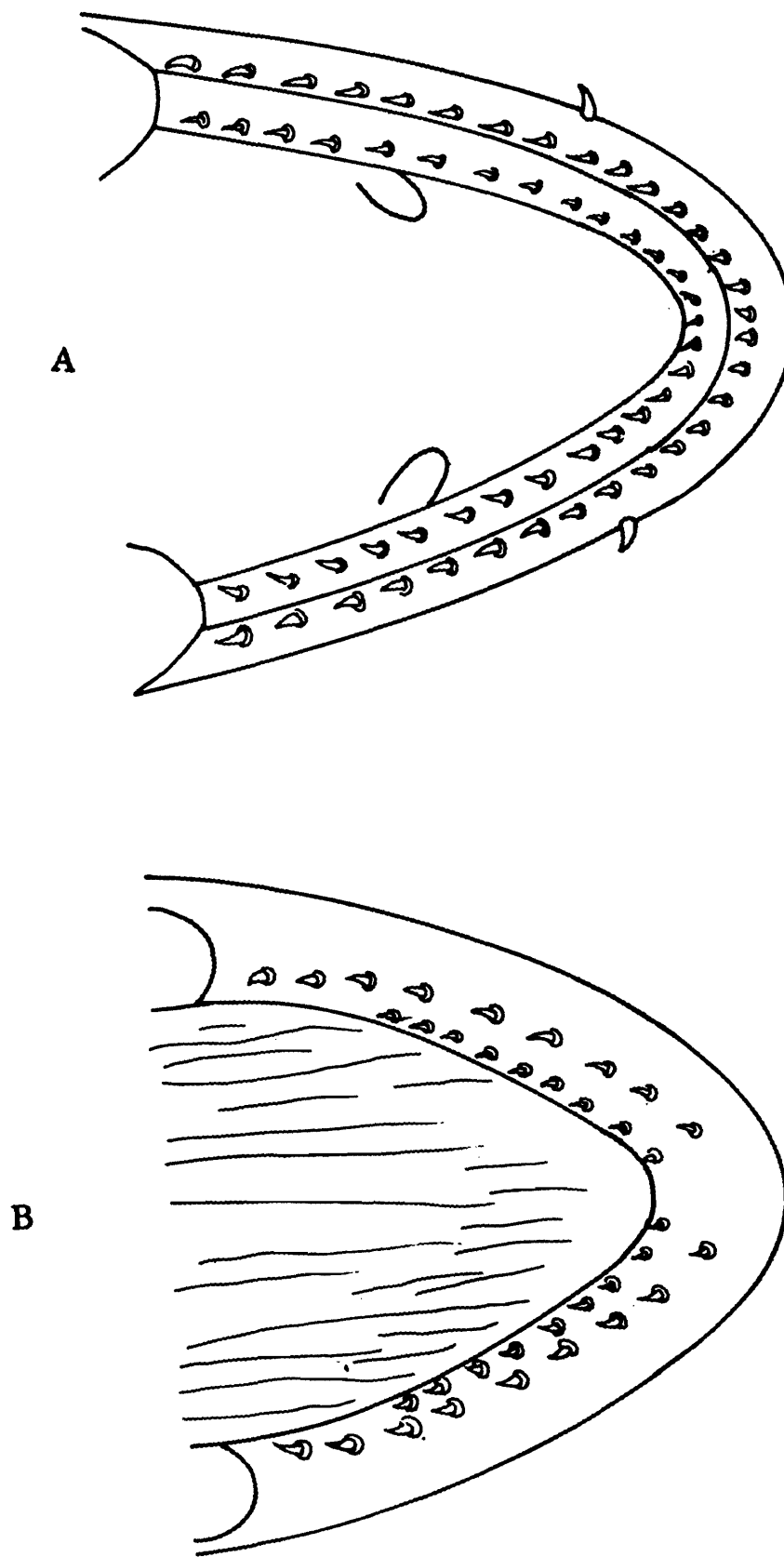


Fig. 1. A, B, upper and lower jaw.

the tip of a needle under a microscope and making allowances for missing teeth (unless it is a diastema).

The shape and disposition of tooth crown in different species appear to be related to their diet. Monocuspid, bicuspid, spoon-shaped or conical tooth crowns are seen in species and families.

Nuchal Collars and Grooves

Behind the head are two nuchal collars which include three to four vertebrae, delineated by three nuchal grooves. The first nuchal groove is usually pronounced and often indicates the hind end of the skull. It may fail to cross the occiput. The second groove representing the hind margin of the first nuchal collar may be absent dorsally and the two collars fused above. Visible usually on the sides, they are more often pronounced ventrally on the throat. The third groove which delimits the second collar on the posterior side may encircle the neck fully or may be incomplete dorsally or ventrally allowing the second collar to partially coalesce with the first body fold above or below. Both the collars may develop incomplete transverse dorsal folds between the nuchal grooves. The limit of the collar is determined by examining the dorsal or ventral side where the groove is well defined. The gill slits in the larvae fall close to or in the same plane as the third groove or rarely on the second groove.

Body Annuli

The body of the caecilian behind the collars is completely or partially surrounded by annuli. Grooves falling between two vertebrae are regarded as primary. Those developing within the primary folds are secondaries or tertiaries.

Tail and Vent

The portion of the body behind the vent constitutes the tail. Presence of a tail is considered to be primitive and its absence is derived. Distinct in some genera, the tail may be very short and rounded, conical or depressed. While the segmentation may continue to the apex in the tail-less forms, the terminal end may be unsegmented constituting a terminal shield. The number of tail folds are counted from the anterior end of vent.

The vent and the area surrounding it and the number of caudal folds are characteristic of a genus and of some diagnostic value among species of a genus. The vent is longitudinal in a number of genera, interrupting several caudal folds. It is transverse or circular in other genera. The edges of the vent may carry lobulate denticulations. An intromittant organ or phallosome is present in males which assists in copulation.

Scales

One of the primitive character that caecilians have inherited from their piscine ancestors is the presence of scales beneath the skin. Scales may begin on the first collar itself. Those on the anterior segments are smaller, fewer or absent. At the middle of the body there may be a few more rows (around four) and several more rows more posteriorly.

Skin Glands

Cutaneous glands cover the entire body which makes the skin slimy when alive. The glands are of different types and sizes serving different functions. When provoked a cream-coloured secretion with the smell of musk is exuded from the skin as a defensive mechanism aimed at discouraging predators. Arrangement and disposition of skin glands may vary within genera or species.

A pair of tiny anal glands may be present on either side of the vent in males. However, their utility in sexing is restricted.

DISTRIBUTION

Caecilians are distributed over parts of the four continental land masses in the southern Philippines, in the western part of Indo-Australian Archipelago and in Seychelles (see Map I). They are restricted to the Pantropical regions, except for Madagascar and southeast of Wallace's Line. Caecilians have not been reported from central equatorial Africa.

The world distribution of the six families of Gymnophiona is as under. Family Ichthyophiidae is restricted to India and Southeast Asia. Family Caeciliidae occurs in tropical Central and South America, equatorial east and west Africa, islands of the Gulf of Guinea, Seychelles Archipelago, and India. Rhinatrematidae is confined to northern South America. Scolecomorphidae occurs only in East and equatorial west Africa. Typhlonectidae is restricted to South America. Uraeotyphlidae has a very restricted distribution in the southern Peninsular India.

The four genera under three families which occur in India are *Ichthyophis* under Ichthyophiidae, *Uraeotyphlus* under Uraeotyphlidae, and *Indotyphlus* and *Gegeneophis* under Caeciliidae. The focal centre of their distribution as evidenced by species diversity appears to be the Western Ghats, particularly the southern Western Ghats. A few isolated species-records are available from the eastern and northeastern India. Genus *Ichthyophis* has the widest distribution in India and are found all over the Western Ghats and in some pockets in the Eastern Ghats and northeast India. *Uraeotyphlus* and *Gegeneophis* are restricted to the southwestern India. *Indotyphlus* is known only from the type locality viz. Khandala and its environs in the northern Western Ghats.

HABITATS AND HABITS

The factors which govern the distribution of caecilians are not properly understood. Preliminary investigations carried out by Gundappa et al (1981) and Balakrishna et al (1982) at Sringeri, Karnataka indicate that they do have certain habitat preferences. Moist porous soil, rich in humus and organic matter and a positively acidic pH appears to be essential for their survival. During the dry seasons of the year, they burrow deep into the soil to find the right conditions and only a porous soil could serve this. From the fact that the habitat features of two species of *Ichthyophis* and one species of *Uraeotyphlus* are fairly identical and as many as four species are seen to coexist in the area of study, it may be presumed that the physicochemical features of the soil is the major single factor limiting the distribution of terrestrial caecilians.

Their preferred habitats as gleaned from literature on Indian caecilians are muddy banks of streams, upper reaches of spring fed rivulets, under rocks and logs, inside rotting vegetation, under haystacks, moist soil in plantation groves and cardamom estates and slushy wetland areas. According to Mc Cann (1927), *Ichthyophis monochrous* Boul. (= *Indotyphlus battersbyi* Taylor) "lives under stones, during rains in burrows much after the fashion of the earthworm which it also resemble in its movements..... On removal of the stone under which it lives the animal soon begins to descend into its burrow away from light" They are seen during the rainy season (June to September) under stones on the grassy hill sites at Khandala and could be mistaken for earthworms in size and colour.

Ichthyophis species are better known among the Indian Gymnophiona and are not uncommon in moist areas, particularly foot hills and in higher altitudes. Abdulali (1954) describes the movements of *I. beddomei* as a series of ripples reminiscent of a millipede rather than a snake or eel. In water they swim well. They are not strong burrowers and prefer compost heaps, rotting vegetation or loose soil. Nussbaum and Gans (1980) who studied the Ichthyophids of Sri Lanka have confirmed this habitat and have collected most of their specimens from piles of manure, rotting vegetation or on the edges of agricultural settlements in moist soil. A few have been found coiled up in small cavities in soil without any obvious tunnel to the surface.

Larvae of caecilians have been taken from shallow streams where they hide in the marginal stretches with sandy bottom. Moist soil overgrown with grass harbours both larvae and adults.

My own collection data reveal the following habitats slushy, muddy forest areas adjacent to springs from where both juveniles and adults were collected, under logs and stones in forest floors, ground litter between buttresses of large forest trees, under decomposing heap of vegetation, bark etc., pepper, cardamom and coffee plantations, compost pits and old cowdung heaps, around arecanut and coconut trees in plantations etc. While sitting still on the embankment of Kunti River in the Silent Valley forests, I once saw a large blackish specimen (resembling *Ichthyophis*

peninsularis) emerge from a crevice between the stones and swim about, the movements resembling the keelback water snake. At the slightest movement it vanished into the crevices.

Earthworms are usually present in the soil they were collected from. Tikader (1965) found a particular species of eel (*Fluta alba*) always associated with *Ichthyophis beddomei* in mud. Curiously enough, the eel superficially resembled the caecilian. So was the case of the small bluish-black blind snakes, *Ramphotyphlus bramina*, which were collected along with *Gegeneophis krishni* sp. nov. from Krishna Farms, Gurpur. In shape, size and colour they were very similar to the caecilian and I had to make use of a handlens to detect the scales of the reptile.

A few specimens which have been run over by vehicles at night have also been taken from tar roads adjoining forests and wetlands. Caecilians emerge from their burrows and wander about at night, more so when rains flood their burrow. Specimens kept in moist soil in the laboratory were also seen to come out only at night. On switching the light on, they hurriedly retreat into the soil. They are easily reared and fed with live earthworms for long periods. When starved, they snap at earthworms dropped on the surface of soil even during day.

Limited studies on the tooth morphology and food reveal that only one South American species, *Typhlonectes obesus* has specialised in one particular item of food. It has spoon-shaped tooth crowns which are used to scrape the coleopteran pupae that cling to the under side of submerged rocks. The species is aquatic and feeds solely on coleopteran pupae (Wake, 1978).

Gut analysis of some species indicate that they consume diverse prey such as earthworms, termites, larval instars of a variety of insects and other arthropods. Surprisingly even lizards have been seen included in the diet of an American caecilian (Moll and Smith, 1967).

Main food of Indian caecilians on which information is available appears to be mainly earthworms (Wall, 1922) but they are also known to take termites and small earthsnakes. Instances where only a single item of prey has been found, often earthworms or termites, are explained as an exploitation rather than specialisation of an unlimited supply of food resource.

Caecilians are themselves predated mostly by snakes. Some aquatic birds like the herons and storks have also been known to swallow them.

Although no record is available in literature on calls or noises made by caecilians, I have experienced short "purrs" or "grunts" emitted by *Gegeneophis carnosus* during handling.

LIFE HISTORY

Very little is known about the breeding and life history of caecilians. Two modes of reproductive strategies related to the type of habitats are exhibited in general. Ovoviviparity is seen in caecilians which are either permanently aquatic or terrestrial. Oviparity appears to be the

mode in those whose life history is amphibious, as in the genus *Ichthyophis*. The duration of the aquatic larval stage also varies.

No sexual dimorphism is seen externally. From what little is known of the anatomy of the sex organs, fertilisation is presumably internal. The fertilised eggs which are fairly large and heavily yolked are either laid or retained inside the body for varying periods. Gills develop while the young one is within the egg cover; the gills are absorbed partially or completely before hatching. Gill slits are present in larvae which are aquatic. Breeding period appears to be between March and September.

Maternal care of eggs has been noticed for all species where there is data. Taylor (1968) narrates the instance of a female of *Ichthyophis* sp. with eggs kept in captivity. She did not make any effort to escape but after a time moved near the eggs and tried to turn them over. Eggs are attached to thread-like processes resembling a collection of tiny air balloons.

Some scanty information is available on the eggs, embryos and parental care of a few genera of Indian Gymnophiona such as *Ichthyophis*, *Gegeneophis* and *Uraeotyphlus*. The only account on *Gegeneophis carnosus* (Beddome) (= *Gegeneophis ramaswamii* Taylor) is by Sheshachar (1942) where the mother with her cluster of eggs numbering about 15 resembled the classical picture of *Ichthyophis glutinosus* by Sarasins. The embryos within the eggs had two pairs of gills as against three in *I. glutinosus*.

The largest number of 100 eggs in one clutch, connected to one another by untwisted cord and guarded by a female of *Uraeotyphlus malabaricus* was reported by Sheshachar et al in 1982 from Sringeri, Karnataka. Another female with a clutch of 82 eggs was collected by Balakrishna et al (1983) from the same locality. After transportation to the laboratory, the female desisted from coiling round the eggs unlike Taylor's specimen. Larvae of *Ichthyophis beddomei* were seen in the same terrestrial environment as the adult by Balakrishna et al (1982) which led them to question the belief that the female parent transported the eggs at the time of hatching to the nearest stream. If the larvae were seen in the streams around such hilly regions, it appears not more than accidental. Tikader (1965) also records a female of *Ichthyophis beddomei* coiled round a cluster of eggs numbering 12 and carrying them with her while moving slowly.

While digging for caecilians in Agumbe forests (Karnataka) I came across a female of *Ichthyophis beddomei* coiled round a cluster of 15 eggs. This female did not appear keen to abandon her eggs and slither down the soil.

Eggs in Ichthyophids are large-sized and few in number. Each egg has a filament and the many filaments of a clutch are twisted unlike in Uraeotyphlids where the cords are untwisted.

Ramaswamy (1947) collected a number of larvae of *Ichthyophis monochrous* Boul. (= *I. peninsularis* Taylor) from Kambakkam (Tamilnadu) which is part of the Eastern Ghats.

Larvae are characterised by the possession of gill slits and a typical caudal fin which disappears during or immediately following the transformation from the larval to the juvenile stage. The larval type of mouth and dentition also give way to that of the adult.

ABBREVIATIONS

AMNH	American Museum of Natural History, New York.
BMNH	British Museum (Natural History), London
BNHS	Bombay Natural History Society, Bombay.
CAS	California Academy of Sciences, San Francisco.
CCB	Central College, Bangalore.
CCM	Christian College, Martandam.
EHT-HMS	E.H.Taylor- H.M.Smith, Herpetological collection, Lawrence, Kansas.
FMNH	Field Museum of Natural History, Chicago.
MCM	Museo Civico di Milano, Milano, Italy.
MCP	Modern College, Pune.
MCZ	Museum of Comparative Zoology, Harvard College, Cambridge.
MGM	Madras Government Museum, Madras.
NMW	Naturhistorisches Museum, Wien, Austria.
ZMB	Zoologisches Museum, Berlin.
ZSIC	Zoological Survey of India, Calcutta.
ZSIK	Zoological Survey of India, Kozhikode.
ZSIM	Zoological Survey of India, Madras.
ZSIP	Zoological Survey of India, Pune.
ZSIS	Zoological Survey of India, Shillong.

TAXONOMIC TREATMENT

Three extant orders are recognised under Class Amphibia. Order Caudata comprises the salamanders, Order Salientia comprises the frogs and toads and Order Gymnophiona comprises the caecilians.

Key to Orders of Class Amphibia

1. Tentacular organ present in adults, limbs absent, eyes present or absent. Body skin with annuli, subdermal scales present..... Gymnophiona
- Tentacular organ absent, limbs present..... 2
2. Body skin without segmentation; tail absent in adult; tympanum usually present Salientia
- Body skin usually if not invariably showing segmentation; tail present; tympanum absent..... Caudata

Order GYMNOPIHIONA Rafinesque, 1814

Gymnophiona are elongate, limbless amphibians with tail either short or absent. Eyes are rudimentary, may or may not be visible externally. A retractile tentacle is always present between the eye and the nostril, most frequently at a point below the level of these two. Tympanum absent, male with an unpaired phallodeum. Body segmented, with two post-cephalic collars separated by grooves which are dim or clear externally. Scales present, concealed under the skin.

Terrestrial, burrowing or aquatic, caecilians are distributed around the earth in tropical and some subtropical areas. They are oviparous or ovoviviparous with or without an aquatic larval stage. Embryos usually are with external gills.

Of the six families of Gymnophiona of the world (Nussbaum & Wilkinson, 1989), three families, four genera and 21 species occur in India as given below. Four out of these are species new to science and one constitutes a new record for India.

CLASSIFIED LIST OF GYMNOPIHIONA OF INDIA

Class	AMPHIBIA
Order	GYMNOPIHIONA
Family	ICHTHYOPHIIDAE Taylor

Genus : Ichthyophis Fitzinger

Ichthyophis beddomei Peters

Ichthyophis bombayensis Taylor

Ichthyophis garoensis sp. nov.

Ichthyophis glutinosus (Linnaeus)

Ichthyophis husaini sp. nov.

Ichthyophis longicephalus Pillai

Ichthyophis malabarensis Taylor

Ichthyophis peninsularis Taylor

Ichthyophis sikkimensis Taylor

Ichthyophis subterrestris Taylor

Ichthyophis tricolor Annandale

Family URAEOTYPHLIDAE Nussbaum & Wilkinson

Genus : *Uraeotyphlus* Peters

Uraeotyphlus interruptus sp. nov.

Uraeotyphlus malabaricus (Beddome)

Uraeotyphlus menoni Annandale

Uraeotyphlus narayani Sheshachar

Uraeotyphlus oxyurus (Dumeril & Bibron)

Family CAECILIAIDAE Rafinesque

Genus : *Indotyphlus* Taylor

Indotyphlus battersbyi Taylor

Genus : *Gegeneophis* Peters

Gegeneophis carnosus (Beddome)

Gegeneophis fulleri (Alcock)

Gegeneophis krishni sp. nov.

Gegeneophis ramaswamii Taylor

Key to families of Indian Gymnophiona

1. True tail present, vent longitudinal, eyes visible externally 2
- True tail absent, vent transverse; eyes hidden, not visible externally Caeciliidae
2. Tentacular opening between and below the eye-nostril line, often closer to eye
..... Ichthyophiidae
- Tentacular opening almost directly below nostril Uraeotyphlidae.

Family ICHTHYOPHIIDAE Taylor, 1968

Diagnosis : Gymnophiona with true tails, mouth nearly terminal, tentacular opening between the eye and the nostril, usually closer to the eye; four (rarely three) dental series; all primary annuli subdivided by secondary or tertiary grooves. Adults terrestrial, oviparous; larvae aquatic with gill slits.

Distribution : India and Southeast Asia.

Remarks Out of the two genera known from the world, only one genus, *Ichthyophis* is represented in India.

Genus *Ichthyophis* Fitzinger, 18261826. *Ichthyophis* Fitzinger, *Neue Classif Rept. Verw.* 36

Diagnosis : Medium to large species, with or without a lateral cream or yellow stripe. Four series of teeth, tentacular opening between and below the eye-nostril line, usually closer to eye than to nostril (about equidistant in *I. beddomei*); primary and secondary folds not separable, folds angular in the midventral line; subdermal scales always present; eye visible externally; tail present, short and pointed.

Type species : *Caecilia glutinosa* Linnaeus, 1758 by monotypy.

Distribution : India Peninsular and northeastern India, Sikkim; Southeast Asia; Sri Lanka; Southern Philippines; Western Indo-Australian Archipelago.

Remarks Out of a total of 31 species known from the world, 8 are from India to which two new species are being added. *Ichthyophis glutinosus* which was considered to be confined to Sri Lanka (Taylor, 1968) is being recorded from India. Indian content of *Ichthyophis* is thus raised to 11 species.

Key to species of Genus *Ichthyophis* of India

1. A lateral cream or yellowish stripe present 2
- A lateral stripe absent 6
2. A narrow dark stripe separating the lateral yellow stripe from the pale venter. Southern Western Ghats. *tricolor*
- No dark stripe separating the lateral yellow stripe from the ventrolateral light colour 3
3. Tentacular aperture nearly equidistant between eye and nostril. Yellow stripe widens on first collar. Peninsular India *beddomei*
- Tentacular aperture closer to eye than to nostril 4
4. Dorsal folds on the anterior half of the body curve forward in the mid-dorsal line. Assam *glutinosus*
- Dorsal folds cross the dorsum straight across 5
5. Body folds around 315; 14 prevomeropalatine teeth on each half of upper jaw; total length over 200 mm. Garo Hills, Meghalaya *garoensis* sp. nov.
- Body folds around 350; 23 to 25 prevomeropalatine teeth on each half of jaw; total length under 200 mm. Southern Western Ghats *longicephalus*
6. Tail short, with 10 or less caudal folds, counted from the anterior end of vent 7
- Tail relatively longer with 12 or more caudal folds counted from anterior end of vent 8

7. Teeth large, recurved, dentary about 14 and splenial 16 to 17 on each half of lower jaw; tail with 9 folds; Garo Hills, Meghalaya *husaini* sp. nov.
 — Teeth not conspicuous, sunk in pits on the gum; dentary 18 to 21 and splenial 8 to 10 on each half of lower jaw. E. Himalayas and Southern Western Ghats ... *sikkimensis*
8. Size large, 390 to 545 mm; tail folds 17 or less 9
 — Size small, less than 360mm, tail folds more than 17 10
9. Body folds 356 to 380, dark slate colour above, dirty greyish yellow below, tail black from vent to tip. Size large, 487 to 545 mm long and 18 to 24 mm wide. Southern Western Ghats (Kerala) and central Western Ghats (Karnataka) *malabarensis*
 — Body folds 386 to 402, dark brown above, light brown below. Size smaller, 390 to 422 mm long and 14 to 15 mm wide. Northern Western Ghats and Central Western Ghats *bombayensis*
10. Splenial teeth few, 3 to 4 on each half of lower jaw, grayish lavender above, lighter laterally and ventrally. Bluish black above and cream below in life. Central Western Ghats, southern Western Ghats and Eastern Ghats *peninsularis*
 — Splenial teeth more, 6 to 13 on each half of lower jaw, dark violet lavender above and brownish lavender below. Southern Western Ghats and Maharashtra *subterrestris*

Ichthyophis beddomei Peters

(Figs. 2, 23, 36)

1879. *Ichthyophis beddomei* Peters, *Monatsb. Akad. Wiss.*, Berlin : 932.
 1882. *Ichthyophis glutinosus* : Boulenger, *Cat. Batr. Grad. Apoda Brit. Mus.*, : 89.
 1960. *Ichthyophis beddomei* : Taylor, *Univ. Kansas Sci. Bull.*, : 40.
 1961. *Ichthyophis beddomei* : Taylor, *J. Bombay nat. Hist. Soc.*, 58 : 362.
 1968. *Ichthyophis beddomei* : Taylor, *Caec. World* : 59

Type locality Nilgiris.

Location of type Originally Berlin Museum. Existence doubtful.

Material examined

1. Two examples No. VAG 5 ZSIM, Samse Estate, Chikmagalur, Karnataka, 5. 7.92, R.S. Pillai.
2. One ex. No. VAG 1 ZSIM, Chethalayam, Wynad, 19.10.76, R.S. Pillai.
3. One ex. No. VAG 2 ZSIM, Agumbe forest, Karnataka, 23. 2. 93, R.S. Pillai.
4. One ex. No. VAG 3 ZSIM, Sringeri, Karnataka, 5.1.94, R.S. Pillai.
5. One ex. No. VAG 4 ZSIM, Chakrani Estate, Alamcholai, Martandam, 12.8.92, R.S. Pillai.
6. Two exs. No. V/1240, ZSIP, Kotegehar, Karnataka, 7.11.74, P. N. Krishnamurthy.
7. Two exs. Nos. 9 and 10, BNHS, Injiparai Estate, Anamalai, Kerala, 22.8.43, A. F. Hutton.

8. One ex. No. 11 BNHS, Gersoppa Falls, Mysore State, 25.10.53, H. Abdulali.
9. One ex. No. 14 BNHS, Kotegehar, Kadur Dist. Mysore, Oct. 1961, E. H. Taylor.
10. One ex. No. 1469 BNHS. Kotegehar, Mysore, 31.1.64, B. K. Tikader.
11. One ex. No. 18 BNHS, Ootcamund, Tamilnadu, date?
12. Four exs. half-grown, MGM, Kasturi Pass, South Coorg, date?, S. G. Myers.

Diagnosis : A small species (170 to 275 mm in length) with body folds ranging from 260 to 295. Head narrow, small. Tentacular aperture about equidistant from eye and nostril, snout pointed. A cream or yellow lateral stripe on body. Two well developed rows of teeth on the lower jaw.

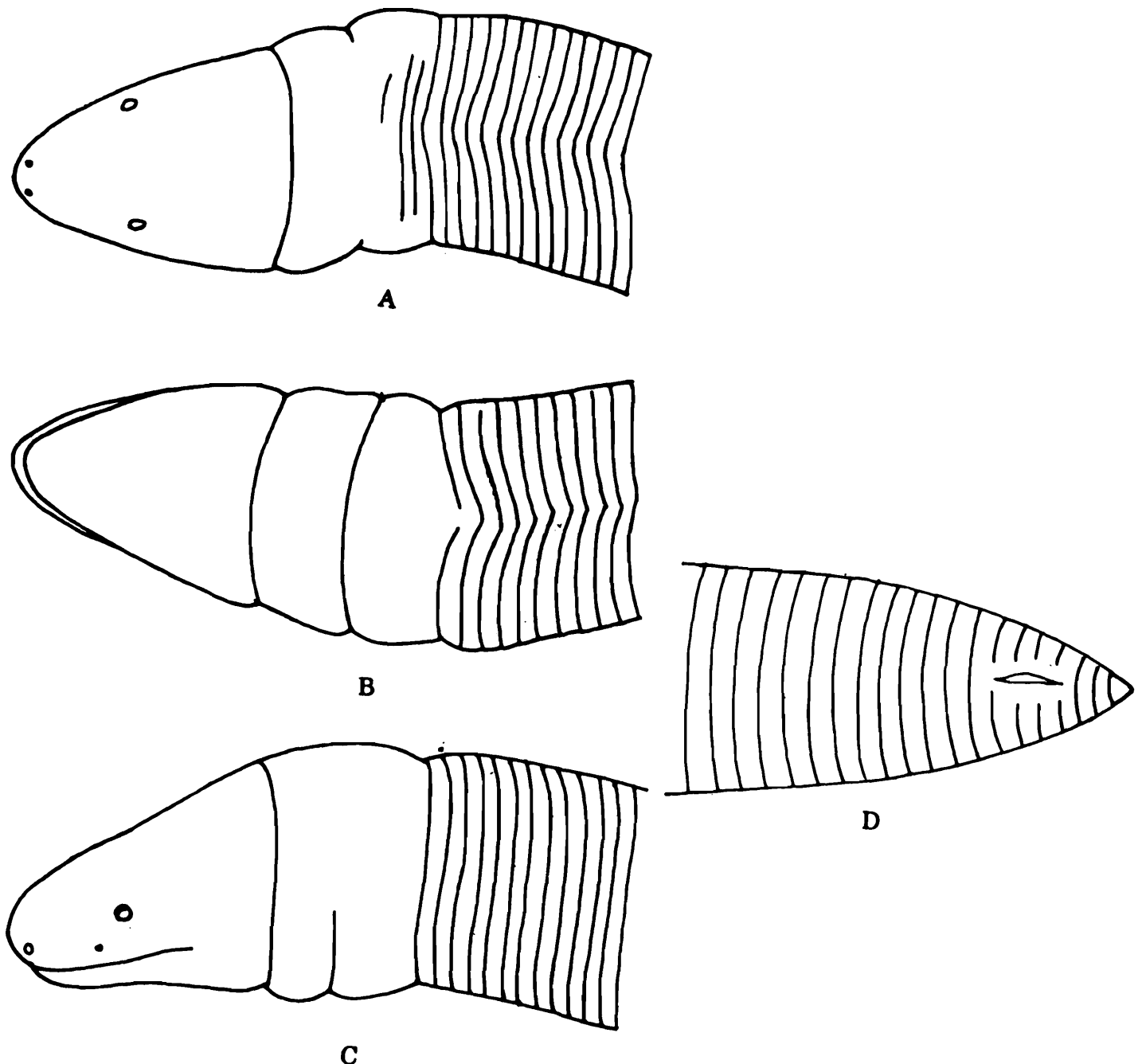


Fig. 2. *Ichthyophis beddomei* Peters. A,B,C, three views of head ; D, subcaudal region.

Description (No. VAG 5 ZSIM from Samse) A medium-sized specimen measuring 247 mm in length and 12.4 mm in body width. Width in length 20 times. Head small, 9.6 mm long and 7.5 mm wide dorsally before the first nuchal groove. Snout triangular, acutely pointed. Collar wider (9.5 mm) than head. Eye distinct, in a socket, 0.7 mm across, slightly elevated and a little farther from the upper lip than the nostril. Interocular distance 4.5 mm. Tentacular aperture a little elevated, close to upper lip, between and below the eye-nostril line, a trifle closer to eye (1.9 mm) than to nostril (2.1 mm.) Eye to nostril 3.5 mm. Nostril nearly terminal, just visible from above. Snout relatively long, 4.7 mm from the edge of eye, projecting a little beyond mouth.

Collars fused dorsally, wider than head. First nuchal groove is conspicuous on the throat and sides and crosses dorsum. Second groove distinct ventrally, crosses laterally on sides and terminates above the level of mouth. Third groove resembles the body folds behind it. It does not cross the midventral line. Two transverse incomplete grooves precede it on the dorsum with another asymmetrical fold on the right side.

There are 275 primary and secondary folds following the collars. The folds are complete above, the anterior ones crossing dorsum rather sinuously. Ventrally through much of the body they form a median angle. Towards the hind end they cross the venter directly across. 7 folds are on the tail which is short (3.2 mm). 4 folds are interrupted by the longitudinal vent which has three anterior and about four lateral lobulate denticulations on each side. Tail tip laterally compressed, pointed and devoid of an unsegmented terminal shield.

Scales are present on all folds beginning with the collars. One or two rows anteriorly, 3 to 4 rows in the middle and 6 to 8 rows posteriorly.

Dentition : Teeth are in four series Premaxillary-maxillary, 19-19; prevomeropalatine, 22-23; dentary, 20-20; splenial, 22-22. Dentary teeth are larger or as large as prevomeropalatines. Splenial teeth are quite small and concealed by the tongue which is sharply pointed and with parallel striae except at the very tip.

Choanae elongate and lateral in position.

Colour : Entire dorsum dark violet brown in life which turns brownish after preservation. Venter lighter than dorsum. A bright yellow (in life) or cream stripe runs laterally from snout to tip of tail. This stripe of uniform breadth (about 3 mm), enlarges a little towards the lower side on the first collar and bifurcates at the angle of the mouth. The upper ramus narrows under the eye and terminates there. The lower ramus extends along the lower lip almost to the tip of chin not meeting its counterpart. Eye with a pale ring around it. Tentacular area with a lighter patch. A prominent spot around the vent, not connected to the lateral stripes. The ventral body folds are clearly demarkated with cream lines, the dorsal folds less so.

The lateral yellow bands in the specimen from Agumbe extends downward on the second collar while an extension of the stripe from the first collar runs down to the median line without meeting its counterpart on the other side. Body in this specimen is 230 mm long. It was dug out from dark moist earth by the side of a forest stream. On removal of the earth, this female was seen coiled round a cluster of 15 eggs. She did not attempt to escape down into the soil abandoning the eggs. The eggs are spherical, 12 mm across. Each has a transparent chord

attached to it and the chords from all the eggs are twisted together. A larva belonging to the same species and measuring 87 mm was also taken from the same spot. It has a pair of gillslits and a vertical caudal fin. The lateral yellow bands are fairly clear.

A smaller specimen was collected at Chethalayam, Wynad, from under a log. On lifting the log it withdrew into the moist soil and had to be dug out. The lateral stripe in this specimen widens on the second collar and is still wider on the first, spreading partly to the venter as well. Dorsum brown with fine pale lines on the folds. Venter lighter. The cream spot surrounding the vent is connected to the lateral stripe by two short arms. Pale rings around the eye, lighter rings around the tentacular aperture and nostril. Tongue acute anteriorly, not covering the splenial teeth. Measuring 198 mm in length, it has 262 folds.

Data and measurements of the specimens studied are indicated in the Table.

Table of data and measurements on *Ichthyophis beddomei*

	VAG-5 ZSIM Samse	VAG-2 ZSIM Agumbe	VAG-4 ZSIM Martandam	VAG-1 ZSIM Wynad	VAG-3 ZSIM Sringeri	ZSIP Kotegehar
Total length	247	230	170	198	249	215
Tail length	3.2	3.2	2.4	3.3	3	2.6
Head width	7.5	7.3	6.7	6	6.1	6.7
Snout length.....	4.7	4.5	4.5	4.5	4.6	4.4
Body width.....	12.4	12.2	9	9.8	9	11.5
Eye to tentacle	1.9	1.9	2	1.8	1.8	2
Tentacle to nostril ...	2.1	2.1	2.2	2	2.1	2.3
Eye to nostril	3.5	4.0	3.7	3.8	3.4	3.6
Eye to eye	4.5	4.5	4.2	4.3	4	4.1
Snout tip to 1st groove	10.3	10	9.3	8.9	9	9
To 2nd groove.....	12.7	12.8	11.5	10.6	11.1	11.2
To 3rd groove	14.6	15.6	14.2	13	12.8	13.6
Body folds	275	296	265	262	267	286
Tail folds	7	6	6	8	6	7
Premaxillary-maxillary	19-19	—	17-17	18-18	20-19	20-20
Prevomeropalatine ...	22-23	—	19-21	24-21	25-25	22-21
Dentary.....	20-20	—	19-18	18-16	18-18	19-20
Splenial	22-22	—	?	17-18	22-21	21-20

Distribution : Southern India (Map-II)

Remarks : Although *Ichthyophis beddomei* resembles *I. tricolor* in the pointed snout, closely approximated position of the premaxillary-maxillary and prevomeropalatine teeth rows and the larger and more teeth in the splenial row, the colour pattern of the two however are quite distinct. (See Remarks under *Ichthyophis tricolor*)

The number of annuli in the type described by Peters (1879) is 240 which is very low compared to that in other examples and the range is from 240 to 300.

The configuration of the lateral yellow stripe on the two collars is not constant and could not be accepted as a specific character.

***Ichthyophis bombayensis* Taylor**

(Figs. 3, 24)

1960. *Ichthyophis bombayensis* Taylor, *Univ. Kansas Sci. Bull.*, 40 : 67.

1961. *Ichthyophis bombayensis* : Taylor, *J. Bombay nat. Hist. Soc.*, 58 : 360.

1968. *Ichthyophis bombayensis* : Taylor, *Caec. World* : 72.

Type locality "Waghii Surat, Bombay Province" (Gujarat)

Location of Type British Museum (Natural History) London.

Material examined

One example No. VAG 12 ZSIM, Sringeri, Karnataka, 5.1.94, R.S. Pillai.

Diagnosis A large species attaining a length of 422 mm. Primary and secondary folds range from 386 to 402, 14 to 17 of which are confined to tail, tail elongate, tapering. Body width in length 26-32 times. Splenial teeth 9-9 to 10-10. Dentary teeth larger than premaxillary-maxillary series. Tongue large, covering splenial teeth.

Description(No. VAG 12 ZSIM from Sringeri) A large specimen, 422 mm in length and maximum body width of 14 mm. Tail 13 mm long, about 32 times in total length. Head long, depressed, roughly oval, 12 mm broad which is a little narrower than that of body. Length of head (snout to first groove) 19.5 mm laterally. Eye distinct, large (1.5 mm across) placed in a circular socket. Tentacular aperture small, situated close to upper lip, closer to eye (3 mm) than to nostril (5.5 mm). Distance between eye and nostril 7.2 mm, snout (eye to tip of snout) 9.5 mm which is equal to interocular distance.

Table of data and measurements on *Ichthyophis bombayensis*

	VAG-12 ZSIM Sringeri	Type BMNH
Total length	422	390
Tail length	13	15.2
Head width	12	10

Snout length	9.5	7
Body width	14	15
Eye to tentacle	3	2.3
Tentacle to nostril	5.5	4
Eye to nostril	7.2	5.5
Eye to eye	9.5	8
Snout tip to 1st groove	19.5	15
To 2nd groove	25	—
To 3rd groove	30.5	—
Body folds	402	386
Tail folds	17	14
Premaxillary-maxillary	26-24	23-22
Prevomeropalatine	23-25	24-24
Dentary	19-19	20-20
Splénial	10-10	9-9

Two collars of about equal width (5.5 mm). First nuchal groove clear ventrally and laterally but not meeting on occiput. Second nuchal groove similar to first, curving backward laterally. Third groove crosses dorsum, extends laterally and crosses the venter partially. The two collars are fused dorsally.

There are 402 folds (both primary and secondary) on the body, 17 of them on the tail, counted from the anterior end of the vent. About 6 folds are interrupted by the vent. Tail portion is compressed, sharply narrowing to the terminus. Annuli cross the dorsum and meet ventrally with a backward angle except those on the anterior one-fifth of the body which do not meet.

Scales are present throughout the body, a single row anteriorly and about 3 rows more posteriorly.

Dentition Four series of comparatively small teeth. Premaxillary-maxillary, 26-24, prevomeropalatine, 23-25, dentary, 19-19 and splénial, 10-10. Premaxillary-maxillary teeth are uniformly large. The anterior teeth (3-3) of the dentary series are larger than the premaxillary teeth, the rest being smaller. Splénials are the smallest, concealed by the large tongue.

Colour Dark brown above, the grooves lighter. Dorsal side of head lighter than body. Venter pale, flesh-coloured, area surrounding vent lighter. Cream ring around eye and nostril. Lip margin and angle of mouth cream.

Body measurements and counts are given in the Table

Distribution Central and Northern Western Ghats (Map III)

Remarks Only a single example viz. the type appears to be on record. The present example

is larger (422 mm) than the type (390 mm) . The number of teeth and other data are in fair agreement with that of type as seen from the Table.

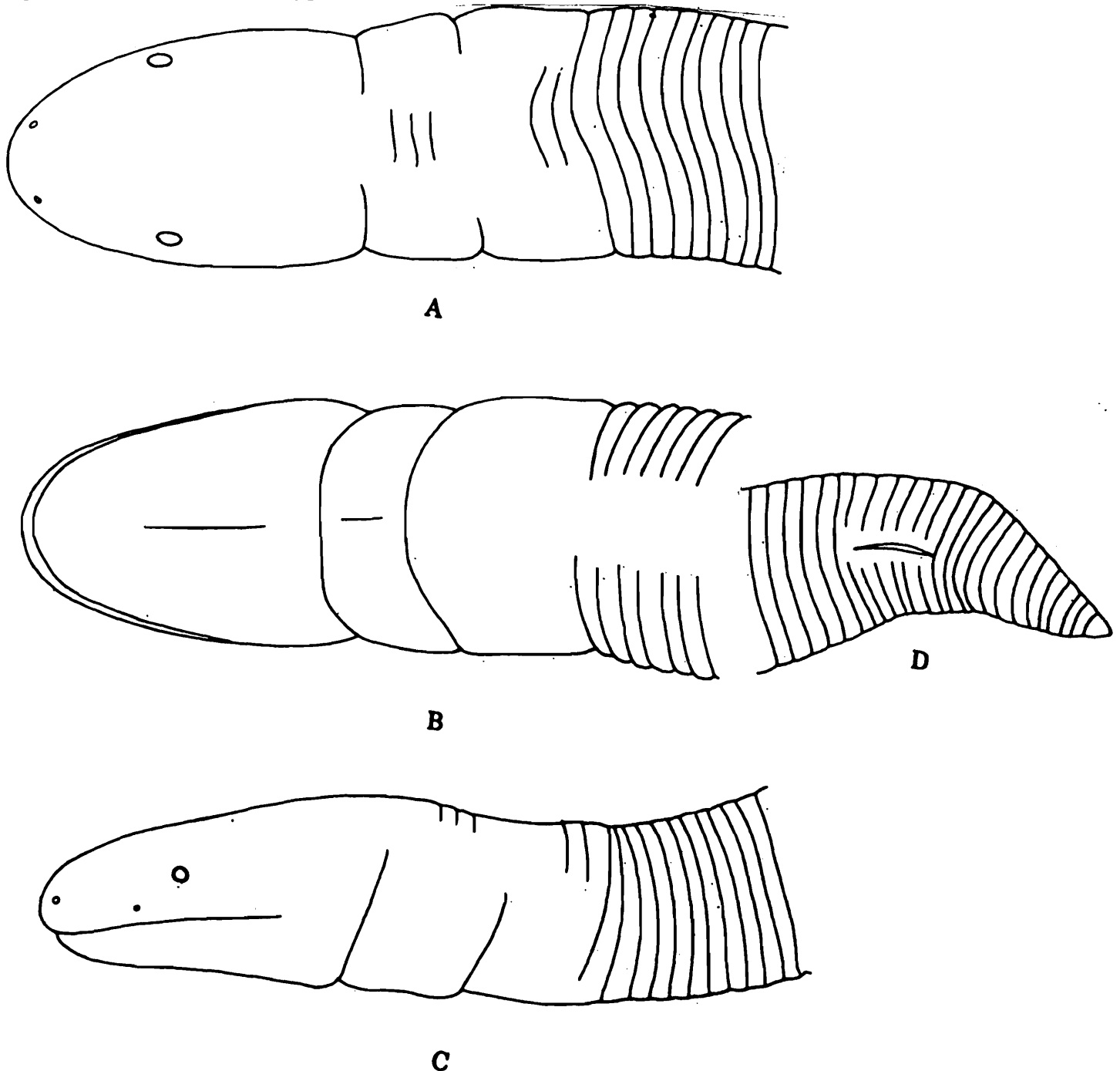


Fig. 3. *Ichthyophis bombayensis* Taylor. A,B,C, three views of head ; D, subcaudal region.

Ichthyophis garoensis sp. nov.

(Fig. 4)

<i>Type locality</i>	Anogiri Lake, Garo Hills, Meghalaya.
<i>Location of type</i>	Zoological Survey of India, Madras
<i>Material examined</i>	

1. One example No. 18458 ZSIS, Anogiri Lake, Garo Hills, Meghalaya, 30.8.83. A. Husain (Holotype)

2. One ex. No. 16 BNHS, Tura, Garo Hills, Meghalaya, date? H. W. Wells.

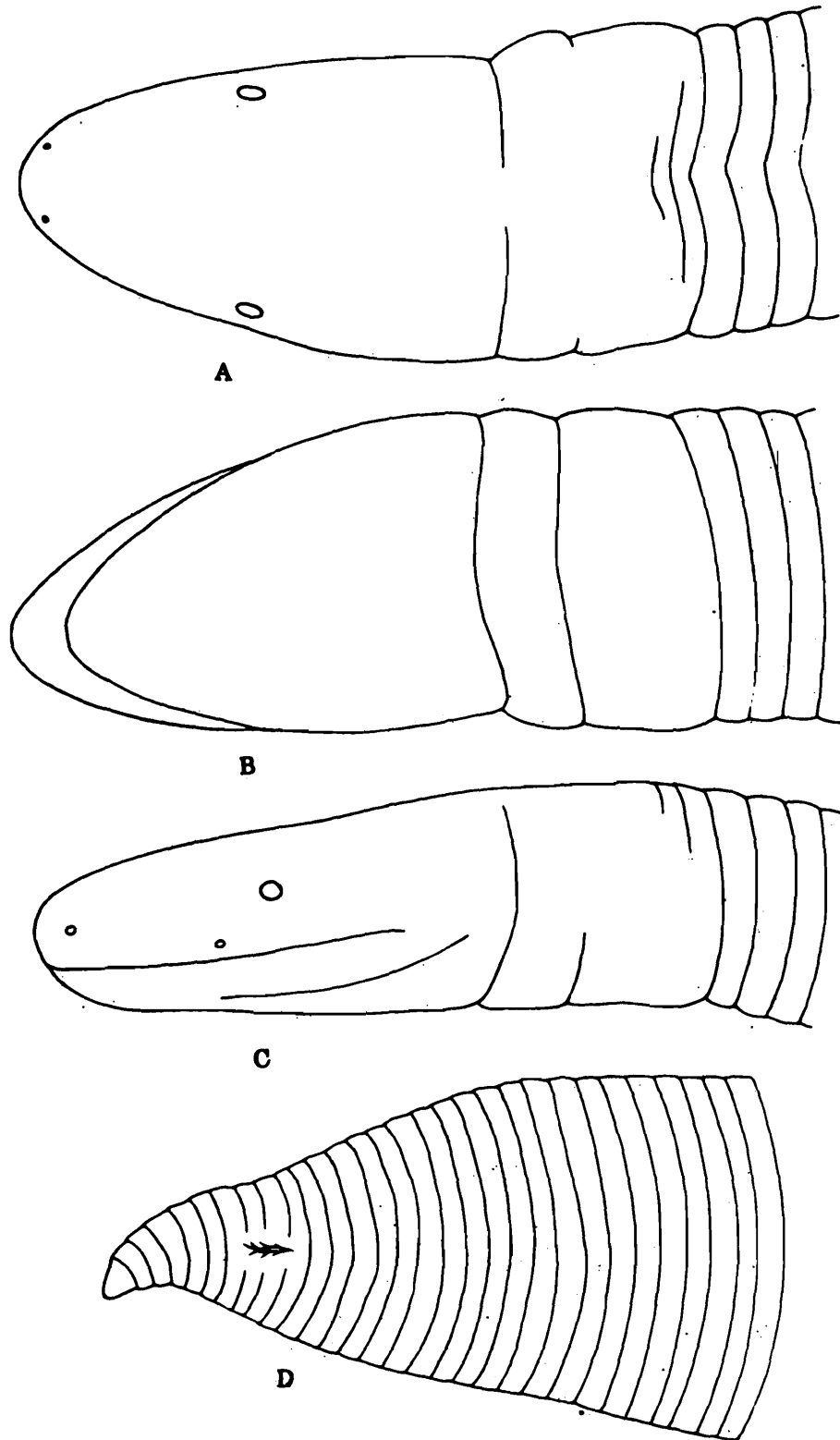


Fig. 4. *Ichthyophis garoensis* sp. nov. A,B,C, three views of head ; D, subcaudal region.

Diagnosis A fairly large species with about 315 body folds. Head long, depressed. Tentacular aperture closer to eye than to the nostril. Splenial teeth 15-14. Tail short with 9 folds from the front end of vent. Dorsally lavender, ventrally light brown, a lateral yellow stripe present.

Description (from Type) (Note This specimen is injured. The left jaws are damaged and the venter incised. However, the right side of the head, dorsum and vent region being undamaged, all the basic morphological characters of taxonomic importance are clearly seen.)

A medium-sized specimen measuring 225 mm from the tip of snout to tip of tail. Head depressed (5 mm in vertical height), subtriangular, 12.2 mm long (dorsally upto the first nuchal groove), 8 mm wide before the first nuchal groove and 9.5 mm at the collar. Eye fairly clear, under the skin with a whitish areola, 0.8 mm at its longer diameter, placed a little higher (1.3 mm) from the upper lip than the nostril (1 mm). Tentacular aperture close to upper lip, nearer to the eye (2 mm) than to the nostril (3.5 mm). Nostrils lateral, hardly visible from above, 5 mm from the eye. Eye to snout tip 5.6 mm. Snout not projecting beyond mouth.

Collars not prominent. The first nuchal groove crosses the dorsum dimly, arches forward on either side and meet medially on the venter. Second nuchal groove is seen only laterally and ventrally, the two collars being fused above. Third groove is faint. Two short transverse folds precede it above.

Primary and secondary folds number 315 of which 9 are on the tail, beginning with the front end of vent. Only three folds are broken by the vent. Tail short (4 mm) with 6 complete folds behind vent. Tail narrows rather abruptly behind the vent to a pointed tip. Body folds regular, cross straight across the dorsum, though they arch forward slightly in the more anterior segments.

Scales arise from the very anterior folds on the body.

Dentition Four series of backwardly directed, fairly long teeth, visible through the gape of mouth. The right side of the upper jaw carries 13 premaxillary-maxillary teeth and 14 prevomero-palatine teeth (left half damaged). The lower jaw carries 13-12 dentary teeth and 15-14 splenial teeth. Tongue narrow anteriorly, partially covers the last few splenial teeth.

Colour Dorsally dark lavender from snout to tail tip. Ventrally light brown. An yellow lateral stripe separates these two from head to tail, engulfing the vent. This stripe widens at the collar and extends along the upper jaw to the tip of snout as a narrow lateral band hardly touching the eye but widening to enclose the nostril. In front of the eye the dorsal lavender dips towards the tentacle. A faint lavender stripe originating from below the nostril runs towards the tentacular aperture. The yellow band on the lower jaw widens and joins the corresponding band on the other side rendering the anterior ventral end of the jaw yellowish. Eye with a circular pale ring around it.

A second and larger specimen, referable to this new taxon and collected from Garo Hills is available with the Bombay Natural History Society. This specimen is longer, measuring 310 mm

from tip of snout to tail. The head is distinctly depressed, its greatest elevation being 4.5 mm. Head relatively narrow (8 mm) compared to the maximum body width (10.5). Eyes under the skin, not very conspicuous, with a whitish circular patch around it. Interocular distance 6.5 mm which is more than snout length. Tentacular opening almost at the margin of upper lip, closer to eye (2.5 mm) than to nostril (4 mm). Distance between eye and nostril 5.2 mm. Nostrils barely visible from above.

First nuchal groove is fairly clear. Second groove clear on the venter, arches backward on sides and become indistinguishable on dorsum. Third groove faint, crosses dorsum, runs down the side to the venter.

Primary and secondary folds 314. They cross both the dorsum and venter except for a few anterior ones which do not meet either dorsally or ventrally. Tail short (4 mm) with about 9 folds counted from the front end of vent.

The number of teeth in the four series could not be ascertained since they are either broken or missing leaving only a few teeth and empty sockets in the gums. The lacerated and teased condition of the gum does not permit a fair count of empty sockets either. Tongue narrow, pointed, not covering the splenial teeth.

The specimen is partially bleached. Dorsally light brown, venter paler. A cream lateral stripe from head to tip of tail. The specimen is presumably quite old (no date) and collected by H. W. Wells from Tura, Garo Hills, Meghalaya. A label inside reads "*Ichthyophis* sp. sent from Museum of Zoology, University of Michigan, U. S. A. on 5.4.79" The entry in the Register denotes the specimen as *Ichthyophis supachaii*.

Data and measurements of the two specimens are given in the Table

Table of data and measurements on *Ichthyophis garoensis*

	Holotype 18458	BNHS 16
Total length	225	340
Tail length	4	4
Head width	8	8
Snout length	5.6	5.5
Body width	11	10.5
Eye to tentacle	2	2.5
Tentacle to nostril	3.5	4
Eye to nostril	5	5.2

Eye to eye	—	6.5
Snout tip to 1st groove	12.5	13.2
To 2nd groove	15.5	16
To 3rd groove	17.5	19
Body folds	315	314
Tail folds	9	9
Premaxillary-maxillary	?-13	—
Prevomeropalatine	?-14	—
Dentary	13-12	—
Splénial	15-14	—

Distribution Garo Hills, Meghalaya (See Map IV)

Remarks Despite the injury to the first specimen and absence of teeth in the second specimen, there is little doubt that these two, both from Garo Hills, are conspecific and belong to the striped category of *Ichthyophis*. In certain features such as the elongated depressed head, position of tentacle, nature and number of body folds, tail, colour etc. the present specimens bear a resemblance to *Ichthyophis supachaii*. However, the highly reduced and distinguishing character of the dentary (8-6) in *Ichthyophis supachaii* alone would seem to differentiate the two. It would also be highly improbable to expect a Thailand species of *Ichthyophis* to occur in India.

It is not possible to assign these two specimens from Garo Hills, Meghalaya to any of the striped species of *Ichthyophis* found in India viz. *I. beddomei*, *I. tricolor* and *I. longicephalus* or to the two striped forms, *I. pseudangularis* and *I. glutinosus* that occur in Sri Lanka. *I. garoensis* is distinguishable from *I. beddomei* in the relatively longer head and snout, more body folds and much less teeth in the premaxillary-maxillary, prevomeropalatine and dentary series. It differs from *I. tricolor* both in the colour pattern and teeth and from *I. longicephalus* in the dental formula, number and nature of body folds etc. The number of teeth in the premaxillary-maxillary, prevomeropalatine and dentary series in both *I. pseudangularis* and *I. glutinosus* is considerably more (Nussbaum and Gans, 1980) than that in *I. garoensis*.

Ichthyophis glutinosus (Linnaeus)

(Figs. 5, 25)

1754. *Caecilia glutinosa* Linnaeus, *Museum SRM Adolphi Friderici Regis* : 19
 1841. *Epicrium glutinosum* : Dumeril and Bibron, *Erpet. Gen.*, 8 : 285.
 1864. *Ichthyophis glutinosus* : Gunther, *Rept. Brit. India* : 441.
 1879. *Ichthyophis glutinosus* : Peters, *Monatsb. Akad. Wiss.*, Berlin : 931.

1882. *Ichthyophis glutinosus* : Boulenger, *Cat. Batr. Grad. Apoda* : 89.
 1960. *Ichthyophis glutinosus* : Taylor, *Univ. Kansas Sci. Bull.*, 40 : 38.
 1968. *Ichthyophis glutinosus* : Taylor, *Caec. World* : 90.
 1980. *Ichthyophis glutinosus* : Nussbaum and Gans, *Spolia Zeylanica*, 35 : 137.

Type locality : "Habitat in Indiis"

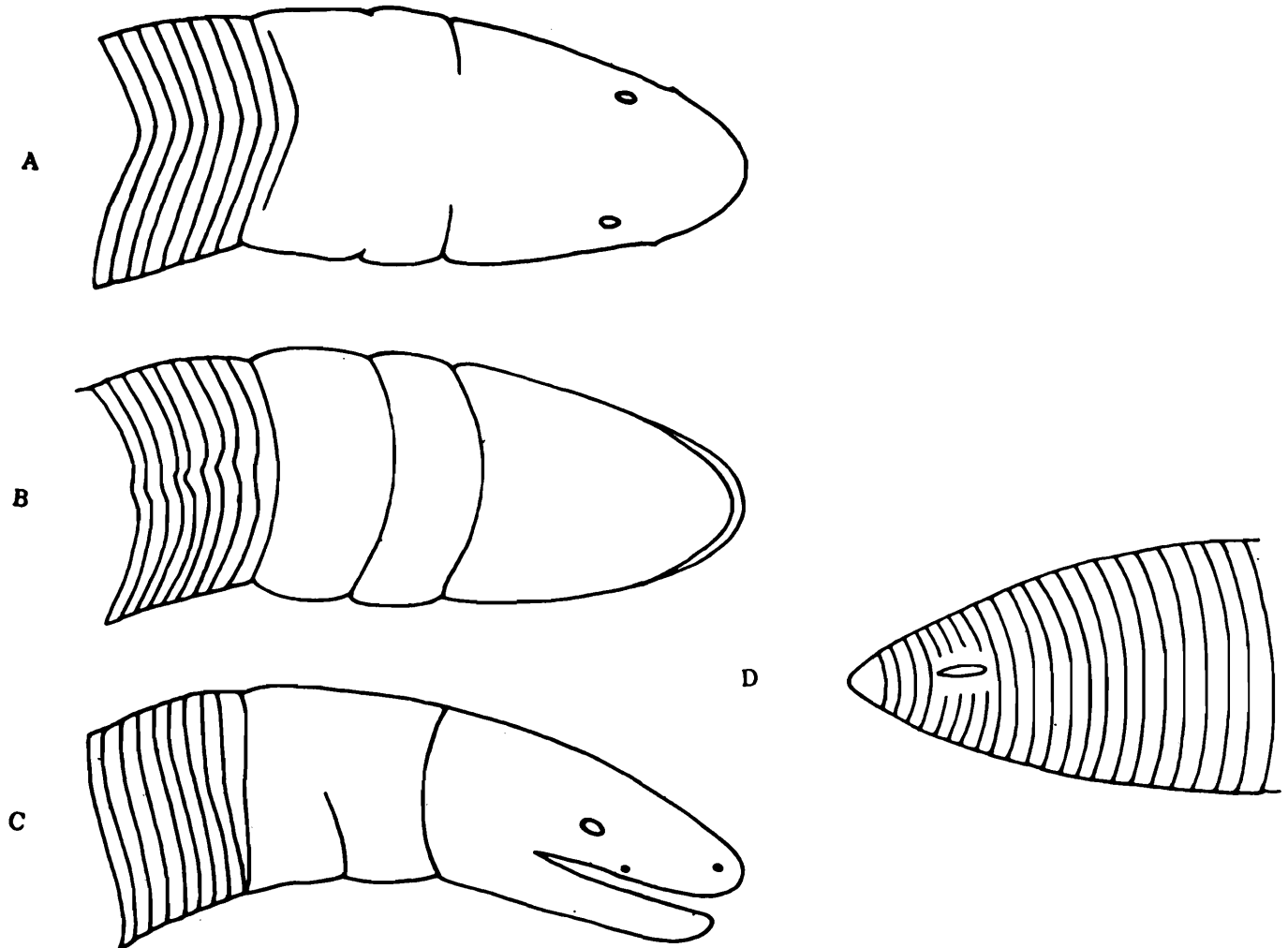


Fig. 5. *Ichthyophis glutinosus* (Linnaeus). A,B,C, three views of head ; D, subcaudal region.

Location of type : Royal Museum of Stockholm.

Material examined :

One example, No. 10402 ZSIC, Goalpara, Assam, Date?, H. L. Haughton (ASB, mutilated).

Diagnosis A large species reaching 400 mm with well defined lateral yellow stripes. Tentacular aperture distinctly closer to eye than to nostril. Number of annuli high, 329 to 415. Scales begin on nuchal collars and occur in every fold.

Description (No. 10402 ZSIC from Goalpara) A large specimen measuring 307 mm in total length. Head a little depressed, long (14 mm dorsally), snout tip bluntly rounded. Eyes below skin, visible, 0.6 mm across. Tentacular aperture close to the upper lip, closer to eye (2.2 mm)

than to the nostril (3.7 mm); a little elevated and circular. Interocular distance (6.5 mm) more than snout length (6.2 mm) from the edge of eye. Snout tip almost on level with the tip of lower jaw. Nostrils lateral, closer to upper lip than the eye, barely visible from above.

Collars not wider than head and rather inconspicuous. Dorsally the two collars are completely fused to each other. First nuchal groove clear ventrally and laterally. Dorsally they do not cross the dorsum. Second nuchal groove equally distinct ventrally and terminates on the sides. Third nuchal groove faint, resembling the other body grooves behind it and could be traced all round the body. A single transverse groove in front of this on the dorsum, terminating at the sides.

In all, there are 361 primary and secondary folds on the body behind the collars of which 8 folds are on the tail (from the anterior end of vent). 4 folds are broken by the longitudinal vent which has about 6 denticulations on each side. Dorsally the folds are complete, those on the anterior half of the body arch forward mid-dorsally. The ventral folds, except the first two or three, and those on the last quarter of the body, make distinct backward angles. Tail end is blunt with a small unsegmented terminal shield.

Small scales are seen on the most anterior folds, those on the hind end much larger.

Dentition Teeth in four series, well developed and clearly visible. Premaxillary-maxillary, 17-18, prevomeropalatine, 17-18, dentary, 16-16 and splenial, 9-9. All teeth including splenials project well out of the gums. Dentary teeth are the largest and recurved. Those on the front and upto midway on sides (about 9 each) are much larger than those following them, the posterior ones are tiny. Premaxillary-maxillary, prevomeropalatines and splenials are roughly of the same size, their size diminishing backwards. Tongue with longitudinal grooves, blunt at the tip and not covering the splenial teeth. No narial plugs. Choanae large, oval and close to palatines.

Colour Brown below the translucent whitish skin that had sloughed off at places on the body. Head which is almost fully sheathed by the translucent slough, appears lighter in colour. Ventrally brown, separated from the dorsal brown by a clear lateral cream stripe, 3 mm in width. This stripe extends anteriorly upto the collars beyond which the translucent whitish slough makes it difficult to be traced to the jaws. Posteriorly it extends right upto the tip of tail. Each body fold is marked by a row of whitish glandules. A patch of cream surrounds the vent. The lateral stripes widen (4mm) on either side of the vent.

This specimen was collected by H. L. Haughton from Goalpara, Assam. The date of collection is not known, but presumably it is quite old and in the process of moulting. As the label indicates, it is broken into two at a quarter of its length from the snout. Otherwise it is in fairly good condition.

The data and measurements of this specimen along with those of one from Sri Lanka described by Taylor (1968) are given in the Table.

Distribution Sri Lanka and now India (Assam) (See Map IV).

Remarks *Ichthyophis glutinosus* described by Linnaeus in 1754 had a surprisingly wide

range of distribution, too wide for a vagile species, from East Indies through Southern Asia to India. Taylor (1960a) studied it in detail and discovered a number of new species out of the specimens available in various museums which till then were considered to be *I. glutinosus*. He recognised the nominal species of *I. glutinosus* (Linnaeus) to be an Asiatic form. In 1968, after a study of the specimens of *I. glutinosus* from Sri Lanka, he concluded "For the time being, I shall regard the species as confined to the Island of Ceylon"

Nussbaum and Gans (1980) re-examined the taxonomic status of the Sri Lankan *Ichthyophis* in detail. Synonymising *I. forcati* Taylor with *I. glutinosus*, they have clearly brought out the range of variation in *I. glutinosus*, in respect of a number of characters. The present specimen from Goalpara accommodates itself easily into this. *I. glutinosus* should now be considered as being distributed both in Sri Lanka and India. Similarities between the Sri Lankan *I. orthoplicatus* and some Indo-Malayan species have been indicated by Nussbaum and Gans (1980) in support of Wallace (1876) who noticed many peculiarities in the fauna of Sri Lanka and remarked on the similarities between the animal assemblages of Sri Lanka and Indo-Malaysia. Several Sri Lankan phyla have subsequently been shown to have their nearest relatives in Malaya and these include a number of anurans as well. Since northeastern India, including Assam is known to harbour Indo-Malayan elements in its fauna and flora, it is not very surprising to record *I. glutinosus* from Assam though far removed from Sri Lanka.

Table of data and measurements on *Ichthyophis glutinosus*

	10402 ZSIC Assam	9102 NMW Srilanka
Total length.....	307	347
Tail length	5	7
Head width.....	10	10.9
Snout length.....	6.2	5.8
Body width.....	14	16
Eye to tentacle	2.2	1.9
Tentacle to nostril	3.7	3.5
Eye to nostril	5.5	5
Eye to eye	6.5	6.2
Snout tip to 1st groove	13.6	14
To 2nd groove.....	17.4	18.5
To 3rd groove	21	23.8
Body folds	361	392

Tail folds	8	9
Premaxillary-maxillary	17-18	20-21
Prevomeropalatine	17-18	20-21
Dentary	16-16	18-19
Splénial	9-9	15-15

Ichthyophis husaini sp. nov.

(Figs. 6,26)

Type locality Garo Hills, Meghalaya.

Location of type Zoological Survey of India, Madras

Material examined

One example No. 18426 ZSIS, Thebronggiri Coffee Garden, Rongram, Garo Hills, Meghalaya, 28.8.1983, A. Husain (Holotype).

Diagnosis A fairly large species measuring 285 mm with about 300 body folds. No lateral stripe. Dorsum brown in preservative, venter lighter brown. Head relatively long, tentacular aperture elevated, closer to eye than to nostril, teeth large, recurved. Splénials 16-17.

Description (from Type) A fairly large specimen measuring 285 mm from snout to tip of tail. Head relatively long (13.5 mm upto first nuchal groove) and 9 mm wide. Eyes distinct, small (0.7 mm) with a circular pale ring around it, a trifle more distant from the upper lip compared to nostril (1 mm and 0.8 mm respectively). Tentacular aperture close to upper lip, elevated, closer to eye (2 mm) than to nostril (3.5 mm). Nostrils almost at the tip of snout, large, just visible from above, with a circular rim bordering it. Snout hardly projects beyond mouth. Interocular distance equal to snout length (6 mm).

Collars not distinct. First nuchal groove fairly clear on sides but dim both above and below. Second groove absent on dorsum, faintly seen on venter, extend laterally upto level of the angle of mouth. Third groove similar to the body folds behind it, crossing dorsum with a forward arch and venter with a backward angle. A single incomplete fold precedes it dorsally.

There are 297 primary and secondary folds of which 9 are confined to tail (counted from the anterior end of vent). 4 folds are interrupted by the longitudinal vent. Tail short with 5 complete folds behind vent. Beginning with the vent, the tail narrows sharply to a pointed terminus. Body folds cross the dorsum straight across except the few anterior ones which curve forward in the mid-dorsal line. Ventrally they form backwardly directed angle except those on the last quarter of the body which are fairly straight. Near the vent and behind it, the folds gently arch forward mesially.

Scales are present from the anterior to the hind end of the body.

Starting from behind the collar are two flabby lateral folds, very prominent in the middle section, upto the hind end of body. Although these could be the result of preservation of the specimen, they are rather too pronounced to be ignored.

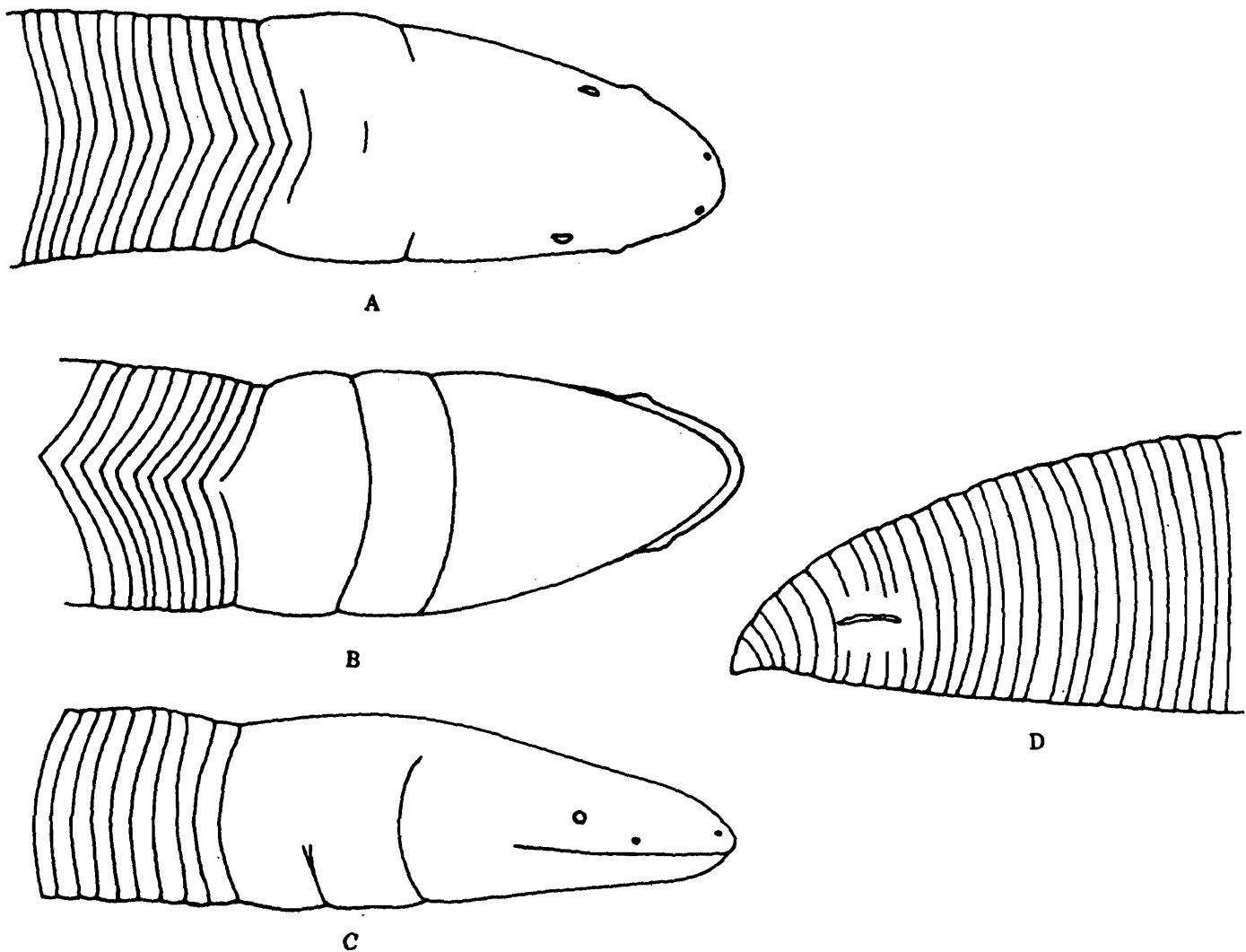


Fig. 6. *Ichthyophis husaini* sp. nov. A,B,C, three views of head ; D, subcaudal region.

Dentition Four series of recurved, fierce-looking teeth which are well visible through the gape of the mouth. The dentaries are the largest of these. Premaxillary-maxillary, 17-18;

prevomeropalatine, 16-17, dentary, 14-14 and splenial, 16-17. Tongue is thin, tapers anteriorly and does not cover the splenial teeth. Choanae large, oval, each with a long backwardly directed shallow groove.

Colour The dorsum is brownish in preservative and clearly areolated, venter a lighter brown. Head is pale both above and below. A median cream hairline from snout tip to level of the angle of mouth. Ventral hind end including the tail is pale, the area around vent paler. A cream ring around eye.

Data and measurements are given in the Table.

Table of data and measurements on *Ichthyophis husaini*

	18426 TYPE
	Garro Hills
Total length	285
Tail length	8
Head width	9
Snout length	6
Body width	11
Eye to tentacle	2
Tentacle to nostril	3.5
Eye to nostril	5
Eye to eye	6
Snout tip to 1st groove	13.5
To 2nd groove	16.5
To 3rd groove	19
Body folds	297
Tail folds	9
Premaxillary-maxillary	17-18
Prevomeropalatine	16-17
Dentary	14-14
Splenial	16-17

Distribution Garro Hills, Meghalaya (See Map IV)

Remarks *Ichthyophis husaini* bears a fairly good resemblance to the single specimen of *I. sikkimensis* with damaged teeth from Anamalai available with the Bombay Natural History Society. However, the more number of teeth in the first three series and their smaller size, reduced number in the splenial series and the shorter tail seen in specimens of *I. sikkimensis* from Kurseong and Suriel (Darjeeling District) are sufficient to segregate it from the present species.

I. subterrestris also has large teeth, particularly the dentaries which are approximately 3 times the size of the premaxillary teeth. However, the dental formula, more number of body folds, longer tail with more folds and the proportionately stouter body in *I. subterrestris* would make it quite distinct from *I. husaini*.

It is a pleasure to name this species for Dr Akhlaq Husain, Zoological Survey of India, Dehra Dun who collected the specimen and provided valuable data.

Ichthyophis longicephalus Pillai

(Fig. 7)

1986. *Ichthyophis longicephalus* Pillai, *Rec. zool. Surv. India* 84 : 231.

1990. *Ichthyophis longicephalus* : Indraneil Das, *J. Bombay nat. Hist. Soc.*, 87 : 310.

Type locality Silent Valley, Nilgiri Biosphere Reserve.

Location of Type Zoological Survey of India, Madras.

Material examined

1. One example, No. VAG 10 ZSIM, Silent Valley, Kerala, 27.1.79, R. S. Pillai (Holotype)
2. One ex. No. VAG 11 ZSIM, Kalakkad Wildlife Sanctuary, Tamilnadu, 1.3.85, R. S. Pillai.

Diagnosis A small-sized caecilian (upto 192 mm) with a relatively longer head and about 350 folds of which 8 to 9 are on the tail. A lateral yellow stripe present. Tentacle closer to eye than to nostril.

Description (from type) A short species, 192 mm long from snout to tip of tail. Body relatively broad, length to breadth ratio about 23 times. Head long, 11.4 mm (16.8 times in total length), thinner (7.4 mm) than body, narrowing where it meets the collar, Snout tip blunt, rounded. Eye distinct, slightly protruding under the skin, placed a little farther from the upper lip than the nostril. Interorbital distance (5.3 mm) equal to length of snout in front of eye. Tentacular aperture close to upper lip, nearer to the eye (1.6 mm) than to the nostril (3.3 mm). Nostrils at the tip of snout, barely visible when viewed from above, 4.4 mm from the eye.

The two collars are fused above. First nuchal groove very clear below and on sides but failing to meet above. The second nuchal groove equally conspicuous on venter and on sides but terminates at the level of the angle of the mouth. Third groove is weak, similar to other body folds behind it and does not meet in the midventral line. Second collar with two incomplete folds on dorsum preceding the third nuchal groove.

Behind the collars are 348 primary and secondary folds of which 8 are on the tail counted from the front end of the vent. 4 folds are interrupted by the longitudinal vent. Tail slightly pointed at the tip. Body folds regular, crossing the dorsum straight across. Ventrally the folds form a backward angle at the midventral line upto four-fifths of the body, behind which they straighten up and pass directly across.

A single row of scales on the anterior folds, two to three rows more posteriorly.

Dentition Four series of tiny teeth. Premaxillary-maxillary, 17-18 prevomeropalatine, 23-23, dentary, 16-16 and splenial, 16-14. Dentary teeth are the largest and splenials smallest. Tongue narrow, pointed, not concealing the splenials. It appears studded with papillae.

Choanae elongate, narrow, distance between them about 8 times the width of each choana.

Table of data and measurements on *Ichthyophis longicephalus*

	VAG-10 ZSIM Silent Valley	VAG-11 ZSIM Kalakad
Total length.....	192	183
Tail length.....	3.5	3.4
Head width.....	7.4	7
Snout length.....	5.3	5.3
Body width.....	8.5	9.5
Eye to tentacle.....	1.6	1.9
Tentacle to nostril.....	3.3	3.1
Eye to nostril.....	4.4	4.2
Eye to eye.....	5.3	5
Snout tip to 1st groove.....	11.1	10.6
To 2nd groove.....	13.8	13.2
To 3rd groove.....	15.5	14.8
Body folds.....	348	347
Tail folds.....	8	9
Premaxillary-maxillary.....	17-18	17-19
Prevomeropalatine.....	23-23	25-24
Dentary.....	16-16	17-18
Splenial.....	16-14	19-19

Colour : Dark violet above, lighter below in life, turning brown in preservative. A lateral yellow stripe (2.5 mm broad) from tip of tail to the first nuchal groove which narrows on the second collar. Another band of cream from the angle of jaws along the upper and lower lips. A cream patch surrounds the vent.

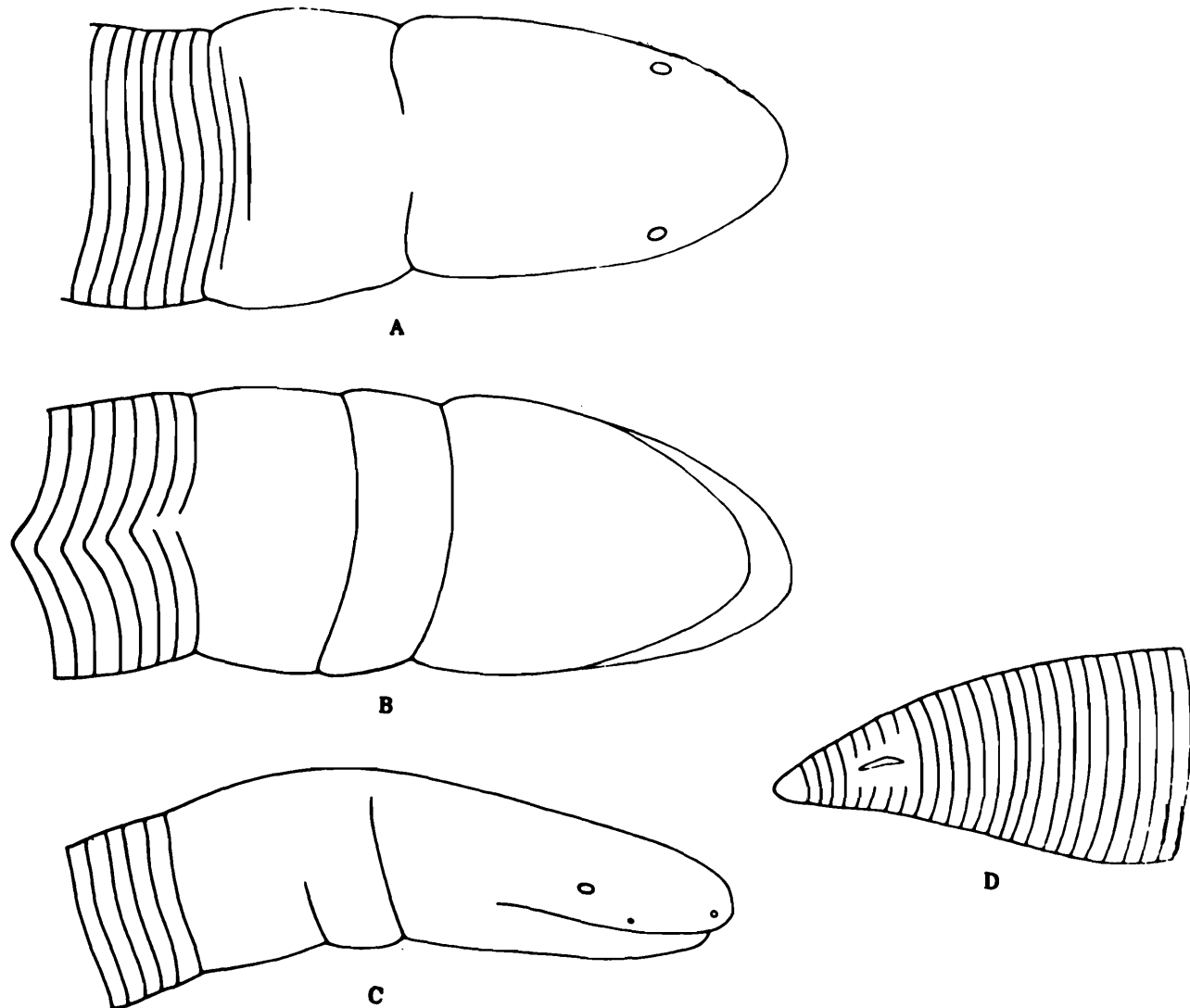


Fig. 7. *Ichthyophis longicephalus* Pillai. A,B,C, three views of head ; D, subcaudal region.

A second specimen of *Ichthyophis longicephalus* was collected from the Kalakkad Wildlife Sanctuary in 1985. Body is slightly shorter but broader than the type. Head 16.7 times in total length. Dorsum brownish above and lighter below in preservative, the lateral stripe rather inconspicuous. Dental formula is premaxillary-maxillary, 17-19; prevomeropalatine, 25-24; dentary, 17-18 and splenial, 19-19. 347 body folds of which 9 are on the tail. This specimen was collected from leaf litter accumulated between the buttresses of a wild mango tree, about 50 metres away from a river.

Data and measurements are given in Table.

Distribution Southern Western Ghats (See Map III)

Remarks The number of prevomeropalatine teeth given in the description of the type (Pillai, 1986) is 14-14. Evidently only the exposed teeth were counted. A recount gives the number as 23-23 which agrees fairly well with the Kalakkad specimen which has 25-24 teeth in the prevomeropalatine series. As Taylor has remarked, there is considerable difficulty in arriving at a satisfactory count of teeth and this is especially true of the two inner series viz. prevomeropalatine and splenial. The enhanced number of prevomeropalatine teeth discovered now in the type does not in any way alter the status of the taxon since the main character on which the species was erected is its much longer head among the striped forms of *Ichthyophis*.

***Ichthyophis malabarensis* Taylor**

(Figs. 8, 37)

1960. *Ichthyophis malabarensis* Taylor, *Univ. Kansas Sci. Bull.*, 40 : 81

1961. *Ichthyophis malabarensis* : Taylor, *J. Bombay nat. Hist. Soc.*, 58 : 359.

1968. *Ichthyophis malabarensis* : Taylor, *Caec. World* : 103

Type locality Maduvangard, Kerala.

Location of type British Museum (Natural History), London.

Material examined

1. One exmple No. VAG 8 ZSIM, Samse, near Chikmagalur, Karnataka, 5.7.92, R.S. Pillai.
2. One ex. No. VAG 9 ZSIM, Sringeri, Karnataka, 4.1.94, R. S. Pillai.

Diagnosis : Largest of Indian caecilians attaining a length of 545 mm. Tail proportionately long (30 to 24 times in total length). 354 to 380 primary and secondary folds on body, 14 to 17 on tail. Folds curve backward at midventer and forward on the dorsum. Tentacular aperture closer to eye than to nostril. Splenial teeth less (7-7 or 9-9). Scales present throughout body. Uniformly dark slate above, lighter below.

Description (No. VAG 8, ZSIM, from Samse) A large specimen measuring 545 mm in length and 21 mm in body width. Head rather short, oval, blunt, narrower (16.5 mm) than body. Collar 20 mm wide. Eyes small, circular, in a depressed socket 1. mm across, not distinct being covered over by semitransparent skin. Tentacular aperture close to upper lip, its distance from eye (3.5 mm) less than its distance from nostril (5 mm). Snout projecting beyond mouth. Interocular distance more than snout length (10 mm and 8.7 mm respectively).

Collars wider than occipital region. First nuchal groove prominent all round. Second groove well defined ventrally, terminates after curving backwards on sides, not reaching dorsum. Third groove fairly clear laterally, curves backwards ventrally not meeting in the middle line. It is distinct on the dorsum, the median part arching forward. This is preceded by three incomplete transverse grooves on the dorsal side of the second collar.

Following the collars are 380 primary and secondary folds of which 17 are confined to the tail, beginning with the front end of vent. Six folds are broken by vent and eleven complete behind. Tail tapers to a blunt tip. Folds cross the dorsum curving forwards in the middle line.

Ventrally they turn backward to meet in the middle except the first 15 or so which are fairly straight across and do not cross the median ventral line. The folds preceding the vent also cross the venter straight across. All folds are distinct, close to each other and regular. There is a short unsegmented shield at the terminus of the tail.

Scales start from the first fold though few in number compared to the posterior folds where there are about 8 rows of imbricating scales in each fold.

Dentition Out of the four series of teeth, those on the upper jaw are clear while the large fleshy tongue covers the splenials fully and the dentaries partially, making accurate counts difficult. Premaxillary-maxillary, 27-28; prevomeropalatines, 26-27; dentaries, 24-26 and splenials

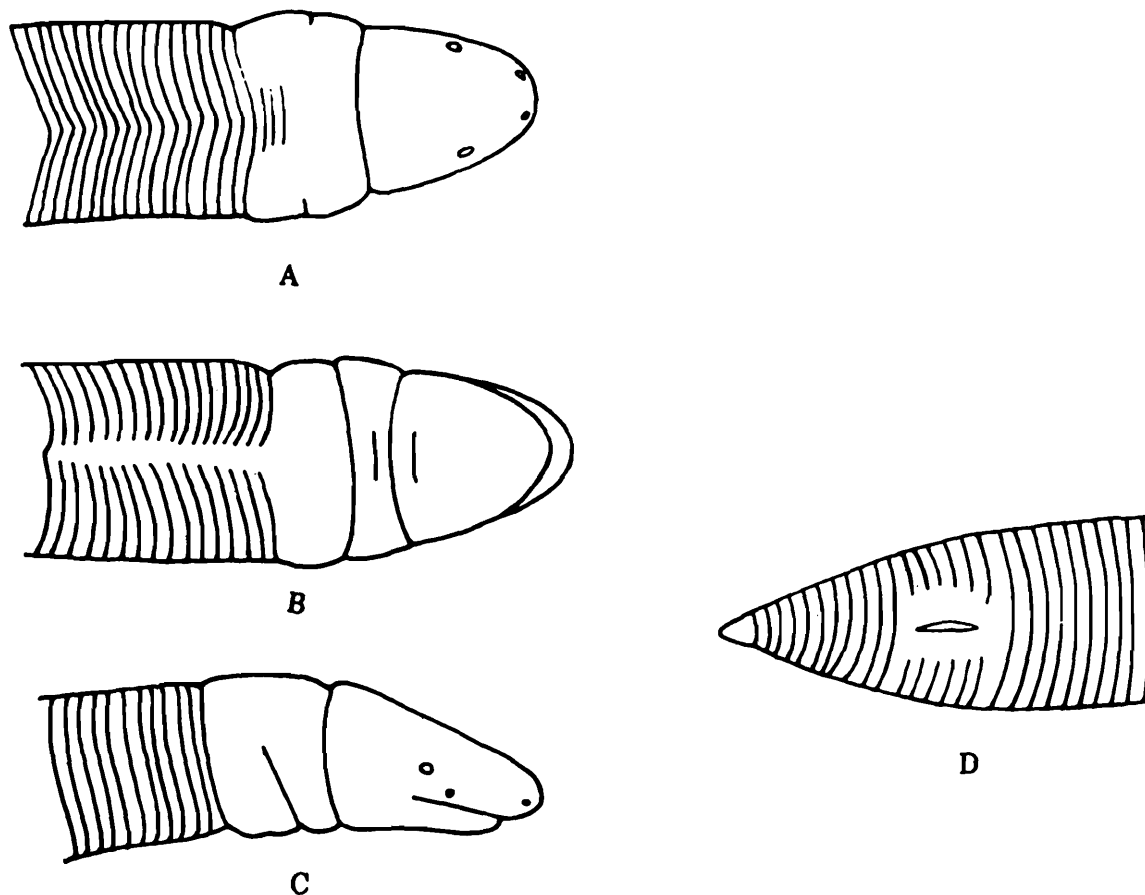


Fig. 8. *Ichthyophis malabarensis* Taylor. A,B,C, three views of head ; D, subcaudal region.

about 7-6. Teeth are small, slightly recurved. the dentaries being the largest of the four series.

Colour The entire dorsum is uniformly dark slate, venter a dirty gray, much lighter than dorsum. The tail end is darker, particularly behind vent upto the tip. A light gray circle around the eye forming a narrow rim. A whitish circular patch around the vent is quite prominent.

The second specimen from Sringeri agrees well with the above. It is smaller (520 mm) but stouter, the maximum body width being 24 mm. The body folds are less (370) with 17 on tail out of which 5 are broken by vent and 12 complete behind. Dental formula also agrees generally with the Samse specimen. Premaxillary-maxillary, 28-29; prevomeropalatines, 29-30, dentary, 26-27 and splenial, 7-7. Colouration is also similar, the patch of cream around the vent very prominent.

Data and measurements of these along with that of the type are given in Table

Table of data and measurements on *Ichthyophis malabarensis*

	VAG-8 ZSIM Samse	VAG-9 ZSIM Sringeri	Bangalore (Taylor, 1968)	Type BMNH Maduvangard
Total length	545	520	487	494
Tail length	17.5	19.5	17	21
Head width	16.5	16.5	15	14.5
Snout length	8.7	10	—	8.4
Body width	21	24	14 (Average)	18
Eye to tentacle	3.5	3	2.6	2.6
Tentacle to nostril	5	6	5	5
Eye to nostril	6.8	7.5	—	6.7
Eye to eye	10	11	10.2	11
Snout tip to 1st groove	20	20	22	19
To 2nd groove	25.3	24.5	—	26
To 3rd groove	30.5	30.7	—	32.3
Body folds	380	370	356	360
Tail folds	17	17	17	14
Premaxillary-maxillary	27-28	28-29	33-34	31-31
Prevomeropalatine	26-27	29-30	34-35	34-34
Dentary	24-26	26-27	28-29	27-27
Splénial	7-6	7-7	9-9	8-?

Distribution Central Western Ghats, Southern India (See Map V)

Remarks *Ichthyophis malabarensis* is the largest among Indian caecilians and the present example with the total body length of 545 mm is the largest known. In body width, the Sringeri specimen is the stoutest. The original description on the basis of a single specimen from Maduvangard, Kerala by Taylor (1960 a) was supplemented by the description of another example from Karnataka lacking specific locality (Taylor, 1968). No other description is available of this species hitherto in literature apart from these two.

The present examples agree fairly well with the type and Taylor's specimen from Bangalore. The type is smaller than the present examples and the number of primary and secondary folds less. The other minor differences indicated in Table serve to indicate the range of variations. The number of teeth in the premaxillary-maxillary and prevomeropalatine series is more in Taylor's material. The difficulty in counting the teeth is quite obvious and Taylor on re-examination (1968) and more careful search in the type has given enhanced number for these

two series of teeth. The Bangalore specimen has more teeth. On the basis of these four specimens (2 of Taylor and 2 here studied) the range of teeth in the four series could be taken as premaxillary-maxillary, 26-28 to 33-34; prevomeropalatine, 26-27 to 34-35; dentary, 24-26 to 28-29 and splenial, 7-6 to 9-9. The colour pattern also agrees well. The small yellowish spots at the tentacular aperture and nostril are absent in the present examples. The whitish patch around vent though absent in the Bangalore specimen is seen both in the type and the present specimens.

Taylor feels that this species is rare in its range or that it burrows to a considerable distance below the surface of the earth. A creature so conspicuous would otherwise be better known.

Ichthyophis peninsularis Taylor

(Figs. 9, 38)

1882. *Ichthyophis monochrous* : Boulenger, *Cat. Batr. Grad. Apoda Brit. Mus.*, 91 (Part)
 1890. *Ichthyophis monochrous* : Boulenger, *Fauna Brit. India.*, 517 (Part)
 1947. *Ichthyophis monochrous* : Ramaswami, *Curr. Sci.*, 16 : 8.
 1960. *Ichthyophis peninsularis* : Taylor, *Univ. Kansas Sci. Bull.*, 40 : 61.
 1961. *Ichthyophis peninsularis* : Taylor, *J. Bombay nat. Hist. Soc.*, 58 : 359.

Type locality "Malabar"

Location of types Type British Museum (Natural History), London.

Paratypes - 1. Zoologisches Museum, Berlin.

2. Museum of Comparative Zoology, Harvard College, Cambridge.

Material examined

1. Three examples Nos. VAG 21, 22, 23 ZSIM, Chakrani Estate, Alamcholai, Martandam, 13.8.92, R. S. Pillai.
2. One ex. Zoology Department, Christian College, Martandam from Chakrani Estate, date? Jaisingh.
3. One ex. No. 10414 ZSIC, "South India" date?
4. One ex. No. VAG ZSIM, Neria River bank, Neria, Karnataka, 4.7.92, Sharath.
5. One ex. No. VAG 24 - ZSIM, Neria Estate, Karnataka, 18.9.92, Sharath.
6. One ex. No. 4376 ZSIC, "from Travancore", South Kerala, date ? R.H. Beddome.

Diagnosis A large species of the genus measuring upto 450 mm. Head short, broad; eyes not prominent, covered over by translucent skin; tentacle nearer to eye than to nostril; tail relatively long with 17 to 19 folds beginning with the front end of the vent. Body folds from 357 to 374. Splenial teeth few (3-4 to 6-6) in comparison with the other series. No lateral stripe. Dark gray or lavender above, lighter below.

Description (No. VAG 21 from Chakrani Estate) A fairly large specimen measuring 300 mm. Head broad, relatively short, triangular. Snout blunt. Width of head less than its length or

collar width. Eyes small, not very prominent, surrounded by a raised areola, 1 mm in diameter, covered over by diaphanous skin. Interocular distance (7.8 mm) a little more than length of snout in front of eyes (7 mm). Tentacular opening circular, very close to upper lip, closer to eye (2.3 mm) than to the nostril (4.2 mm). Eye and nostril equidistant from upper lip, distance between them 5 mm. Snout projecting beyond lower jaw, the tip of lower jaw on a level with the nostril. Nostril just visible from above.

Collars prominent. First nuchal groove conspicuous and complete all around. Second groove equally prominent both ventrally and on sides where it stops abruptly, visible from above as a nick. Third groove is less conspicuous resembling the body folds. It crosses the dorsal and lateral sides but leaves a wide gap mesially below. Third groove is preceded dorsally by 3 transverse incomplete folds. Collars a little wider than head.

There are 364 primary and secondary folds following the collars of which 19 are on the tail (from the front end of vent). 6 to 7 folds are broken by vent. The folds behind these are complete and curve forward in the midventral part. Tail tapers from the hind end of vent. Body folds are distinct, regular and encircle the body except the few anterior ones which do not meet ventrally. While they curve forward a little to meet mid-dorsally, they turn backward midventrally. The very tip of tail is devoid of folds:

Scales are present below the skin throughout the body from the first groove onwards. Anteriorly few and small. the scales are more in number posteriorly.

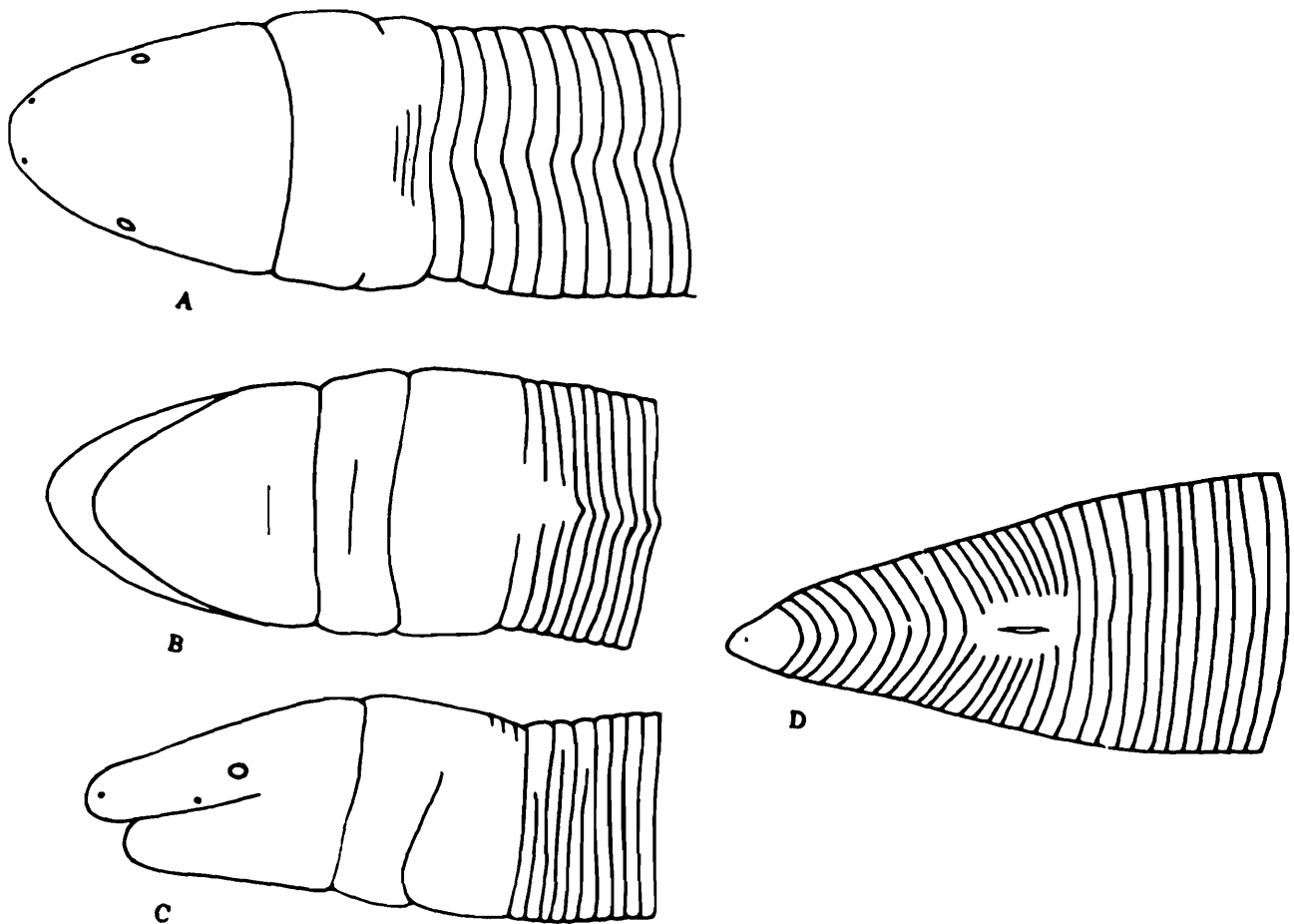


Fig. 9. *Ichthyophis peninsularis* Taylor. A,B,C, three views of head ; D, subcaudal region.

Dentition Four series of teeth embedded in the fleshy gums. Premaxillary-maxillary, 22-19;

prevomeropalatine, 25-25; dentary, 18-18 and splenial, 3-4. The tongue is large, fleshy and conceals the splenials completely and the dentaries partially. Teeth extend behind the angle of the jaws as well. Splenials are the most difficult to count. Choanae are large and far apart (3.2 mm).

Colour Bluish black above and cream below in life. After preservation dark gray above, lighter laterally and ventrally. Head lighter gray. Tail darker ventrally with a circular cream patch surrounding the vent.

A second specimen collected from Chakrani Estate (VAG 22) escaped from the vivarium at night and was picked up dead and desiccated three days later. The body is shrunk though in tact. Measuring 243 mm in total length, the body folds number 363 with 19 folds on tail from the front end of vent. 6 folds are broken by vent. The tail is acutely pointed. The dental series are: premaxillary-maxillary, 23-24; prevomeropalatine, 20-21; dentary, 19-18 and splenial, 4-4.

A third specimen from Chakrani Estate (VAG 23) had its tail end cut off by the spade while digging. Total length, tail length and tail folds could not hence be ascertained. In colour and other features it agrees well with the first specimen. Premaxillary-maxillary, 20-19; prevomeropalatine, 20-20, dentary, 18-20 and splenial, 4-3.

I have also examined the specimen available in the Zoology Department at the Christian College, Martandam through the courtesy of Dr Jaisingh who published a note on it in 1978. The data given by him are total length, 330 mm; folds 364 with 18 on tail. An oval white spot around vent. This specimen was also taken from Chakrani Estate.

Ichthyophis peninsularis specimens collected from Chakrani Estate were all from under rotting vegetation and compost heaps. They are usually available only after an overnight drizzle. One specimen of *I. beddomei* was also collected along with them.

Another larger specimen measuring 415 mm in total length with a locality label "South India" is available with the Zoological Survey of India, Calcutta. Eyes under a translucent patch of skin. Head typically broad and short. Nostrils quite prominent and on one side of a depression. Tentacular aperture at the summit of a conical protuberance. Vent surrounded by a whitish patch.

A smaller example (ZSIC No. 4376), collected from "Travancore" by R.H. Beddome measures only 190 mm. Body is narrow (7 mm), tail 8.5 mm, acutely pointed. Flesh-coloured or light brownish above, paler below.

Two examples collected from the vicinity of Neria House, Neria Estate, 102 km from Mangalore have been examined. VAG 24 measures 425 mm and was collected from under rotting timber on the banks of Neria River. It escaped from captivity at night and was later found dead. There are 380 folds on body of which 18 are on tail. The other example (VAG 25) measuring 332 mm was collected from cowdung slurry at the Neria Dairy farm. The eye in this specimen is not as clear as in the Chakrani Estate specimens being whitish and covered over by skin as in the Type (Taylor, 1960 a and 1968). 360 folds of which 17 are on the tail. The dairy workers around there have reported seeing caecilians often under old cowdung heaps. Although several compost heaps and moist soil in banana and arecanut plantations in the vicinity were dug, no more specimens could be found.

Data and measurements of these along with other examples are given in Table.

Table of data and measurements on *Ichthyophis peninsularis*

	VAG-21 ZSIM Martandam	VAG-22 ZSIM Martandam	VAG-25 ZSIM Neria	TYPE BMNH "Malabar"
Total length	300	243	332	330
Tail length	11.3	10	12	15.2
Head width	11.5	8.5	11.5	14.4
Snout length	7	6.4	7.3	6.1
Body width	16	9.2	15.5	14.8
Eye to tentacle	2.3	2.1	2	2.5
Tentacle to nostril	4.2	3.5	4	4
Eye to nostril	5	5	5.2	5
Eye to eye	7.8	6.5	7.6	7.1
Snout tip to 1st groove	15	12.5	15	14
To 2nd groove	18.5	16	19.3	19
To 3rd groove	23	20	22.5	24
Body folds	364	363	360	363
Tail folds	19	19	17	18
Premaxillary-maxillary	22-19	23-24	20-19	24-25
Prevomeropalatine	25-25	20-21	18-18	25-26
Dentary	18-18	19-18	19-19	25-24
Splénial	3-4	4-4	4-4	4-4

Distribution Southern India (See Map V)

Remarks All the eight specimens examined here agree well with the type, the extent of variations being indicated in the Table.

Ichthyophis peninsularis is the second largest species of Indian caecilians, the largest being *I. malabarensis*.

The type locality of *I. peninsularis* has not been specified. The only information available is that both type and paratypes are from "Malabar", the second paratype from "near Madras". Since Ramaswami (1947) recorded *I. peninsularis* (described as *I. monochrous* Bleeker) from the Kambakkam Hills of Eastern Ghats near to Madras, it is quite probable that the paratype locality record of "near Madras" is the Kambakkam Hills of Tamilnadu. There are records of this species in literature from "Travancore" "South India" "Lower India" etc. which are of little use from the distribution point of view. Precise records are now available from Chakrani Estate (Alamcholai near Marthandam, Tamilnadu) and Neria Estates (near Mangalore, Karnataka).

Ichthyophis sikkimensis Taylor

(Figs. 10, 27)

1881. *Ichthyophis glutinosus* : Blanford, *J. Asiat. Soc. Bengal*, 50 : 239.
 1960. *Ichthyophis sikkimensis* Taylor, *Univ. Kansas Sci. Bull.*, 40 : 91.
 1961. *Ichthyophis sikkimensis* : Taylor, *J. Bombay nat. Hist. Soc.*, 58 : 360.
 1968. *Ichthyophis sikkimensis* : Taylor, *Caec. World* : 129.

Type locality Darjeeling, West Bengal.

Location of types

Holotype California Academy of Sciences, San Francisco.

Paratypes British Museum (Natural History), London , Museum of Comparative Zoology, Cambridge , Zoologisches Museum, Berlin.

Material examined

1. One example No. 16668 ZSIC, Kurseong, Darjeeling Dist. E. Himalayas, 5000 ft., date? N. Annandale.
2. One ex. No. 17 BNHS, Injiparai Estate, Anamalai, Kerala, 22.8.49, A. F. Hutton.
3. One ex. No. 20433 ZSIC, Suriel, Darjeeling Dist. E. Himalayas, 1917, N. Annandale & F. H. Gravely.
4. Three exs. (larvae) No. 19049 ZSIC, Darjeeling Dist. 1918, S. W. Kemp.
5. Two exs. (Larvae) No. 19334-35, ZSIC Gangtok, Sikkim, 1922, F. M. Barley.

Diagnosis A medium-sized species devoid of lateral yellow stripe; 276 to 304 folds. Splenials few (8-8 to 10-10). Tail short, about 50 times in total length with 6 or 7 folds. Tentacular aperture closer to eye than to nostril.

Description (No. 16668 from Kurseong, Darjeeling Dist.) A fairly large specimen measuring 320 mm. Head relatively narrow (8 mm) and 12.5 mm long. Width at first collar a trifle less than that at occiput (7.5 mm). Tentacular aperture almost at the margin of upper lip, a little elevated, closer to eye (1.7 mm) than to nostril (3.2 mm) Eyes small (0.4 mm across), distinct and under the skin, the distance between them (6 mm) about equal to snout length from eye to the tip. The eye is about as distant from the upper lip as the nostril. Snout projects a little beyond mouth. Nostrils placed immediately behind the tip of snout, visible when viewed from above.

Collars very inconspicuous and not separated dorsally. The first nuchal groove faint below and on sides. (This groove is quite distinct in the other smaller example no. 20433 where it could be traced to the dorsum where they fail to meet mesially). The second groove is faintly visible ventrally and laterally (quite distinct in the smaller example). The third groove also faint, seen only on the sides, not crossing dorsum or venter (again more distinct in the smaller example which is figured).

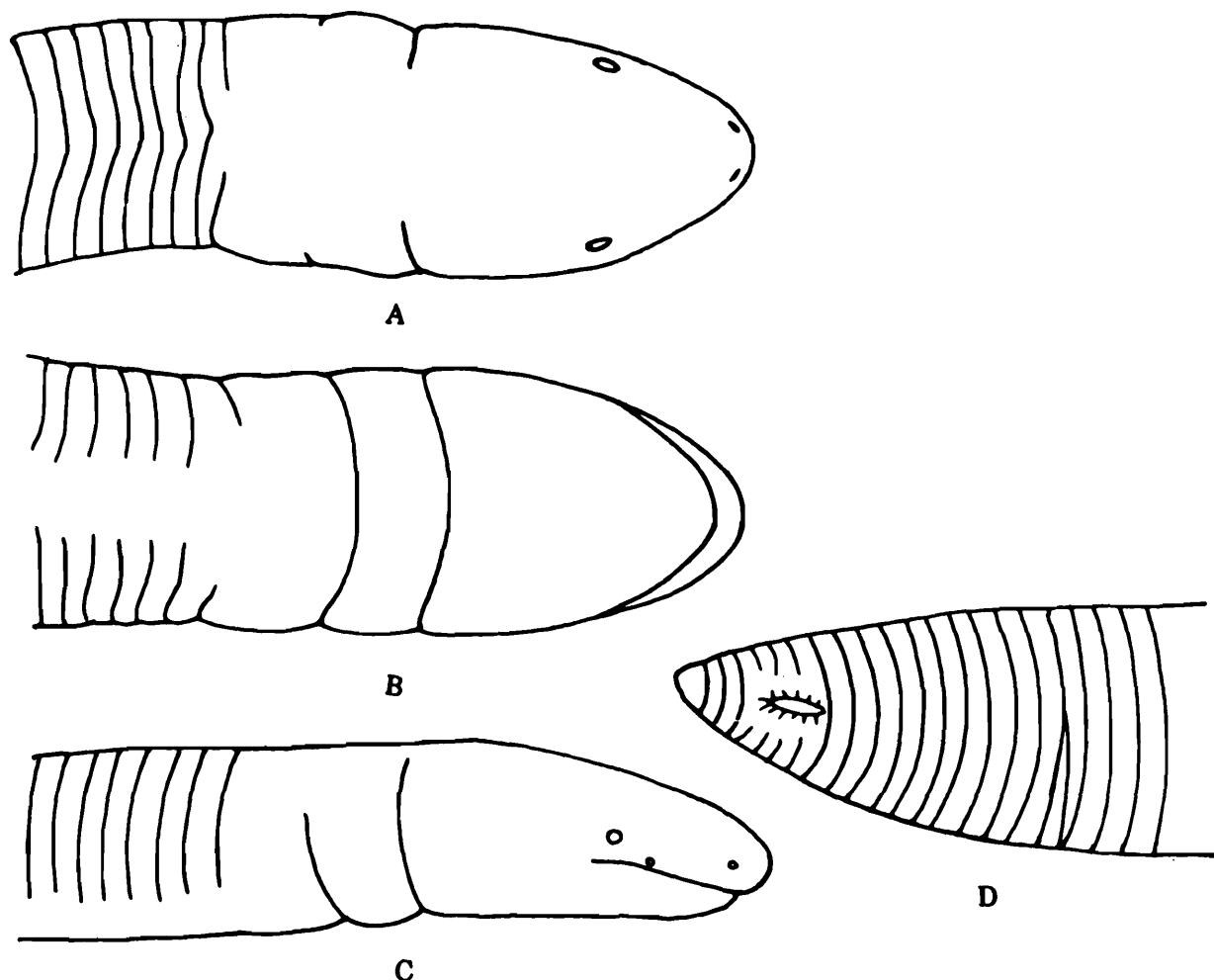


Fig. 10. *Ichthyophis sikkimensis* Taylor. A,B,C, three views of head ; D, subcaudal region.

There are 288 primary and secondary folds following the collars of which 7 are on the tail (counted from the anterior end of vent). 4 folds broken by vent. Vent in this specimen is open, circular, fringed by 14 lobulate denticulations all round. In the smaller example the vent (figured) is a longitudinal slit with the same number of lobules. The body folds cross the dorsum straight across except the first few. The folds meet each other ventrally only towards the last quarter of the body, though the fine areolae on the hind margin of each fold could be traced to meet mesially, angulate at first and straight across more posteriorly. The skin appears leathery and the folds are not as clear and distinct as in the smaller specimen.

Small scales appear about the middle of the body and continue backwards.

Dentition Four series of small teeth whose tips alone project from pockets in the fleshy gum. Premaxillary-maxillary, 19-21, prevomeropalatine, 17-18, dentary, 20-18 and splenials, 10-10. Apex of the flat tongue reaches the splenial series.

Colour Dark brownish above, pale below. Lips and throat paler. The nostril and tentacular aperture with cream patch around. No pale ring around the eye. Vent and its denticulations with a ring of cream colour.

The smaller example from Suriel, Darjeeling is brownish, tinted green all over. The upper side of head and collars is lighter than the rest of the dorsum.

I have examined a third specimen of *I. sikkimensis* from Injiparai Estate, Western Ghats available with the Bombay Natural History Society, collected by A. F. Hutton in 1949 and determined by Dr. R. A. Nussbaum, University of Michigan. It measures 290 mm in length and has 304 folds. Tail partly damaged and folds could not be counted. First nuchal groove clear laterally, indistinct both above and on throat. Second groove clear on throat and fairly so on the sides. Third is distinct on the sides but not so either ventrally or dorsally. Body uniformly flesh coloured both above and below. Teeth are small, inconspicuous and sunk in pits in the fleshy gum which is lacerated. Most teeth are either broken or knocked off possibly by probing needles trying to count them. The gums are in shreds making any precise teeth count difficult. The result of my count which I do not claim to be accurate is as follows Premaxillary-maxillary, 22-23 prevomeropalatine, 21-20 and dentary, 18-18. Splenial teeth are the most difficult to count, the jaw bone apparently broken. I could feel only six of them on one side but would put it as only less than 10 on each side.

The type specimen measures 276 mm and has 284 folds on the body. Eyes are distinct and interocular distance greater than snout length. The first nuchal groove distinct ventrally, not crossing neck, second groove visible below and on sides of neck, third groove distinct laterally but not completely crossing the neck either above or below. Four folds interrupted by vent, the sides denticulated, a pair of anal glands present one on each side of vent near the anterior end. Dark brown all over, lighter on the venter. Underside of chin still lighter, cream ring about eye, spots at nostril, tentacle, at the tip of snout and tip of tail. Lips marked with narrow cream.

The Table gives the data and measurements of the three specimens examined along with those of the Type and three Paratypes.

Table of data and measurements on *Ichthyophis sikkimensis*

	16668	20433		Para	Para	Para	
	ZSIC	ZSIC	BNHS	Type	Type	Type	
	Darjeeling	Darjeeling	Injiparai	CAS	BMNH	MCZ	ZMB
				Darjeeling	Darjeeling	Sikkim	Sikkim
Total length	320	225	290	276	263	271	270
Tail length	3.7	3.3	—	5.5	5.4	4.5	4.5
Head width	8	8	8.5	—	—	—	—
Snout length	5.9	5	5.5	5.2	—	—	—
Body width	11	9.5	9	12.2	12	10	10
Eye to tentacle	1.7	1.7	1.8	1.7	—	—	—
Tentacle to nostril	3.2	3.2	3	2.9	—	—	—
Eye to nostril	4.2	4	4	—	—	—	—
Eye to eye	6	5.1	6	6.1	—	—	—

Snout tip to 1st groove	12.5	12.5	13.5	—	—	—	—
To 2nd groove.....	14.3	14.2	15.8	—	—	—	—
To 3rd groove	18.5	17.2	19	—	—	—	—
Body folds	288	248	304	284	292	282	276
Tail folds.....	7	7	—	6	—	—	—
Premaxillary-maxillary	19-21	16-14	—	23-23	23-23	23-23	23-23
Prevomeropalatine	17-18	13-10	—	21-21	21-21	20-20	21-21
Dentary	20-18	—	—	20-21	20-21	21-21	18-19
Splential	10-10	8-8	—	10-10	10-10	9-9	9-9

Distribution Sikkim, Darjeeling in Northeast India and Anamalai in Southern Western Ghats (See Map VI)

Remarks *Ichthyophis sikkimensis* was hitherto thought to be a Himalayan species confined to Sikkim and Darjeeling. The present record of this species from the Western Ghats of Kerala is surprising and underlines the extreme scantiness of our present knowledge on the distribution of caecilians.

Ichthyophis subterrestris Taylor

(Fig. 11)

1960. *Ichthyophis subterrestris* : Taylor, *Univ. Kansas Sci. Bull.*, 40 : 65.

1961. *Ichthyophis subterrestris* : Taylor, *J. Bombay nat. Hist. Soc.*, 58 : 358.

1968. *Ichthyophis subterrestris* : Taylor, *Caec. World* : 139.

Type locality : "Travancore-Cochin, plains"

Location of type :

Type Field Museum of Natural History, Chicago.

Paratype Division of Systematic Biology, Museum, Stanford, California.

Material examined

1. One example No. 7 BNHS, Injiparai Estate, Anamalai, Kerala, 22.8.49, A. F. Hutton.
2. One ex. MGM, Ootacamund, Tamilnadu, date? F. H. Gravely.
3. Three exs. (one adult and two larvae), MGM, Kambakkam Hills, Tamilnadu, Aug. 1922, F. H. Gravely.

Diagnosis A medium-sized species, the largest known measuring 360 mm. Total folds range from 355 to 383. Tail long (20 to 22 times in total length) with 16 to 18 folds or less. Tentacular opening squarish, with arching sides. Very large dentary teeth, approximately 3 times the size of the premaxillary teeth. Shiny dark violet lavender above and lavender-brown below. No lateral stripes.

Description (No. 7, BNHS, from Anamalai) A large specimen with a total body length of 360 mm and a maximum body width of 18 mm. Tip of snout and tail injured. Occiput of head a little elevated. Length and width of head 14 and 11.5 mm respectively. Snout length 7 mm from the anterior edge of eye which is slightly more than interocular distance. Tentacular aperture closer to eye (2 mm) than to nostril (4.2), large, squarish with arched sides. Distance from eye to nostril 5 mm.

Nuchal collars not distinct. First nuchal groove fairly clear ventrally and laterally but not crossing dorsum. Second groove though prominent on the throat, stops short on sides. Third groove is faint.

Primary and secondary folds 355, closely arranged. Tail end injured, 10 folds could be counted. The expected number according to Taylor (1961) is 16-18. 5 folds broken by vent. Tail measures 9 mm, laterally compressed. Vent is at the bottom of a depression with a shallow backward groove. A few of the anterior body folds do not meet ventrally. The folds on the neck cross the dorsum arching forwards. Ventrally they curve backward in the midventral line.

Scales are present in all the folds, their number increasing backwards to four or five rows in a fold.

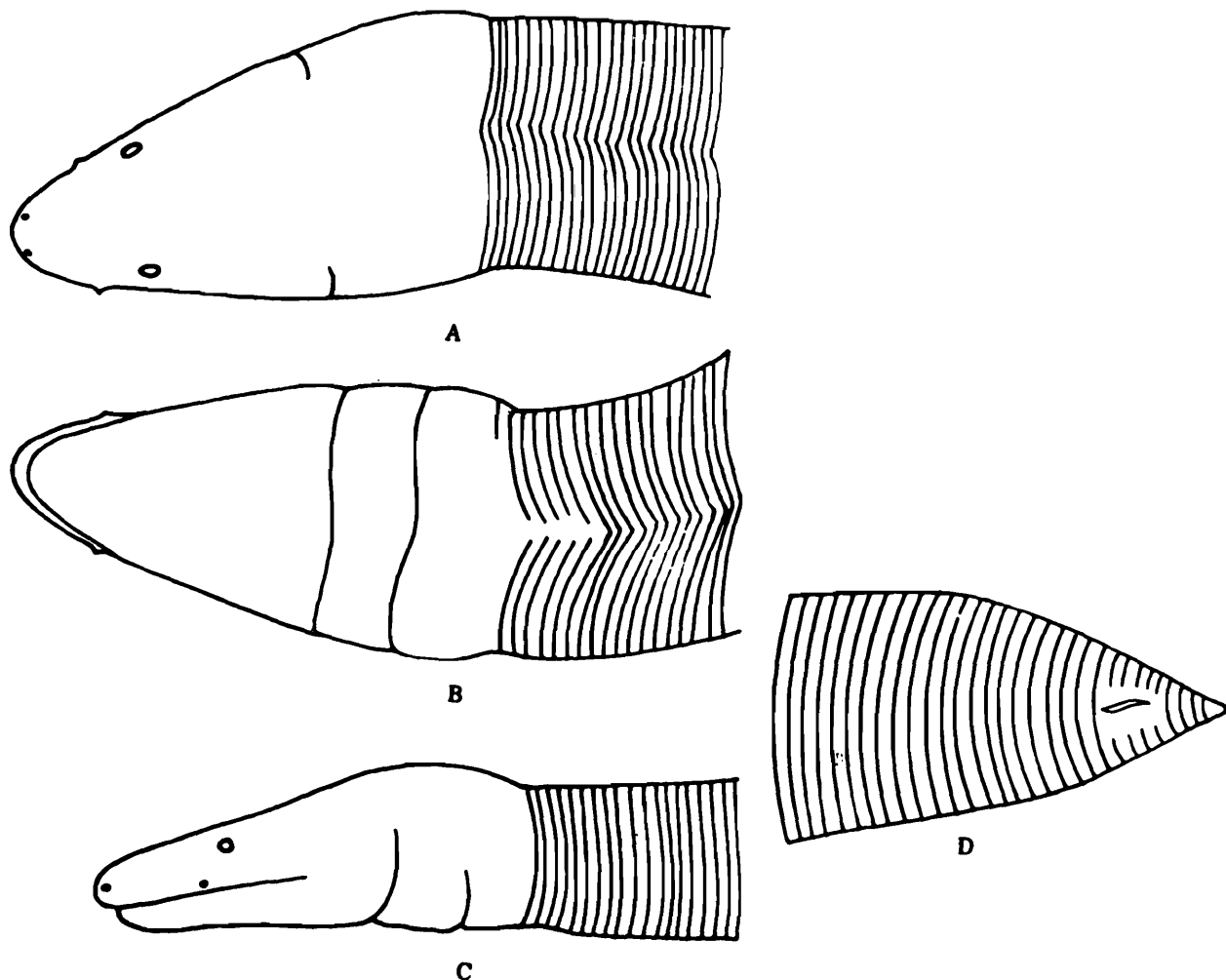


Fig. 11. *Ichthyophis subterrestris* Taylor. A, B, C, three views of head ; D, subcaudal region.

Dentition Only a few teeth are left standing on the jaws, the others represented by empty sockets in the fleshy gums. Either the teeth have fallen off or damaged by needle tips of those who have examined it from time to time. Fortunately Taylor (1961) has earlier reported the number of teeth of this specimen as premaxillary-maxillary, 23-23, prevomeropalatine, 23-23, dentary, 20-20 and splenial, 13-13. The dentary teeth are stated to be very large, nearly three times the size of maxillary teeth. The tongue is not as large as reported for the type and does not seem to cover the splenial series. Choanae angular and well separated.

Colour The colour has faded and is now darkish brown above, a little paler below. No areola around eyes or vent. The colour of *I. subterrestris* according to Taylor (1968) is dark violet-lavender above becoming more brownish-lavender on the venter. Area about eyes somewhat lighter and a few small rounded yellowish glandules present close to the edge of the eye, a small cream spot at nostril. Somewhat lighter about vent.

Another smaller example No. 8 from Alibag, Kolaba District, Bombay, available with the Bombay Natural History Society is now broken into bits and unfit for study.

We have examined 4 examples of *I. subterrestris* available in the Zoological collections of the Madras Government Museum. The largest of this, measuring 210 mm (originally 222 mm, Satyamurthy, 1967) from Ootacamund, Nilgiris is mounted on glass plate and exhibited in the gallery and hence could not be subjected to detailed examination. The specimen apparently is quite old, date of collection not known. The dorsum is completely bleached to a flesh colour and brownish below where it is possibly less bleached. Body folds are very closely set and an approximate count of 330 is made. Only 8 folds could be counted on the tail which is rather less according to Taylor (1961). Two clear transverse folds on the hind dorsal side of second collar. Dental formula ascertained through the gape of the mouth since the jaws could not be opened for fear of damage reveals premaxillary-maxillary, 20-20, prevomeropalatine, ?, dentary, 18-16 and splenial, 8-8. Scales are seen protruding in all the folds.

The second example measuring 215 mm in length and 12 mm in maximum width, preserved in the study collections is from Kambakkam Hills (Chenglepet Dist., Tamilnadu) of the Eastern Ghats, collected by F. H. Gravely in August, 1922 from an altitude of 200-250 feet. It was identified by Dr. G. S. Myers of the University of California, U. S. A. Folds could not be counted. However, the long, pointed tail has 17 folds. Colour is a uniform dark brown both above and below. The other two are young specimens from Kambakkam displayed in the gallery.

It has not been possible to trace the two examples stated to be available with the Zoological Survey of India, Calcutta. However the data and measurements of one as given by Taylor (1968) are reproduced in the Table.

Distribution Peninsular India (See Map V).

Table of Data and Measurements on *Ichthyophis subterrestris*

	BNHS Anamalai	MCZ Tamilnadu	MCZ Tamilnadu	17670 ZSIC Param- bikulam	TYPE FMNH Travancore
Total length.....	360	198	192	290	260
Tail length	9	10	9.5	13	11.7
Head width.....	11.5	7.6	7.5	10.5	11
Snout length.....	7	—	—	5.5	5.4
Body width.....	18	8.3	1.5	14	12.4
Eye to tentacle	2	1.5	1.1	1.8	1.8
Tentacle to nostril	4.2	3	2.6	4	3.0
Eye to nostril	5	—	—	—	—
Eye to eye	6.5	—	—	7.5	6.8
Snout tip to 1st groove	16	10.5	9.8	13.8	13
To 2nd groove.....	19	13	12	17	16.8
To 3rd groove	21.5	15.7	16	22	20.2
Body folds	355	383	374	380	364
Tail folds	10?	18	17	18	18
Premaxillary-maxillary	23-23	24-24	23-23	23-24	21-21
Prevomeropalatine	23-23	26-26	21-21	24-25	21-21
Dentary	20-20	20-21	16-17	22-22	17-17
Splential	13-13	8-8	6-7	9-9	5-5

Remarks The number of teeth in the four series appears to vary considerably in *I. subterrestris*, particularly the splenials. The number is given as 5-5 in the type though Taylor states that some of the posterior splenial teeth are missing since the paratype carried 8-8. The specimen described here carries a higher complement of 13-13 splenial teeth. The dentary teeth range from 15-16 to 22-22, the prevomeropalatine from 18-18 to 25-28 (highest count in the paratype from Kottayam) and the maxillary teeth from 18-18 to 27-27 (highest in paratype). While the total length of the known specimens ranges from 149 mm to 360 mm (the largest being the present BNHS specimen), the primary and secondary folds show much less variation (364 to 383).

The number of caudal folds (from the front end of vent) carried by the type and paratype is 18 and 16 respectively. Though 17 and 18 folds are carried by most, a few examples show much less number of 8 or 10.

Ichthyophis tricolor Annandale

(Figs. 12, 28)

1909. *Ichthyophis glutinosus tricolor* Annandale. *Rec. Indian Mus.* 3 : 286.
 1915. *Ichthyophis glutinosus tricolor* : Annandale, *Rec. Indian Mus.*, 9 : 341.
 1960. *Ichthyophis tricolor* : Taylor, *Univ. Kansas Sci. Bull.*, 40 : 113.
 1961. *Ichthyophis tricolor* Taylor, *J. Bombay nat. Hist. Soc.*, 58 : 361.
 1968. *Ichthyophis tricolor* Taylor, *Caec. World* 148.

Type locality Madathorai near Cochin.

Location of type Zoological Survey of India, Calcutta.

Material examined

1. One example No. VAG 7 ZSIM, Varagaliar, Anamalai Sanctuary, 27.11.79, Ashok Kumar.
2. One ex. No. VAG 6 ZSIM, Sabarigiri Hills, 9.5.81, R. S. Pillai.
3. One ex. No. 17667 ZSIC, Parambikulam, Kerala, 16-24. 9.1914, F. H. Gravely.
4. Type No. 16173 ZSIC, Madathorai, Travancore, 16.11.1906, Annandale.
5. Two exs. MGM, Kavalai, Cochin, June 1932, K.P.Aiyer.
6. One ex. (Juvenile) No. 5916, ZSIK, Mannanthara, Tenmalai, 21.3.92, K.C.Gopi.

Diagnosis A species of fairly large size, known to reach a length of 325 mm, with a lateral cream or yellow stripe, a broad ventral pale stripe separated from the lateral stripe by a dark stripe. Primary and secondary folds 245 to 284.

Description (No. VAG 7, ZSIM from Anamalai)

A fairly large specimen 325 mm long and quite stout (14 mm), width in length 23 times. Head triangular, 13 mm long (dorsally) and 9.7 mm wide before the first nuchal groove. Snout pointed, 6 mm from eye to tip of snout. Eye distinct, slightly projecting, under the skin. Distance between eyes (6 mm) equal to snout length. Tentacular aperture close to the edge of lip, between and below the eye nostril line, its distance from the edge of eye (2.2 mm) less than its distance from the nostril (3 mm). Nostril 4.6 mm away from the eye, almost terminal and just visible when viewed from above.

Collar region wider than head being 11.5 mm., the two collars fused above. First nuchal groove very distinct both ventrally and laterally. Dorsally it arches forward and fail to meet mesially. The second nuchal groove is equally conspicuous below, terminating abruptly on the sides at the level of the mouth. Third nuchal groove is evident above, arching forward in the mid-dorsal line. It crosses the sides and extends downward but does not cross the midventral line like the few body grooves following it. A fairly long transverse groove precedes it dorsally. Another incomplete short fold before it.

There are 284 primary and secondary folds following the collars of which 7 are on the tail (from the front end of vent). Dorsally the folds cross the dorsum fairly straight across while ventrally they curve back and form clear median backward angles except in the last one-tenth portion of the body where they cross straight across. 4 tail folds are interrupted by vent. Vent longitudinal, denticulations not visible since the orifice is tightly closed. A small unsegmented terminal shield.

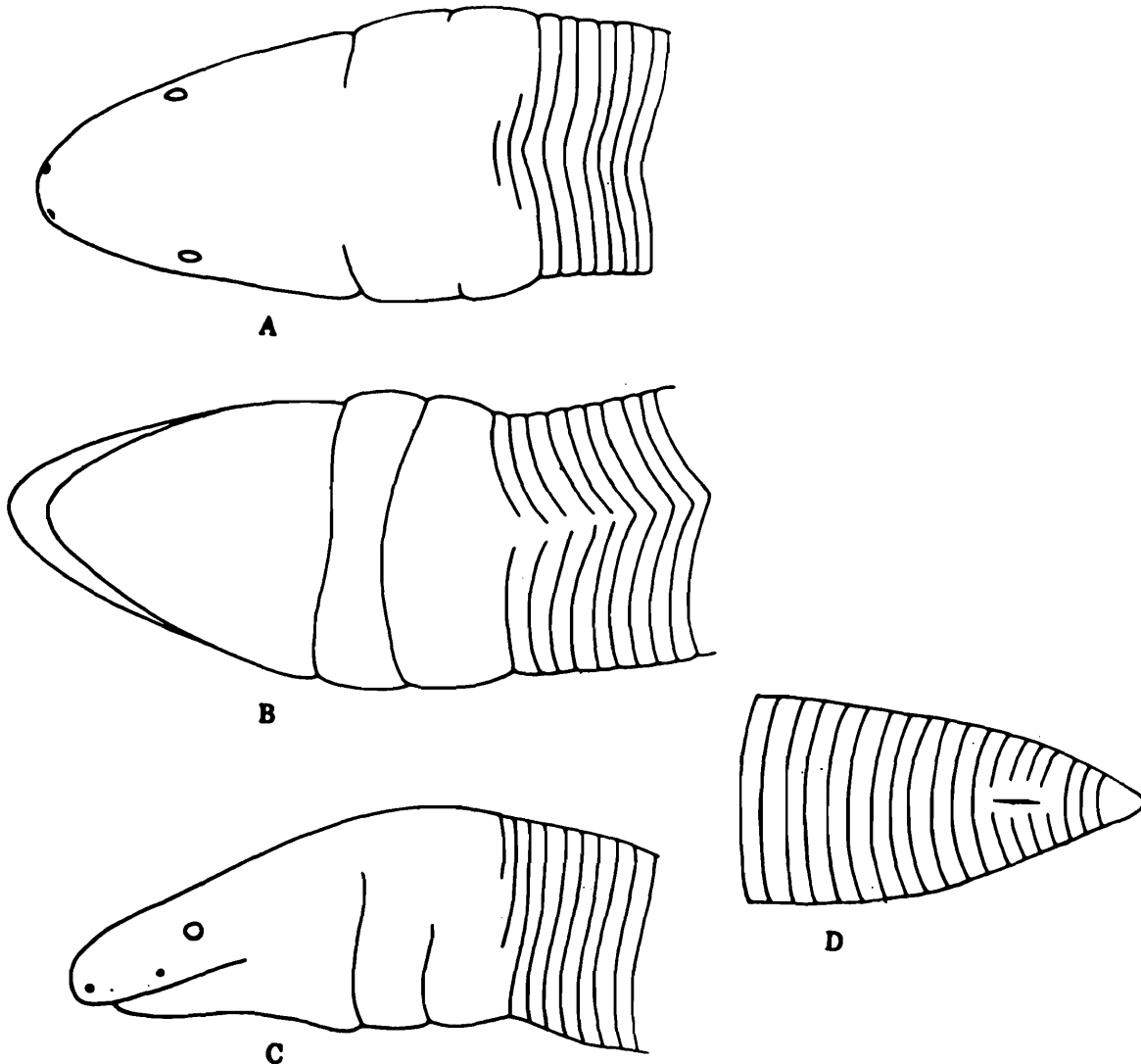


Fig. 12. *Ichthyophis tricolor* Annandale. A, B, C, three views of head ; D, subcaudal region.

Dentition Teeth are in four series premaxillary-maxillary, 14-14 , prevomeropalatine, 22-23 , dentary, 14-15 and splenial, 23-24. Dentary teeth are the largest and splenials smallest.

Choanae are separated by a distance roughly equal to three times the width of each choana.

Colour Dorsum is dark brown, lighter along each fold. A cream band 3-4 mm wide runs laterally from the snout to the tip of tail. It is unbroken on the collar. The cream stripe forks at the angle of mouth and continues along the two jaws to the tip. A narrow light brown stripe borders the lower margin of the lateral cream band , the venter below it is whitish. Throat is light brown. No ring around the eye.

Scales are present in all the folds.

A specimen collected from Sabarigiri Hills, Western Ghats, Kerala is available. Shorter (170 mm) and thinner (8 mm) its colour has faded considerably and is now a light brown above and flesh-white below. The lateral cream and dark stripes are faintly evident. Body folds number 275. Dental formula and other data are given in the Table.

We have examined the type specimen deposited with the Zoological Survey of India, Calcutta, the existence of which was doubted by Taylor (1968). I could also locate the specimen collected by F. H. Gravely from Parambikulam and reported by Annandale (1915) to which Taylor (1960 a) has made a reference.

The data and measurements of the type are as under. A small specimen, 132 mm in total length and with 254 body folds. Head is long (13.5 mm) but narrower than body, eyes very distinct. First and second nuchal grooves prominent ventrally and on sides, the former seen faintly above. Third nuchal groove is dim, not crossing venter and faint above. Body folds pass straight across the dorsum. Ventrally they make a backward angle except those on the last quarter. Tail short (1.8 mm behind vent), compressed. 6 folds on tail (from the front end of vent), 3 interrupted. Dorsum brownish, venter lighter. Lateral stripe cream, the dark band below it is not very prominent. Teeth appear to be partly damaged. We could count only three series premaxillary-maxillary 13-14, prevomeropalatine, 19-20 and dentary, 14-14. Splenial series could not be counted. The maxillary-premaxillary teeth are placed far apart. Dentaries larger than premaxillary-maxillaries. Scales are seen from the anterior folds. There is an abnormal growth on the right side of the head near the first nuchal groove. The small size and nature of tail is suggestive of a juvenile specimen. It was taken from the hollow of a tree at Madathorai.

The other example from Parambikulam is larger (243 mm), with 280 folds on the body. Jaws are damaged and the number of teeth could not be ascertained. Data and measurements of these specimens along with the two specimens in the British Museum from Nilgiris and Peermed (Taylor, 1968) are also given in the Table.

Two more examples from Kavalai, Cochin, available with the Madras Government Museum have been examined. One, measuring 220 mm (originally 230 mm measured by Satyamurthy, 1967) is stout (12.5 mm) and is now completely bleached to a uniform whitish colour. The other example, mounted and displayed in the gallery measures about 225 mm.

Another juvenile available with the Zoological Survey of India, Kozhikode, collected from Tenmalai shows the typical "tricolor" pattern clearly. Snout very blunt, 115 mm in total length, gill openings and caudal fin clear.

Distribution Southern India (See Map VII).

Remarks Annandale (1909) regarded his specimen of *tricolor* as a variety of *I. glutinosus* (= *I. beddomei*). On the basis of the striking difference in colouration, Taylor (1960a) gave it the status of a distinct species though he failed to find Annandale's type specimen at the Zoological Survey of India, Calcutta for a detailed comparison.

Nussbaum and Gans (1980) have suggested that *Ichthyophis beddomei* and *I. tricolor* may be only geographical races or colour morphs of a single species which differs from all other striped Indo-Chinese and Malaysian species mainly by the position of the tentacular aperture which according to them is nearly equidistant between the eye and the nostril. After examining

Annandale's type and his specimen from Parambikulam, and three other specimens, we agree with Taylor (1960a) in treating *I. tricolor* as a distinct species and not as a geographical race or subspecies of *I. beddomei*. The foremost reason is that in all the specimens of *I. tricolor* that we have examined, the tentacular aperture is distinctly closer to eye by a distance varying from 0.5 to 0.9 mm (as against 0.2 to 0.3 in *beddomei*). The distinctive colour configuration, a wider head and less number of premaxillary-maxillary teeth in *I. tricolor* also lend support to this.

Table of data and measurements on *Ichthyophis tricolor*

	VAG-7 ZSIM Anamalai	VAG-6 ZSIM Sabarigiri	17667 ZSIC Parambi- kulam	TYPE ZSIC Madda- thorai	BMNH Nilgiris	BMNH Peermed
Total length.....	325	170	243	132	296	226
Tail length	3	2.5	2.3	1.8	4.8	4.4
Head width.....	9.7	6.5	6.7	5.3	9	8.1
Snout length.....	6	4.5	4.7	4.4	5.6	4.7
Body width.....	14	8	12.5	7.2	12.8	12.8
Eye to tentacle	2.2	1.5	1.7	1.5	2.5	2.3
Tentacle to nostril	3	2.2	2.6	2.3	3	—
Eye to nostril	4.6	3.5	4.5	3.7	—	—
Eye to eye	6	4.2	4.6	4.2	5.5	5
Snout tip to 1st groove	13.7	9	11.8	9.3	13	11
To 2nd groove.....	16.1	10.9	14.5	10.9	—	—
To 3rd groove	20	12.7	16.3	12.2	19.8	21
Body folds	284	275	280	254	279	253
Tail folds.....	7	7	8	6	5	5
Premaxillary-maxillary	14-14	14-14	—	13-14	15-16	18-20
Prevomeropalatine	22-23	22-23	—	19-20	24-25	29-30
Dentary.....	14-15	12-13	—	14-14	15-15	19-19
Splential	23-24	22-23	—	?	23-24	28-29

Family *URAEOTYPHLIDAE* Nussbaum & Wilkinson 1989

Diagnosis Gymnophiona with true tails, mouth subterminal or recessed, tentacular opening far forward, below nostril, a few anterior primary annuli usually not subdivided by secondary grooves. Four series of teeth, splenials well developed. Eyes visible in socket, not covered over by bone. Adults terrestrial, oviparous.

Distribution Southern Peninsular India.

Remarks The family was erected by Nussbaum and Wilkinson (1989) to receive the single genus, *Uraeotyphlus*.

Genus *URAEOTYPHLUS* Peters, 1879.

1879. *Uraeotyphlus* Peters, *Monatsb. Akad. Wiss. Berlin* 930

Diagnosis As for the family.

Type species *Coecilia oxyura* Dumeril and Bibron, 1841, by subsequent designation of Noble (1924).

Distribution Southern India.

Remarks Genus *Uraeotyphlus*, originally misclassified under Caeciliidae was transferred to Ichthyophiidae by Nussbaum (1979). The possibility of the earlier Caeciliidae to be a composite of two or more families had already been indicated by Taylor in 1968. To the four species known hitherto under the genus, a new species is being added.

Key to species of Genus *Uraeotyphlus* of India

1. Primary annuli crossing dorsum anteriorly 2
- Primary annuli not crossing dorsum anteriorly. Southern India *interruptus* sp. nov.
2. Venter white or cream 3
- Venter not white or cream 4
3. About 190 primary and secondary folds , brownish violet above, venter and lower lateral sides cream. Southern India *menoni*
- About 175 primary and secondary folds , slaty violet or brownish above, white ventrally , throat, chin and behind vent light brownish. Southern India *narayani*
4. 230 to 250 primary and secondary folds , brownish violet (in life) to brownish (in preservative) above, a little lighter below. Southern India *malabaricus*
- 180 to 240 primary and secondary folds , uniformly dark brown (in preservative) both above and below. Southern India *oxyurus*

Uraeotyphlus interruptus sp. nov.

(Figs. 13, 29, 30)

Type locality Chengalam Village near Ponkunnam, Kerala

Location of type Zoological Survey of India, Madras

Material examined

1. One example No. VAG 14 ZSIM, Chengalam Village, Kerala, July, 1992, Thomas Velanparampil (Holotype).

2. One ex. No. VAG 15 ZSIM, with data same as above (Paratype).

Diagnosis A small-sized species (185 mm) with eyes distinct , tentacle ventral, below nostril , body folds 162, primary annuli cross dorsum only on the hind half and venter only in front of vent. Splenials 4-4. Slaty violet above, a little lighter below. Folds marked by white lines which are more conspicuous on the posterior ventral one-third of the body.

Description (from Holotype) A small-sized specimen measuring 173 mm with a relatively stout (9 mm), cylindrical body , width in length 19 times. Snout projects well beyond mouth by 1.7 mm, tip of lower jaw a little behind the level of nostril. Head narrower (6 mm) than body,

fairly long (8 mm dorsally). Eyes below skin, fairly clear, interocular distance (4 mm) about equal to snout length from edge of eye (4.2 mm). Nostrils small, dorsal. Tentacular aperture crescentic, ventral and directly below the nostril at the edge of upper lip, completely hidden when viewed from above. It is much closer to nostril (1.2 mm) than to eye (2.7 mm).

Collar region slightly wider than head (6.5 mm), the two collars completely fused above but distinct ventrally. First nuchal groove does not cross the dorsum but clearly demarcated ventrally and laterally. Second nuchal groove equally pronounced ventrally, terminates laterally a little above the level of the angle of jaws. Third nuchal groove clear, crosses dorsum dimly but does not do so ventrally leaving a wide gap.

Behind the collars are 162 folds (93 primaries and 69 secondaries) of which 7 are on the tail (counted from the anterior end of vent). Five folds interrupted by vent and behind the last two uninterrupted tail folds is an unsegmented conical terminal shield. The longitudinal vent has 6 to 7 lobules on either side.

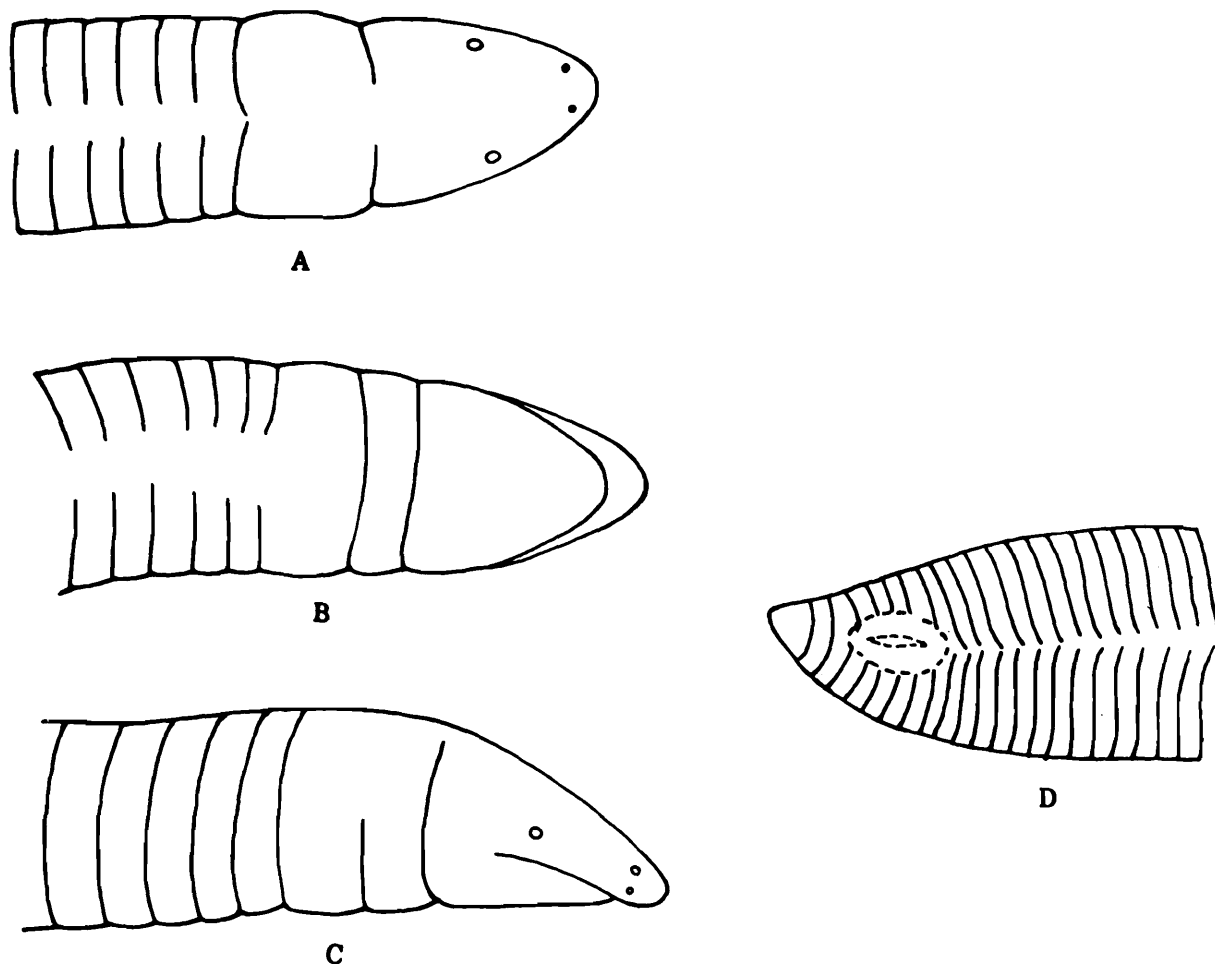


Fig. 13. *Uraeotyphlus interruptus* sp. nov. A, B, C, three views of head ; D, subcaudal region.

The primary annuli are well demarcated though they cross the median line dorsally only on the hind half of the body. They cross the midventral line only a little in front of the vent. The secondaries start as two very inconspicuous short folds on each side, one on the dorsolateral side

and the other below it on the ventrolateral aspect. These two faint folds meet on the lateral side near the 25th annulus or so, behind which a few stray ones may remain discontinuous. The 48th primary is the first fold to cross the dorsum. The secondaries cross the dorsum about 10 folds behind this, after which both secondaries and primaries cross directly across the dorsum. In all, there are 19 to 20 folds at the hind end which cross the venter (upto the tip of tail including those broken by the vent). These do not however, strictly cross the venter but merely reach the middle line since the corresponding folds on either side are not placed directly against each other but alternate in position. From the interrupted way the secondaries start, it is rather difficult to ascertain the exact number of secondaries. We have counted the secondaries from the 25th body segment where the interrupted lateral folds on each side join each other first, though there are still some interrupted laterals folds behind it.

Scales are absent in the anterior folds, small scales start from near the middle of the body which grow larger toward the hind part of the body.

Dentition Premaxillary-maxillary, 10-10, prevomeropalatine, 10-12, dentary, 12-13 and splenial, 4-4. All teeth are small, premaxillary-maxillary being largest. Tongue acutely pointed at tip, not covering the splenial. Narial plugs conspicuous. Choanae small, close to palatines.

Colour Dark slaty-violet above. Hind part relatively darker. Ventrally brownish violet, lighter than dorsum. Folds are marked by thin whitish lines which are more distinct ventrally. These lines are much broader and conspicuous in the darker background colour on the ventral posterior one-third of the body which is quite distinctive of the species. An oval white patch around the vent very pronounced. Hind terminus and tip of snout cream. Collar and throat are comparatively paler. A dark bluish midventral line from behind the collar extending to near the vent.

A large specimen from the same locality which is designated as paratype has the same distinctive colour pattern. It measures 185 mm in total length and has a slightly stouter body. Folds number 162 of which primaries number 93 and secondaries 69. The disjointed secondary folds on the lateral side coalesce with each other first on the 24th segment of the body behind which are 69 secondaries though some succeeding it are still interrupted. The 56th primary fold is the first to cross the dorsum. The 7th secondary fold is the first to cross the dorsum and following it are a few more which do not cross. However, towards the last quarter, all secondaries and primaries cross the dorsum clearly. Only the last 16 folds (primary and secondary folds combined) cross the venter, 4 of them interrupted by the vent. The white rings along the folds on the hind end and the white patch around the vent are equally conspicuous as in the holotype. Dental formula is premaxillary-maxillary, 12-11, prevomeropalatine, 12-13, dentary, 13-13 and splenial, 4-4.

Data and measurements of the types are given in the Table.

Table of data and measurements on *Uraeotyphlus interruptus*

	Holotype Chengalam	Paratype Chengalam
Total length	173	185
Tail length	4	4.3
Head width	6	5
Snout length	4.2	4
Body width	9.0	9.5
Eye to tentacle	2.7	2.6
Tentacle to nostril	1.2	1.2
Eye to nostril	2.7	2.6
Eye to eye	4.0	3.5
Snout tip to 1st groove	8.2	7.8
To 2nd groove	10	9.5
To 3rd groove	12.2	12
Body folds	162	162
Tail folds	7	6
Premaxillary-maxillary	10-10	12-11
Prevomeropalatine	10-12	12-13
Dentary	12-13	13-13
Splential	4-4	4-4

Distribution Southern India (See Map No. IX)

Remarks Only four species are known hitherto under the genus *Uraeotyphlus* to which another new species is being added. The more important characters for the erection of a new taxon are the interrupted nature of the body folds, distinctive colouration, particularly the conspicuous white rings along the body folds on the ventral hind end of the body and the presence of narial plugs on tongue.

Uraeotyphlus interruptus differs from *U. malabaricus* in the nature and disposition of the nuchal collars and grooves, number and nature of body folds, dental formula, colour pattern and presence of narial plugs on tongue. From *U. oxyurus* the present species is distinguishable by the nature of primary and secondary folds, colour, dental formula and narial plugs. Though coming closer to the other two species viz. *U. menoni* and *U. narayani*, it is specifically distinct from

U. menoni in the nature of annuli, colour and white rings on the tail portion and narial plugs. And from *U. narayani* it could be segregated again by the nature of body folds, totally different colour pattern, narial plugs, teeth etc.

Both specimens were dug out of earth in a rubber plantation.

***Uraeotyphlus malabaricus* (Beddome)**

(Figs. 14, 31)

1870. *Caecilia Malabarica* Beddome, *Madras Month. J. Med. Sci.*, 2 : 175
 1879. *Uraeotyphlus malabaricus* : Peters, *Monatsb. Akad. Wiss.*, Berlin : 933.
 1882. *Uraeotyphlus malabaricus* : Boulenger, *Cat. Batr. Grad. Apoda Brit. Mus.* : 92.
 1888. *Uraeotyphlus malabaricus* : Thurston, *Cat. Batr. Sal. Apoda South India* : 49.
 1890. *Uraeotyphlus malabaricus* : Boulenger, *Fauna Brit. India* : 518.
 1961. *Uraeotyphlus malabaricus* : Taylor, *J. Bombay Nat. Hist Soc.*, 58 : 358.
 1968. *Uraeotyphlus malabaricus* : Taylor, *Caec. World* : (697.)

Type locality "Malabar"

Location of type British Museum (Natural History), London.

Material examined

1. One example No. VAG 13 ZSIM, Kalakkad Wildlife Sanctuary, 3.3.85, M. Vasanth.
2. One ex. No. 19 BNHS, Ootacamund, Tamilnadu, date?

Diagnosis A medium-sized species with total length ranging from 145 to 240 mm. Primary and secondary folds in approximately equal number totalling 206-247. Tail short with 7 folds. Tentacle below and a little in front of nostril, brick red or brownish above, lighter below.

Description (No. VAG 13 ZSIM, from Kalakkad)

A medium-sized specimen measuring 240 mm with a relatively stout body, 10 mm wide. Snout projecting beyond mouth, tip of lower jaw on level with the nostril. Head narrower than body (6.8 mm), short (6.4). Eyes small, beady, projecting under the skin and devoid of cream ring around. Interocular distance, 4 mm, a little less than snout length. Nostrils dorsal, wide. Tentacular aperture small, below and a little in front of nostril, more ventral than lateral in position and totally hidden when viewed from above, much closer to the nostril (1.2 mm) than to the eye (4 mm).

Collars are not clearly delineated. First nuchal groove dim, visible above and vaguely seen below. The second groove faint above and absent below. Third groove is evident above and on sides but does not cross the venter.

Table of data and measurements on *Uraeotyphlus malabaricus*

	VAG-13	19	TYPE	
	ZSIM	BNHS	BMNH	BMNH
	Kalakad	Ooty	"Malabar"	Malabar
Total length	240	160	145	234
Tail length	4.5	—	4.1	6
Head width	6.8	—	—	6.1
Snout length	4.8	—	—	—
Body width	10	7.6	6	9
Eye to tentacle	4	—	—	—
Tentacle to nostril	1.2	—	—	—
Eye to nostril	3.6	—	—	—
Eye to eye	4	—	—	—
Snout tip to 1st groove	9	—	6	8.4
To 2nd groove	12.3	—	—	—
To 3rd groove	15.7	—	—	14.6
Body folds	247	240	246	232
Tail folds	7	7	—	—
Premaxillary-maxillary	17-18	16-17	18-17	18-18
Prevomeropalatine	19-21	17-19	20-19	20-21
Dentary	18-19	19-20	19-20	18-18
Splential	8-8	8-9	8-8	8-8

There are 247 primary and secondary folds which look alike, behind the collars. 7 folds (counted from the front end of vent) on the short tail (4.5 mm). 4 folds are interrupted by the vent. The body folds are weak and regular. They meet across the mesial dorsal and ventral line. The terminus of tail is conical and unsegmented. Vent with one large and five small lobulate denticulations. 3 complete folds behind the vent.

Scales present from the middle of body. Larger skin glands along the folds and innumerable whitish glandules between folds. These glandules are more profuse behind the 10th fold.

Dentition Four series of teeth. Premaxillary-maxillary, 17-18; prevomeropalatine, 19-21; dentary, 18-19 and splential, 8-8. The premaxillary-maxillary teeth get larger towards the hind end while the dentary teeth grow smaller posteriorly.

Choanae large, close to the palatine teeth.

Colour In life it is a shade of violet above and lighter below which turns to brick colour above and flesh colour below in preservative. Dorsal colour is interrupted by whitish lines on folds. The head, throat, chin and jaws appear light-rose in preservative.

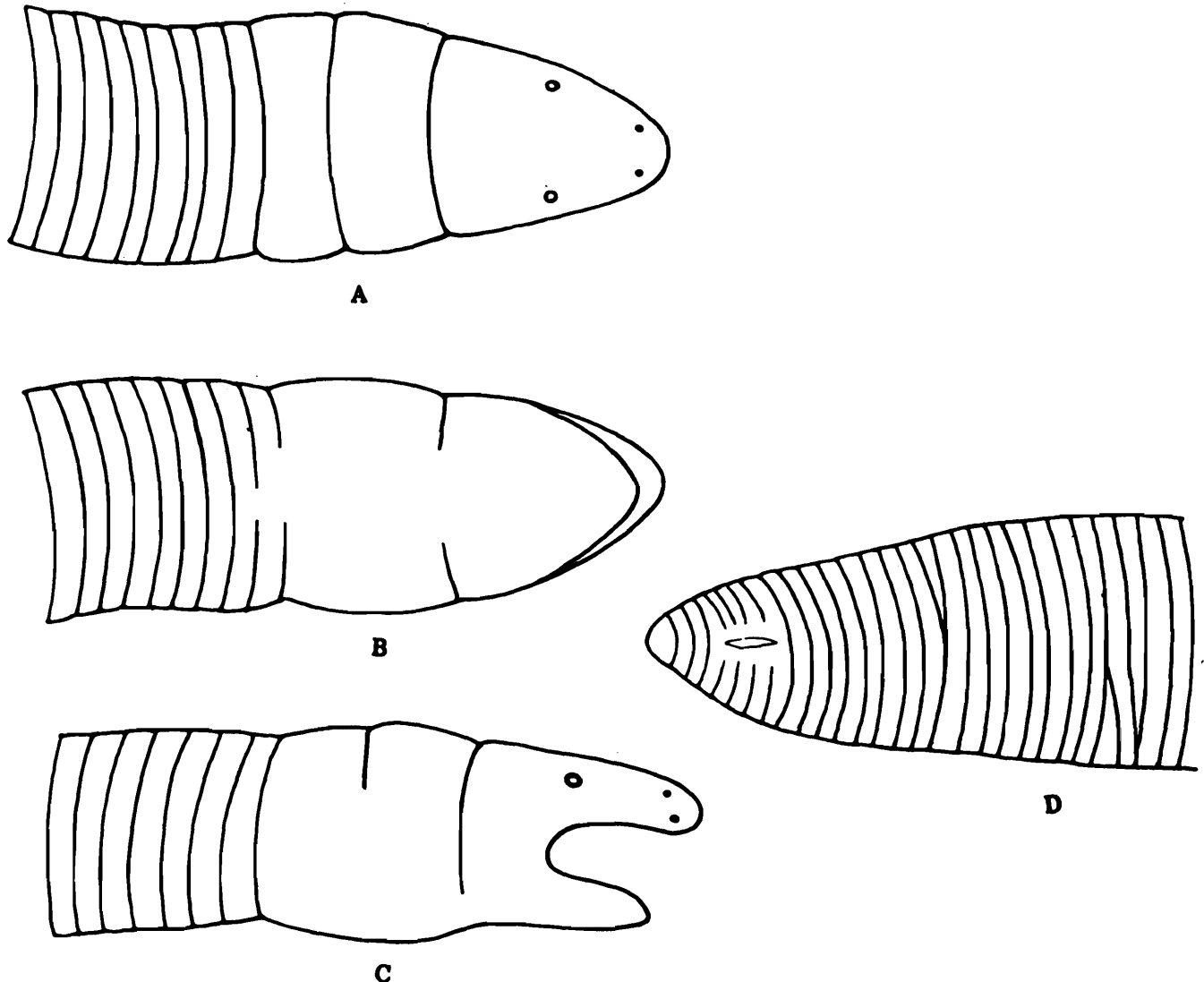


Fig. 14. *Uraeotyphlus malabaricus* (Beddome). A, B, C, three views of head ; D, subcaudal region.

I have examined a second specimen available with BNHS which measures about 160 mm in total length. It is injured and is in a poor condition. The skin on the head and body has disintegrated, obscuring the details. 240 primary and secondary folds could be made out. All the teeth are damaged and could not be counted now. The dental formula of this example recorded earlier by Taylor (1961) is premaxillary-maxillary, 16-17, prevomeropalatine, 17-19; mandibular, 19-20 and splenial, 8-9.

The available data and measurements of the above specimens, that of the type and some others with the British Museum of Natural History (Taylor, 1968) are given in the Table.

Distribution Southern India (See Map VIII).

Uraeotyphlus menoni Annandale

(Figs. 15, 32.)

1913. *Uraeotyphlus menoni* Annandale, *Rec. Indian Mus.*, 9 : 301.1968. *Uraeotyphlus menoni* Taylor, *Caec. World* : 700.*Type locality* Trichur, Kerala*Location of type* · Zoological Survey of India, Calcutta.*Material examined*

1. One example, MCP, from Kerala, 1989, H.V. Ghaté
2. Type No. 16707, ZSIC, Trichur, Kerala, date ? Ramunni Menon.
3. Co-type No. 16695, ZSIC, Kondatti, South Malabar, date?, Ramunni Menon.
4. One ex. MGM, Kondatti, S. Malabar, date?, coll.?
5. One ex. MGM, Western Ghats, date? coll.?

Diagnosis Medium-sized species, the largest known 248 mm. Eyes distinct, tentacle below and slightly in advance of the nostril, much closer to nostril than to eye. Primary and secondary folds number less than 200 (172 to 197). Above brownish with a touch of violet, grooves marked with pale rings, more pronounced towards hind end. Ventral and lower lateral sides cream with a brownish tinge towards the hind end.

Description (from the specimen with the Zoology Department, Modern College, Pune) A medium-sized specimen, 248 mm long with a cylindrical stout body (8 mm behind collar and 10.4 mm at the hind region). Head narrow, 9 mm long (dorsally from the first groove), 6.5 mm wide. Eyes quite distinct, a little elevated, below skin with a narrow black rim and a transparent central spot, closer to upper lip than the nostril (1.4 & 1.9 mm respectively). Interocular distance almost equal to length of snout in front of the eye. Nostrils dorsal, clearly visible from above, opening upwards and backwards. Tentacular aperture on the ventral side of snout, very close to upper lip and not visible when viewed from above, placed directly below or a little in advance of nostril and much closer to nostril (1.4 mm) than to the eye (3.7 mm). Snout projects 1.8 mm in front of lower jaw.

Collars wider than head (8 mm), distinct ventrally. First nuchal groove clearly defined below but dim above. Second nuchal groove is not evident on the dorsum but distinct both laterally and ventrally. Third nuchal groove well defined both dorsally and laterally but does not cross the venter.

There are 194 folds in all, out of which 100 are primary, complete both dorsally and ventrally. The secondaries which are about 94 originate vaguely as short lateral incomplete folds anteriorly which run round the body at about the 6th primary fold. Both dorsal and ventral folds cross the body straight across. 7 caudal folds (counted from the front end of vent) of which 4 are interrupted by the vent which in this specimen is a large open oval delimited by a circular rim.

Its inner margin is fringed with eight small lobulate denticulations on either side. The hind half of the open vent is obscured by a tough white membrane stretching across. Three folds behind the vent are complete and behind this is an unsegmented nipple-like terminal shield.

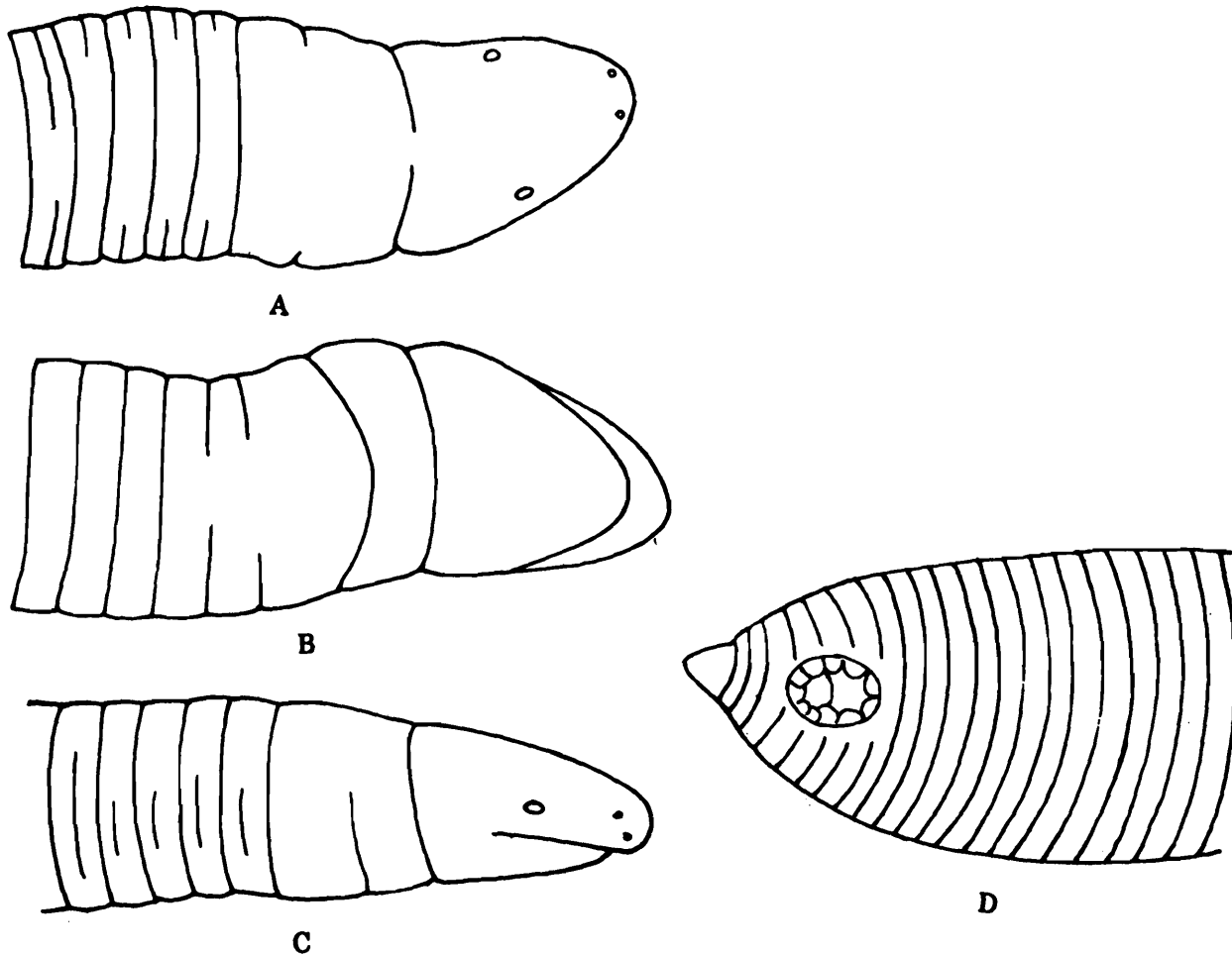


Fig. 15. *Uraeotyphlus menoni* Annandale. A, B, C, three views of head ; D, subcaudal region.

Tiny glands on the skin. These glands are larger and more closely packed on the hind half of the body particularly along the folds.

Small elliptical scales develop from the 10th or 11th fold onwards which get enlarged in size towards the hind end.

Dentition Four series of teeth. Premaxillary-maxillary, 12-12; prevomeropalatine, 12-12; dentary, 13-12 and splenial, 6-6. A few of the premaxillary-maxillary teeth on the lateral middle part are larger than those preceding or succeeding them. Dentary teeth corresponding to these are also larger. Though slightly recurved, they have rather blunt tips. Prevomeropalatine and splenial teeth are relatively much smaller.

Tongue is smooth, acute in front with a pit-like depression behind its tip. Splenial teeth are concealed by the tongue. Choanae relatively small and far apart, close to the palatine teeth.

Colour Dorsum appears brownish with a touch of violet in the preserved state. Head appears lighter in colour, snout tip and nostrils pale. The grooves are marked with pale lines which are

more pronounced on the hind end. Venter and lower lateral sides are cream with a brownish tinge towards the hind end. A bluish midventral line from collar to near the vent as in *U. narayani*. Area surrounding the vent is paler, the circle delimiting the anal lobules is flesh-white.

Two more examples of this species are available in the Madras Government Museum, Madras. One example from Kondatti measures 140 mm in body length. Annuli are not clear and the specimen is totally bleached. The second specimen from Western Ghats is larger, measures about 185 mm (originally 210 mm according to Satyamurthy, 1967). Dark brown above, lighter below. Folds could not be counted in either of the specimens which are presumably very old and without any collection data.

The original description of *U. menoni* (Annandale, 1913) is too brief and deficient in details. After an examination of the type available at the Zoological Survey of India, Calcutta, we offer the following to supplement Annandale's description. The type measures 248 mm from tip of snout to tail end. Head is 8 mm long. Eyes are distinct in the type with a whitish central spot. (Only the right eye is clearly seen in the co-type). Tentacle to nostril 1.3 mm; tentacle to eye 3.5 mm; tongue without narial plugs, its tip acutely pointed. Nuchal collars fused above. First nuchal groove faint ventrally and laterally, not meeting above. Second groove evident only ventrally and laterally. Third groove more complete but not meeting midventrally. Two transverse incomplete folds precede it dorsally. The number of folds on the body as given by Annandale is "about 170 rings" Seshachar (1939) recounted the folds in both type and co-type and gives the number as 197 and 195 respectively. We have counted 7 tail folds in the type of which 4 are interrupted by the vent. The vent is depressed in both the types with lobulate folds radiating all round. The body folds cross straight across both mid-dorsally and midventrally. Scales start at the beginning of the second quarter of body length, first a few, and more behind in each fold. Colour now is dorsally buff with a median broad brickred line from behind the collar to about middle of body. I believe this line is an artefact since such a prominent line is totally absent in the co-type which has flesh colour above and a uniform off-white or cream below. The colour given by Annandale (1913) is "Dorsal surface slate-grey; throat a little paler; lips narrowly pale; ventral surface of body white blotched with slate-grey becoming darker posteriorly, the white extending for some distance up each fold on the side; tail uniform slate grey; a pale spot round the vent"

Data and measurements are given in the Table

Table of data and measurements on *Uraeotyphlus menoni*

	MCP Kerala	Type ZSIC Trichur	Cotype ZSIC Kondatti	MCZ Kottayam	McZ Kottayam
Total length	248	248	204	245	207
Tail length	4	4.7	4.2	6.3	5
Head width	6.5	6.2	6	5.7	5.1
Snout length	4.5	4.1	4.2	—	—

Body width	10.4	11.2	8.8	12	10
Eye to tentacle	3.7	3.5	3.2	3.6	3.3
Tentacle to nostril	1.4	1.3	1.2	1.2	1.1
Eye to nostril	3.5	3.4	3.5	—	—
Eye to eye	4.4	4.5	4?	—	—
Snout tip to 1st groove	10	8.8	8.5	10	8
To 2nd groove	12.3	11.5	10.7	—	—
To 3rd groove	14.8	14	13.2	15.2	13
Body folds	194	197	195	176	172
Tail folds	7	7	7	—	—
Premaxillary-maxillary	12-12	—	—	14-14	12-13
Prevomeropalatine	12-12	—	—	14-14	14-14
Dentary	13-12	—	—	13-13	14-14
Splénial	6-6	—	—	8-8	7-7

Note : Tail length of MCZ specimens is from the front end of vent while it is from the hind end of vent in others.

Distribution Southern India (See Map VIII).

Remarks In the Table of data and measurements on the two specimens of *Uraeotyphlus menoni* collected from Kottayam and deposited with the Museum of Comparative Zoology, Harvard College, Cambridge (Nos. 17990 & 17991), Taylor (1968) has given the number of prevomerine teeth as 18-18 which is apparently an error, since the number indicated in the text is 14-14 which should be more accurate. The primary folds according to him are interrupted mid-dorsally on the anterior three-fourths of the body. However, we find the primaries complete.

Uraeotyphlus narayani Seshachar

(Fig. 16, 33.)

1939. *Uraeotyphlus narayani* Seshachar, *Proc. Indian Acad. Sci.*, B 9 : 224.

1968. *Uraeotyphlus narayani* : Taylor, *Caec. World.*, : 703.

1982. *Uraeotyphlus narayani* : Balakrishna et al, *Curr. Sci.*, 51 : 415.

Type locality Kanam near Kottayam, Kerala

Location of type Central College, Bangalore (?) "Co-type" with British Museum (Natural History), London.

Material examined

1. One example No. VAG 18 ZSIM, Kottayam, Kerala, date? purchased from a dealer.
2. One ex. No. VAG 17 ZSIM, Sringeri, Karnataka, 6.1.94, R.S. Pillai.

3. One ex. No. 20404 ZSIC, Kottayam, received on 27.6.1939 from Central College, Bangalore.

4. One ex. MGM from Kottayam, 1941.

5. Two exs Nos. VAG 19 & 20 ZSIM, Wallardie, 13 km. west of Kumily, Kerala, 1993, Thomas Velanparampil.

Diagnosis A medium-sized species growing to about 237 mm. Total folds less than 190 (168-178). Head relatively long, narrowing sharply and smoothly truncated in front. Tentacular aperture almost ventral, below and a little in front of nostril, much closer to nostril than to eye. Steel grey or brownish above, the folds marked by white lines. Venter whitish with a median bluish green line.

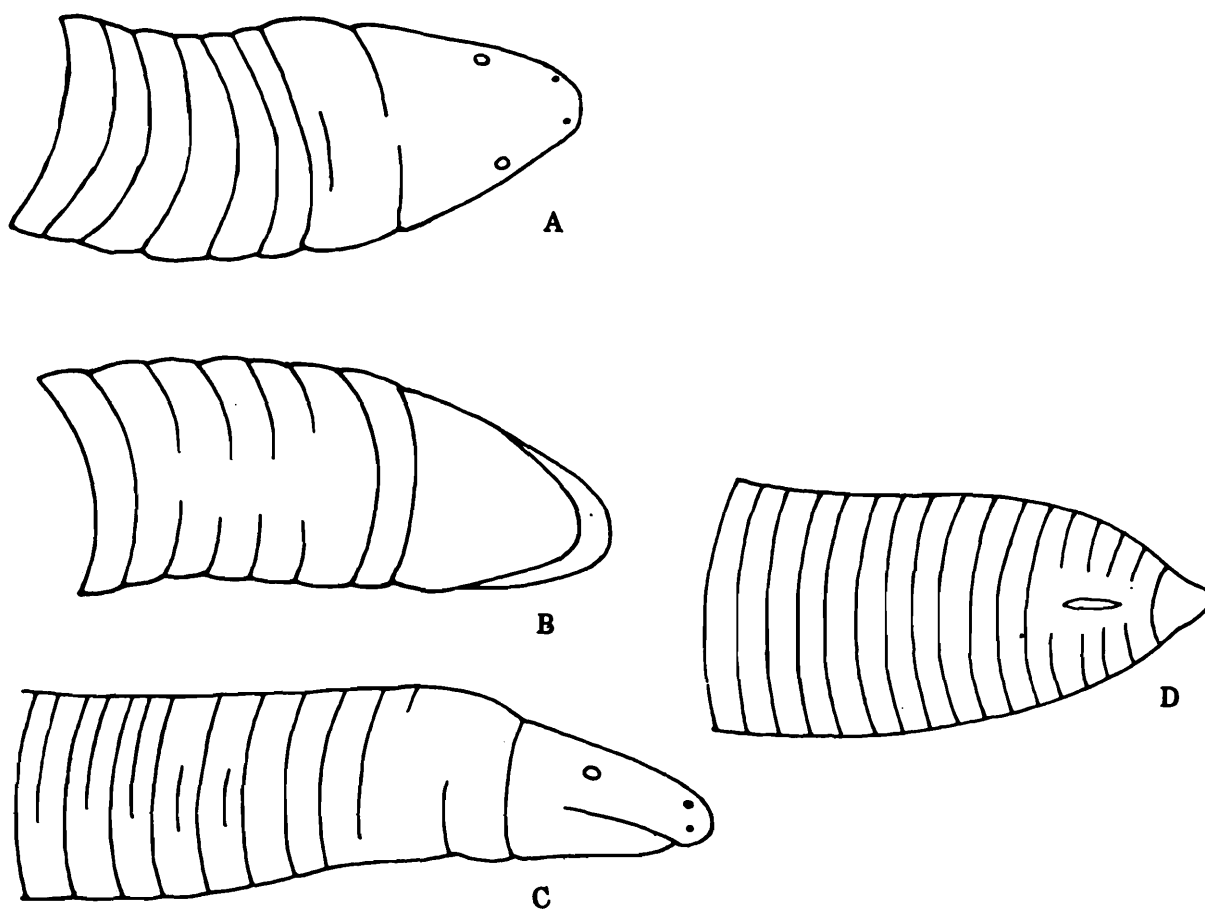


Fig. 16. *Uraeotyphlus narayani* Seshachar. A, B, C, three views of head ; D, subcaudal region.

Description (VAG 18 ZSIM from Kottayam). A small specimen, 163 mm long from snout tip to tail and about 8.5 mm wide. Head is 5.8 mm across in front of the collar, 7 mm long, narrowing sharply to a blunt tip which is smoothly truncated. Eye under the skin, distinct with black rim and a central transparent cornea, and as close to the upper lip as the nostril. Interocular distance (3.5 mm) about equal to snout length (3.8 mm) from the edge of the eye. Snout projects beyond the mouth by about 1.5 mm. Nostrils dorsal, not too close to snout tip (1.4 mm behind). Tentacular aperture appears as a slit in a circular crater, almost ventral and not visible when viewed from above. It is directly below or a little in advance of the nostril (0.8 mm). Eye to tentacle is 2.7 mm while eye to nostril is 2.6 mm.

Collars wider than head (6.6 mm), distinct ventrally and laterally. First nuchal groove clear ventrally, less so above, nearly crossing dorsum. Second groove prominent below, reaches only the level of mouth or just crosses it, the two collars being fused above. The third groove complete dorsally and laterally, does not cross the venter and resembles the three or four primary grooves behind it. Dorsally there is one incomplete transverse fold in front of this groove.

There are 168 folds behind the collars of which 87 are primaries and 81 secondaries. The secondaries commence as short, lateral folds from the fourth segment and start reaching the dorsum from the 6th segment onwards. They get broken dorsally on the 10th segment to again cross the dorsum on the hind half of the body. The primaries however, are complete dorsally. Ventrally they cross straight across the midventral line except the first three or four which fail to meet each other. Secondary folds are not well defined on the venter, they cross the venter only from the fourth annulus in front of the vent. 5 or 6 folds are on tail (from the front end of vent), four of them broken near the vent which is a longitudinal slit, the edges of which bear 7 lobulate, radiating denticulations on each side.

Small scales start from about the 15th fold onwards and are restricted to the primary folds.

Dentition : Four series of teeth premaxillary-maxillary, 15-15, prevomeropalatine, 15-16, dentary, 14-15 and splenial, 6-6. Teeth are small, sunk in pits in the fleshy gums. Tongue sharply pointed and clearly ribbed longitudinally at the tip and sides. Choanae small, oval, close to palatines.

Colour Dorsally slaty violet in life, brownish after long preservation, darker on the hind half of body and lighter on head. Body folds are marked with clear whitish lines. Ventrally whitish from throat to near the vent. Throat, chin and area in front and behind the vent are light brownish. A mid-ventral bluish green line from the throat to the vicinity of vent. Tip of tail whitish.

A second specimen available with the Zoological Survey of India, Madras (No. VAG 17) from Sringeri is larger being 192 mm long and 9.5 mm wide. Collar region is a little puffed up and this has partly obliterated the nuchal grooves. There are 89 primary and 84 secondary body folds, 173 in all. Colouration and teeth are comparable. Greenish midventral line present. Other measurements are indicated in the Table.

We have also examined a specimen of *U. narayani* available at the Zoological Survey of India, Calcutta (No. 20404 from Kottayam). Total length is 204 mm with 94 primary and 84 secondaries. Secondaries are fully formed only from the 10th annulus though they make their appearance laterally in the more anterior segments. It is not easy to decide from where to start counting the secondary folds. 6 folds on the tail, counted from the anterior end of vent of which 4 are interrupted. The slate gray colour of the dorsum which terminates abruptly on the lateral sides is divided by distinct cream lines along the folds. Ventrally yellowish, throat and hind venter appear a little greenish. Greenish line on midventer. The jaws are damaged and hence the number of teeth could not be ascertained.

A single example collected in 1941, mounted and exhibited in the gallery of the Madras Government Museum, Madras, measures 203 mm in total length. There are 167 folds of which 92 are primaries and 75 secondaries. Brownish above, marked by white rings along the folds. Head pale, venter cream. Teeth, particularly the lateral ones in the premaxillary-maxillary and dentary series are quite prominent, recurved and not sunk in pits.

The two specimens from Wallardie measuring 230 and 118 mm are dark slate above, the grooves marked by fine white lines. The whitish venter is clearly demarkated laterally from the dorsal dark colour. While the venter in the small example is very white from the lower jaw to the tail tip, it is flesh-coloured in the larger example, the dorsal colour extending to the area preceding the vent with a few dark blotches further in front. The vent is surrounded by a conspicuous white patch. Median greenish blue line on venter clear.

Measurements and data are given in the Table.

Table of data and measurements on *Uraeotyphlus narayani*

	VAG-18 ZSIM Kottayam	VAG-17 ZSIM Sringeri	20404 ZSIC Kottayam	2 CCB	Type? CCB Kanam	Cotype BMNH Kanam
Total length.....	163	192	204	237	220	233
Tail length	3.6	3.8	3.5	5	4	5
Head width.....	5.8	5.8	5	8	7.5	6.5
Snout length.....	3.8	4	3.8	—	5	—
Body width.....	8.5	9.5	8.8	10	10	11
Eye to tentacle	2.7	3	2.5	3.6	3.5	3.7
Tentacle to nostril.....	0.8	1.0	0.8	—	—	—
Eye to nostril	2.6	2.8	2.9	3.6	3.5	3.6
Eye to eye	3.5	3.5	3.9	—	4	—
Snout tip to 1st groove	7.5	8	8.6	—	—	—
To 2nd groove.....	9.1	10.5	12.2	—	—	—
To 3rd groove	11.1	12.4	14.1	—	—	—
Body folds.....	168	173	178	174	178	169
Tail folds	6	5	6	3*	3*	—
Premaxillary-maxillary	15-15	12-14	—	14-15	—	15-16
Prevomeropalatine	15-16	14-15	—	19-19	—	19-19
Dentary.....	14-15	14-14	—	15-16	—	15-15
Splenia.....	6-6	6-6	—	7-8	—	8-7

* Behind vent

Distribution Southern India (see Map IX)

Remarks Taylor (1968) remarks "Seshachar named his specimen (measuring 220 mm) as the type, the one measuring 225 mm as a co-type, and mentions six other specimens measuring 165-200 mm in length which are paratypes although not so stated. I have not ascertained the present location of the type. Cotype is now BMNH 1940. 1.5.1 (RR. 1946. 9.5.55). The whereabouts of the other six specimens are unknown to me (One only could be found at the Bangalore Central College in 1962.) This may be the type"

The original description of the species by Seshachar (1939) is rather brief and deficient in details including the dental formula.

Uraeotyphlus oxyurus (Dumeril & Bibron)

(Fig. 17, 34)

1841. *Caecilia oxyura* Dumeril and Bibron, *Erpet. Gen.*, 8 : 280.
 1879. *Uraeotyphlus oxyurus* : Peters, *Monatsb. Akad. Wiss.*, Berlin : 933.
 1882. *Uraeotyphlus oxyurus* : Boulenger, *Cat. Batr. Grad. Apoda Brit. Mus.* : 92.
 1890. *Uraeotyphlus oxyurus* : Boulenger, *Fauna Brit. India* : 517.
 1913. *Uraeotyphlus oxyurus* : Annandale, *Rec. Indian Mus.*, 9 : 302.
 1968. *Uraeotyphlus oxyurus* : Taylor, *Caec. World* ; 707.

Type locality "Malabar"

Location of type Musee National d' Histoire Naturelle, Paris.

Material examined

1. One example No. VAG 16 ZSIM, Kuliratti Estate. Kalakkad Wildlife Sanctuary, 26.11.84, M. Vasanth
2. One ex. No. 16511 ZSIC, Anamalai, date ?, F. Wall
3. One ex. No. 16701 ZSIC, Cochin, Malabar Coast, date? K. R. Menon.
4. One ex. No. 17669 ZSIC, Kavalai, Cochin, date? K. R. Menon.

Diagnosis A fairly thick-bodied species with a narrow head; primaries nearly equal to secondaries in number; eye distinct; tentacular opening directly below nostril, much closer to nostril than to eye; collars fused together above. Maximum size known 300 mm.

Description (VAG 16 ZSIM from Kalakkad) A small specimen measuring 180 mm. Body cylindrical, widest at middle (8.2 mm), head narrow, oval, 6.3 mm long dorsally upto first collar, 4.2 mm wide. Eye distinct, small, covered by skin, a little closer to upper lip on comparison with the nostril. Interocular distance (3.2 mm) about equal to snout length (3.5 mm). Nostrils dorsal, crescentic and opening outward. Tentacular opening ventral, not visible from above, directly below nostril and much closer to it (0.6 mm) than to eye (2.8 mm). Snout projects well beyond the tip of lower jaw.

Collar wider (5 mm) than head, the two collars fused above. First nuchal groove distinct ventrally, evident both laterally and dorsally. Second nuchal groove clear ventrally, terminates at the level of the angle of mouth. Third groove dim both above and on sides, just meet in the midventral line.

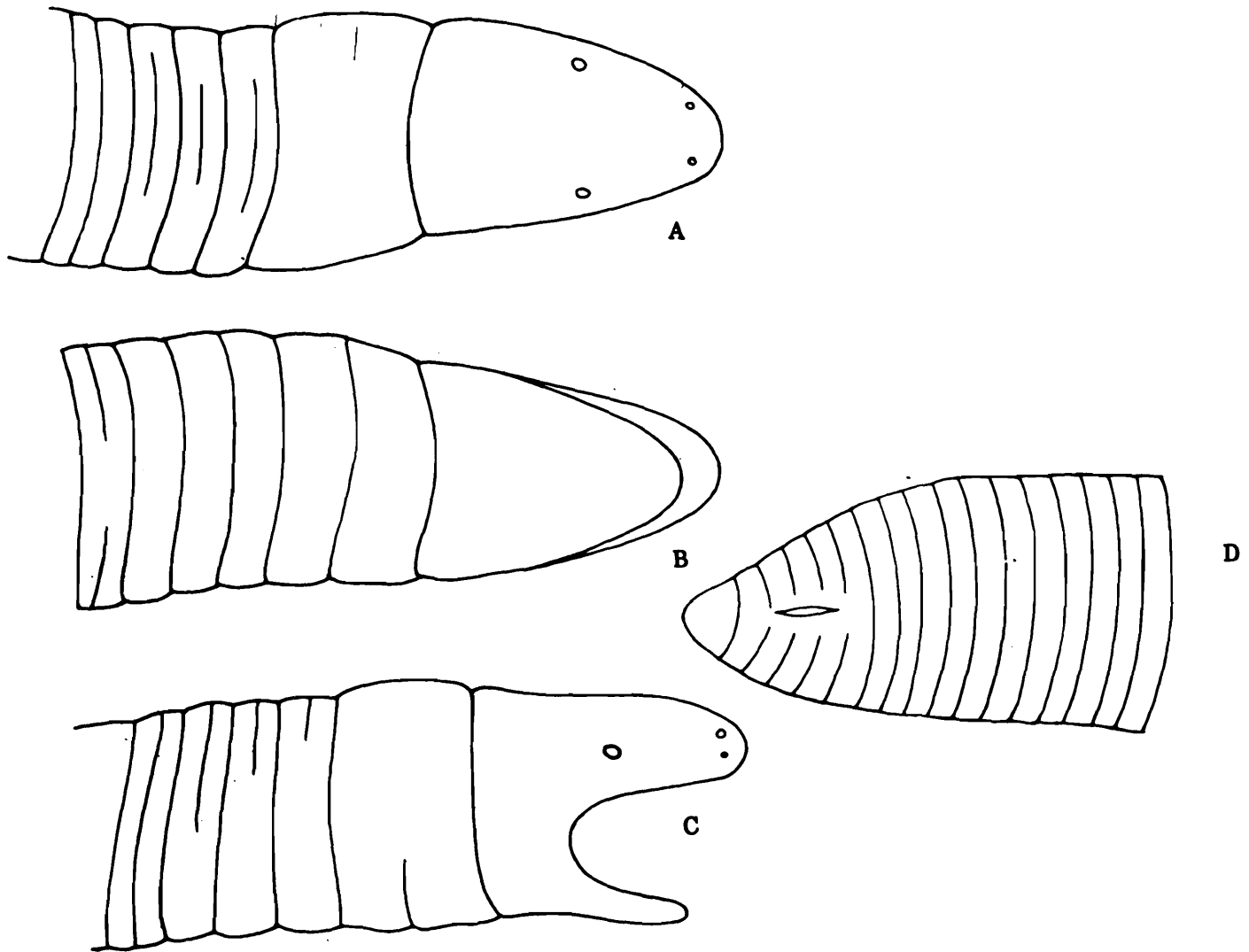


Fig. 17. *Uraeotyphlus oxyurus* (Dumeril and Bibron). A, B, C, three views of head ; D, subcaudal region.

There are 243 primaries and secondaries on the body. The anterior primaries cross the dorsum. Secondary folds appear on the mid-dorsal region from the first annulus. They extend ventrolaterally and become fairly complete all around from the fourth segment onwards. Both primary folds and secondaries cross the dorsum and venter straight across. While the primaries are distinct, the secondaries are relatively less so. On the last one-eighth of the body, both primaries and secondaries are equally well developed and in front of the vent it is difficult to tell one from the other. 4 folds are on the tail (from the front end of vent) of which 3 and another one in front are interrupted. The terminal shield is large, conical and compressed. About 6 lobulate folds surround the vent on either side. Fairly large skin glands on the dorsum, absent on the venter.

Small scales appear from about the 15th fold onwards.

Dentition Four series of teeth. The lateral teeth on the premaxillary-maxillary and dentary series are recurved and comparatively larger than the others. Prevomeropalatine teeth smaller, splenials smallest. Premaxillary-maxillary, 10-11; prevomeropalatine, 13-13; dentary, 10-10 and splenial, 4-4. Tongue quite small, not covering splenial teeth and devoid of narial plugs. Choanae elliptical, opening backwards.

Colour In preservative uniformly dark brown both above and below. Rows of glandules, less brownish, along the folds on the dorsum. No white or yellowish patch on jaws, terminal shield, around nostrils or vent.

We have examined three more specimens available with the Zoological Survey of India, Calcutta. A large specimen from Anamalai Hills measures 248 mm with 221 primary and secondary folds. Collars rather indistinct. Tails folds 7 of which 4 are broken by vent. Teeth are very clear; premaxillary-maxillary, 14-13; prevomeropalatine, 14-15; dentary, 11-11 and splenial, 5-5.

Another specimen from Kavalai, Cochin is smaller, 157 mm long and with 202 folds. Teeth are not very clear.

The smallest example, also from Cochin, measures 126 mm with 182 body folds, 8 of which are on the tail. Dental formula is fairly in agreement with the example described here premaxillary-maxillary, 10-10; prevomeropalatine, 10-11; dentary, 10-11 and splenial, 4-5.

Data and measurements of these specimens along with two other examples, one from Taliparamba and the other from Wynad (Taylor, 1968) are included in the Table.

Table of data and measurements on *Uraeotyphlus oxyurus*

	VAG-16	16511	17669	16701		
	ZSIM	ZSIC	ZSIC	ZSIC	MCZ	NMW
	Kalakad	Anamalai	Kavalai	Cochin	Taliparamba	Wynad
Total length.....	180	248	157	126	215	185
Tail length.....	3	3.5	3.5	3	5	5
Head width.....	4.2	5.2	4.7	4.1	7	5.2
Snout length.....	3.5	4.3	3.5	3.2	—	—
Body width.....	8.2	7.5	7.4	6.5	12	8.7
Eye to tentacle.....	2.8	3.2	2.5	2.3	3	2.5
Tentacle to nostril.....	0.6	0.5	0.4	0.3	—	—
Eye to nostril.....	2.5	3.3	2.4	2	1	1
Eye to eye.....	3.2	3.8	3.1	2.8	—	—
Snout tip to 1st groove.....	6.8	9	7.8	6.3	—	—

To 2nd groove.....	8.6	11.5	9.2	7.5	—	—
To 3rd groove	10.2	14.5	12.0	8.8	—	—
Body folds	243	221	202	182	209	187
Tail folds	4	7	8	8	—	—
Premaxillary-maxillary	10-11	14-13	—	10-10	17-18	17-16
Prevomero-palatine	13-13	14-15	—	10-11	17-17	16-17
Dentary	10-10	11-11	—	10-11	12-12	16-16
Splential	4-4	5-5	—	4-5	8-8	8-8

Distribution Southern India (See Map IX)

Remarks A good deal of variation is seen in respect of tail folds, body proportions, number of body folds and teeth.

Family CAECILIAIDAE Rafinesque, 1814

Diagnosis Gymnophiona with no tail, a pseudotail may be present; eyes not well developed; three or four dental series present. Some, none or all primary annuli with secondary folds.

Distribution Tropical Central and South America, Africa, India, Seychelles Archipelago, Islands of Gulf of Guinea.

Remarks Comprising as many as 23 heterogeneous genera distributed all over the world, Family Caeciliidae does not present a well defined set of familial characters, particularly on external morphology. Taylor has refrained from defining the family in his monograph (1968). Nussbaum and Wilkinson (1989) have given the diagnostic characters which deal more with osteology. Out of 23 genera known from the world, only two viz. *Gegeneophis* and *Indotyphlus* are known from India.

Key to Genera of Family Caeciliidae of India

Tentacular aperture closer to eye than to nostril and on a line between the two; eye in socket, hidden under flesh *Indotyphlus*

Tentacular aperture below and behind nostril, closer to nostril than to eye; eye buried under bones of skull *Gegeneophis*

Genus *Indotyphlus* Taylor, 1960

1960. *Indotyphlus* Taylor, *Univ. Kansas Sci. Bull.*, 40 31

Diagnosis Vent transverse, tail absent; eye in socket buried under flesh, not under bone; tentacular opening on a line connecting eye and nostril, closer to eye than to nostril. Scales present. Splenial teeth few (2-2).

Type species *Indotyphlus battersbyi* Taylor, 1960 b, by original designation and monotypy.

Distribution and remarks Only a single species is known hitherto from the northern part of Western Ghats, India.

Indotyphlus battersbyi Taylor

(Fig. 18)

1960. *Indotyphlus battersbyi* Taylor, *Univ. Kansas Sci. Bull.*, 40 : 31.1961. *Indotyphlus battersbyi* : Taylor, *J. Bombay nat. Hist. Soc.*, 58 : 355.1968. *Indotyphlus battersbyi* : Taylor, *Caec. World.* : 746.1970. *Indotyphlus battersbyi* Taylor, *Univ. Kansas Sci. Bull.* XLIV : 337.*Type locality* Khandala, Maharashtra.*Location of type* American Museum of Natural History, New York.*Material examined*

1. Three examples, BNHS, Khandala, Maharashtra, 18.8.59, H. Abdulali.
2. Two exs. BNHS, Khandala, Maharashtra, 17.7.59, H. Abdulali.
3. One ex. BNHS, Lonavla, Maharashtra, 22.9.57, H. Abdulali.
4. One ex. No. A 3384 ZSIC, Dorle Village, Taluka. Ratnagiri Dist. Maharashtra, 12.8.67, P.W. Soman.

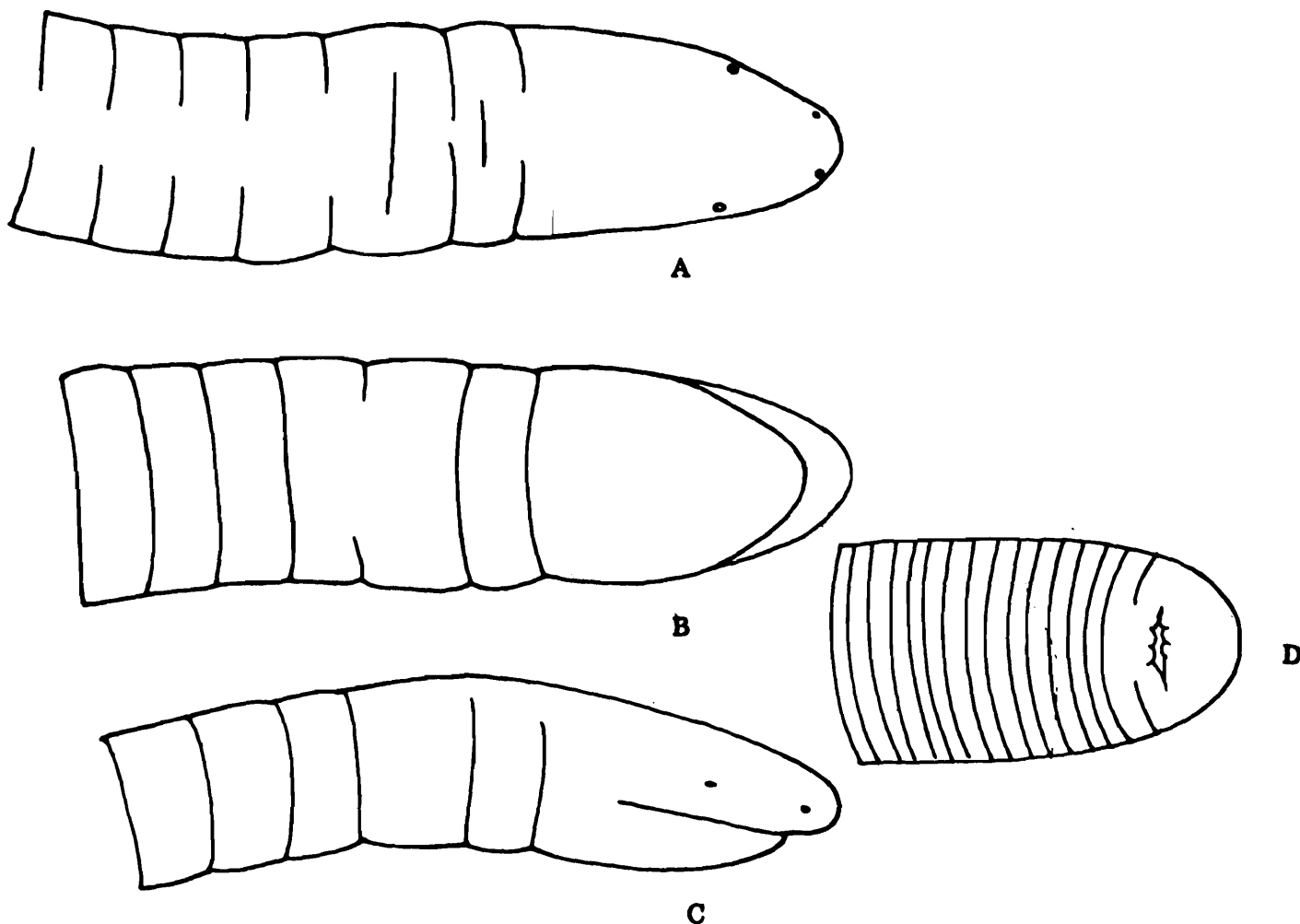


Fig. 18. *Indotyphlus battersbyi* Taylor. A, B, C, three views of head ; D, subcaudal region.

Diagnosis Body slender, width in length about 45 to 58 times; 13-15 secondary folds towards the hind end. Eye hidden under flesh, usually invisible; tentacular aperture on level with eye, nearer to it than to the nostril. Primary folds 130 to 144. Secondaries from 17 to 32 of which 9 or 10 are complete. Vent transverse, no tail. Splenial teeth, 2-2. In colour, shape and size they resemble earthworms.

Description (No. 1178 BNHS, from Khandala) Small, thin specimen measuring 205 mm in length and 3.5 mm in width. Hind end not wider than front end. Head small, slightly pointed, the snout projecting a little (0.8 mm) beyond the tip of lower jaw. Eye hidden. Tentacular opening at the bottom of a crater, 1.5 mm behind nostril on a level with the eye, nearer to eye than to nostril. Maximum width of head about 1 mm less than the distance from snout tip to angle of jaw and about equal to the width of the body. Distance from snout tip to first nuchal groove 5.8 mm, to the second groove 7 mm and to the third groove, 9 mm. Second collar is slightly less than double the width of the first collar laterally.

First nuchal groove is clearly seen both ventrally and laterally but does not cross the dorsum. Second groove is folded, prominent both ventrally and laterally and meet above though indistinctly. Third groove is feeble and could be seen only on the lateral aspect and crosses neither the venter nor the dorsum. First collar bears a short transverse fold dorsally while the second has a little longer one.

Behind the collars are 160 primary folds which are quite prominent below and on sides but incomplete on the median aspect of the dorsum. Secondary folds begin towards the posterior end of the body, faintly first and then getting to encircle the body. Out of the 22 such secondary folds, about 16 appear to be complete. Vent is transverse, the edges denticulate. No grooves behind vent; hind end blunt.

Scales begin towards the hind end where the secondary folds develop. Areolated glandules on skin more prominent towards the tail end.

Dentition All the four series present. Premaxillary-maxillary teeth, 11-11, prevomeropalatine, 13-13, dentary, 10-10 and splenials, 2-2. Premaxillary-maxillary teeth are much larger than the prevomeropalatines, dentary series largest. Tongue small, hardly reaching the splenials. Choanae small, narial plugs not very clear.

Colour Light brown on the dorsum and lighter below in preservative.

Four adults and one juvenile from Khandala (type locality) and one from Lonavla, all collected by Humayun Abdulali, available with the Bombay Natural History Society have been examined, the data and measurements of some of these are given in the Table. Another specimen from the Zoological survey of India, Calcutta, collected at Dorle Village, Ratnagiri District measures 127mm with 125 folds. Dorsum darker than Khandala and Lonavla specimens. The unsegmented terminus is longer, 3 to 4 times as long as the preceding annulus.

Distribution *Indotyphlus battersbyi* is known only from Khandala, Lonavla and Dorle Village in Maharashtra (See Map X)

Remarks In a juvenile specimen measuring 85 mm (No. 1180 with BNHS) the eye is fairly visible through the skin. Though dim the eye could be made out in another specimen also (No. 1181, 218 mm in length). It is totally invisible in others. Taylor (1960), describing the new genus and species has stated that the eye is completely concealed below the skin and flesh. In a subsequent paper (1970) however, he refers to the eye as usually visible through the skin in a socket.

The fact that the eye is fairly clear and distinguishable under the skin in juveniles is interesting. Since juveniles were not known hitherto, it has to be considered whether the eye gets concealed under the tissues during the transformation of the young to the adult. It cannot be doubted that this juvenile could belong to another genus since dentition (particularly splenials, 2-2), shape of head, terminus, position of tentacles and nostrils all indicate that it belongs to *Indotyphlus battersbyi*. The whitish patch over the eye seen by Taylor (1970) in a young specimen may also be suggestive of this. Study of more juveniles alone could settle this.

In 1970 Taylor described four more specimens taken from "near Bombay" which permitted further study including the skull characters. As a result he amplified the diagnosis as follows. "A slender species with head width somewhat less than the greatest body width. Body width contained in total length from about 45 to 53 times. Primary body folds vary from 130 to 144, secondary folds from 17 to 32, with 9 or 10 folds complete. Dental formula varies, but in the oldest (largest) specimens it is approximately 14-14 for the combined premaxillary-maxillary series, 17-17 prevomeropalatine, 12-11 dentary, and 2-2 for splenial. Teeth relatively large. Tentacular aperture in the adult fixed at a point twice as close to eye as to nostril, and in a nearly direct line between eye and nostril. Eye usually visible through the skin, in a socket that is continuous with the tentacular groove. Anal vent transverse, tail absent. Scales, in two or three rows posteriorly, in folds. Tongue with two well-defined black narial plugs. Large elongate recumbent glands especially prominent in posterior part of body. A prominent elongate cream-white spot present on sides of head, covering eye and tentacular aperture."

It is evident that the number of teeth except the splenials are variable, the range being premaxillary-maxillary, 8-8 to 14-14, prevomeropalatine, 6-7 to 17-17 and dentary, 9-7 to 11-12. The splenial, however, are constant being 2-2.

A male specimen from near Bombay had the anterior part of the snout from the region of the tentacle to the tip thickly covered with minute hairlike processes which break off easily. Taylor (1970) believes this to be a temporary phenomenon during the breeding season.

Table of data and measurements on *Indotyphlus battersbyi*

	BNHS Khandala	BNHS Lonavla	BNHS Khandala	Type Khandala	EHT-HMS Near Bombay	EHT-HMS Near Bombay
Total length.....	205	200	220	170	208	238
Head width.....	3.6	3.7	3.8	3	3.2	3.2
Body width.....	3.5	4	4.1	3.7	4.6	4.9
Tentacle to nostril	1.5	1.3	1.4	1.3	1.3	1.3
Body folds	182	155	162	168	147	166
Premaxillary-maxillary ..	11-11	12-12	14-14	9—9	11-12	12-11
Prevomeropalatine	13-13	13-14	17-17	12-12	13-12	6-7
Dentary	10-10	11-11	11-11	9-9	10-10	9-7
Splénial	2-2	2-2	2-2	2-2	2-2	2-2

Genus *Gegeneophis* Peters, 1879

1879. *Gegeneophis* Peters, *Monatsb. Akad. Wiss. Berlin* 932.

Diagnosis Tail absent, vent transverse, tentacle globular, opening behind the nostril, closer to nostril than to eye. Scales present posteriorly. Splénials, few, narial plugs on tongue, secondary folds towards the hind end.

Type species *Epicrium carnosum* Beddome, 1870, by monotypy.

Distribution Southern India and Assam.

Remarks Three species were known to which a new species, viz. *Gegeneophis krishni* is being added here. Three out of these are from Southern India and one from Assam.

Key to species of Genus *Gegeneophis* of India.

1. Body of nearly equal width throughout, hind end not broader 2
- Body increasing in width posteriorly, hind terminal region broadest 3
2. Body thin (3.5 mm wide), width in length 40 to 56, primary and secondary folds about 140. Southern India *krishni* sp. nov.
- Body thicker (8 to 9 mm wide), width in length 21 to 31, folds 105 to 115. Southern India *carnosus*
3. Body heavy and large (greatest known length 340 mm), premaxillary-maxillary teeth, 15-19 and prevomeropalatine, 13 to 20 on each half of upper jaw. Southern India *ramaswamii*
- Body size smaller (220 mm), premaxillary-maxillary teeth 11 and prevomeropalatine 11 or 12 on each half of upper jaw. Assam *fulleri*

***Gegeneophis carnosus* (Beddome)**

(Figs. 19, 39)

1870. *Epicrium carnosum* Beddome, *Madras Month. J. Med. Sci.*; 2 : 176
 1879. *Gegeneophis carnosus* : Peters, *Monatsb. Akad. Wiss.* 932.
 1882. *Gegenophis carnosus* Boulenger, *Cat. Batr. Grad. Apoda Brit. Mus.* 101
 1890. *Gegenophis carnosus* Boulenger, *Fauna Brit. India* : 518
 1943. *Gegenophis carnosus* Ramaswami, *J. Mysore Univ.* 3 205.
 1968. *Gegeneophis carnosus* Taylor, *Caec. World* 733.

Type locality Periah Peak, Wynad.

Location of type Two syntypes with British Museum (Natural History), London.

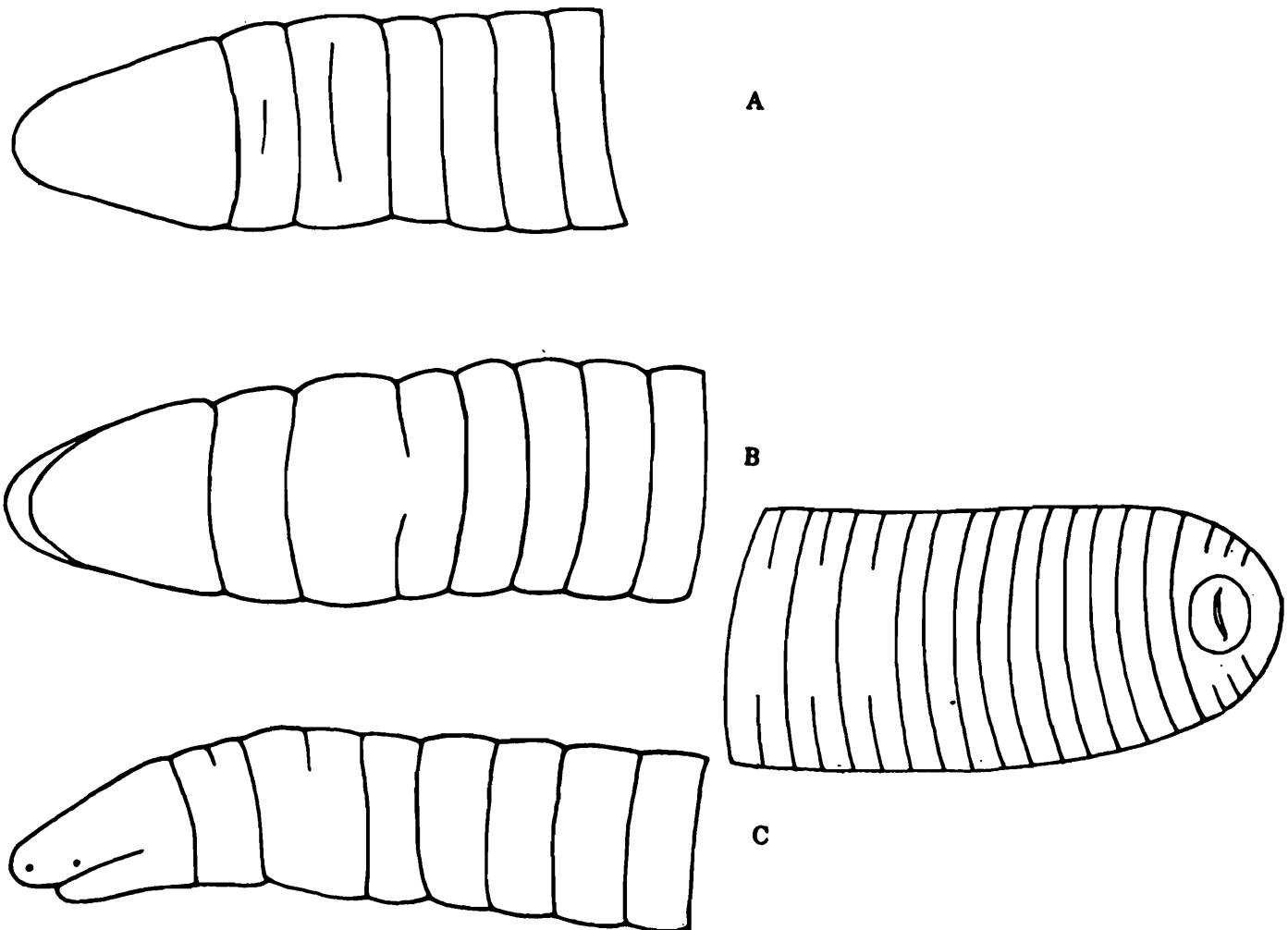


Fig. 19. *Gegeneophis carnosus* (Beddome). A, B, C, three views of head ; D, subcaudal region.

Material examined

1. Four examples Nos. VAG 26-29 ZSIM, Bonnakad Estate, Kerala, 23.10.93, R. S. Pillai

2. Two exs. Nos. VAG 30. 31 ZSIM, Botanical Gardens, Palode near Trivandrum, 24.10.93, R. S. Pillai.

3. Two exs. ZSIC, "from South India" date?

4. One ex. MCP, Kerala, date? H. V. Ghate

Diagnosis A small species, greatest known length 280 mm. About 105 to 115 primary folds including 7-10 secondaries. Body width nearly equal throughout, width in length about 30 times, eye not visible externally, tentacular aperture below and a little behind nostril. Splenial teeth few (1-1 or 2-2), tongue with narial plugs. Light pink or flesh coloured throughout.

Description (No. VAG 26 ZSIM from Bonnakad Estate), Body 278 mm long, slender, length to width ratio 31. Head oval, narrow and blunt in front, about 30 times in total length. Snout projecting beyond mouth. Eyes not visible, buried under skull bones. Tentacular area a little swollen, crater-like, below and behind nostril. Nostrils on the terminal, lateral side of snout, barely visible from above, the distance between the two more than the distance from tip of snout to nostril.

The two collars are distinct. First nuchal groove is distinct on the ventral and lateral sides and moderately so dorsally. Second groove is pronounced all round while the third groove is clear on the dorsal and lateral aspects but fail to meet in the midventral line where the two folds on either side get deflected backwards before fading off. The second collar is one and a half times larger than the first, and has a more distinct and longer transverse fold dorsally.

There are 115 folds in all on the body of which the last 10 are secondary folds, 105 being primary. 5 or 6 of the secondaries are complete. The posterior unsegmented terminus is blunt. Vent transverse, crescentic and sunk in the middle of a circular depression. 4 to 5 lobulate denticles on the anterior and posterior margins of the vent.

Scales are present in the last 30 folds or so.

Dentition Four series. Premaxillary-maxillary, 14-15, prevomeropalatine, 13-14; dentary, 9-9 and splenial, 1-2. Teeth are blunt, not recurved, dentary teeth largest. Tongue fleshy, does not cover the splenial teeth. Narial plugs present.

Colour Slate-colour above, much paler on the venter. The ventral pale colouration of the first collar extends upwards laterally. Tentacular area with a lighter patch. The very tip of snout also pale. Venter with minute dark spots while dorsum has closely set whitish dots. Folds are marked by dark lines.

Three more examples from Bonnakad are available which agree well with the above examples.

Two examples measuring 195 and 185 mm were collected from the Botanical Garden, Palode, about 20 km. from Trivandrum. They were taken from moist soil under the nursery plants. Both

are lighter in having a flesh colour with a shade of light pink and no spots. The tip of tail is quite dark. Snout also has a darker shade.

We have also examined two specimens of this species available at ZSIC of unknown provenance, the label showing that it is from "South India" The larger one measures 207 mm in length with 110 folds of which 7 are secondaries. Smaller one is 152 mm long with 106 folds (5 to 6 secondaries). Number of teeth in the smaller example is fewer compared to the described specimen.

Another smaller specimen is available with the Zoology Department, Modern College, Pune. It measures 165 mm.

Data and measurements are given in the Table

Table of data and measurements on *Gegeneophis carnosus*

	VAG-26 ZSIM Bonnakad	VAG-27 ZSIM Bonnakad	VAG-28 ZSIM Bonnakad	VAG-31 ZSIM Palode	Syntype BMNH Wynad	EHT- HMS Kotegehar
Total length.....	278	280	233	185	172	146
Head width.....	7.2	6.5	6	6.8	—	3.9
Body width.....	9	9	8	8.5	4.9	4.2
Tentacle to nostril	1.6	1.7	1.3	1.4	1.2	—
Snout tip to 1st groove ..	9.2	8.5	8	8.7	—	4.8
To 2nd groove.....	11.2	11.8	9.7	10.6	—	5.4
To 3rd groove	14.8	14	12.5	14.2	—	7.7
Body folds.....	115	112	110	108	118	112
Premaxillary-maxillary ...	14-15	14-12	13-13	13-14	12-13	10-11
Prevomeropalatine	13-14	14-13	11-13	13-13	12-12	9-10
Dentary.....	9-9	11-11	9-9	9-10	10-10	9-9
Splénial	1-2	1-2	1-2	1-2	2-2	1-1

Distribution Southern India (See Map X)

Remarks Some variations in colour are seen. Some specimens are flesh-coloured or light pink all over, venter being a shade lighter. The first collar region and tentacular area lighter.

***Gegeneophis fulleri* (Alcock)**

(Fig. 20)

1904. *Herpele fulleri* Alcock, *Ann. Mag. nat. Hist.*, 14 271.

1968. *Gegeneophis fulleri* Taylor, *Caec. World* 735.

Type locality Kuttal, 10 km SW of Silchar, Assam.

Location of type Zoological Survey of India, Calcutta

Material examined

One example No. 14759 ZSIC, Assam (Type)

Diagnosis Body increasing in girth gradually from head to terminus, with about 105 folds, vent transverse with a large unsegmented terminal shield behind it. Eyes not visible outside, tentacles behind and below nostril, tongue with two narial plugs. Skin profusely areolated.

Description (from Type) A small specimen measuring 220 mm. Front end of the body narrow (3 mm), gradually increasing in girth towards the hind end where it is 9 mm wide.

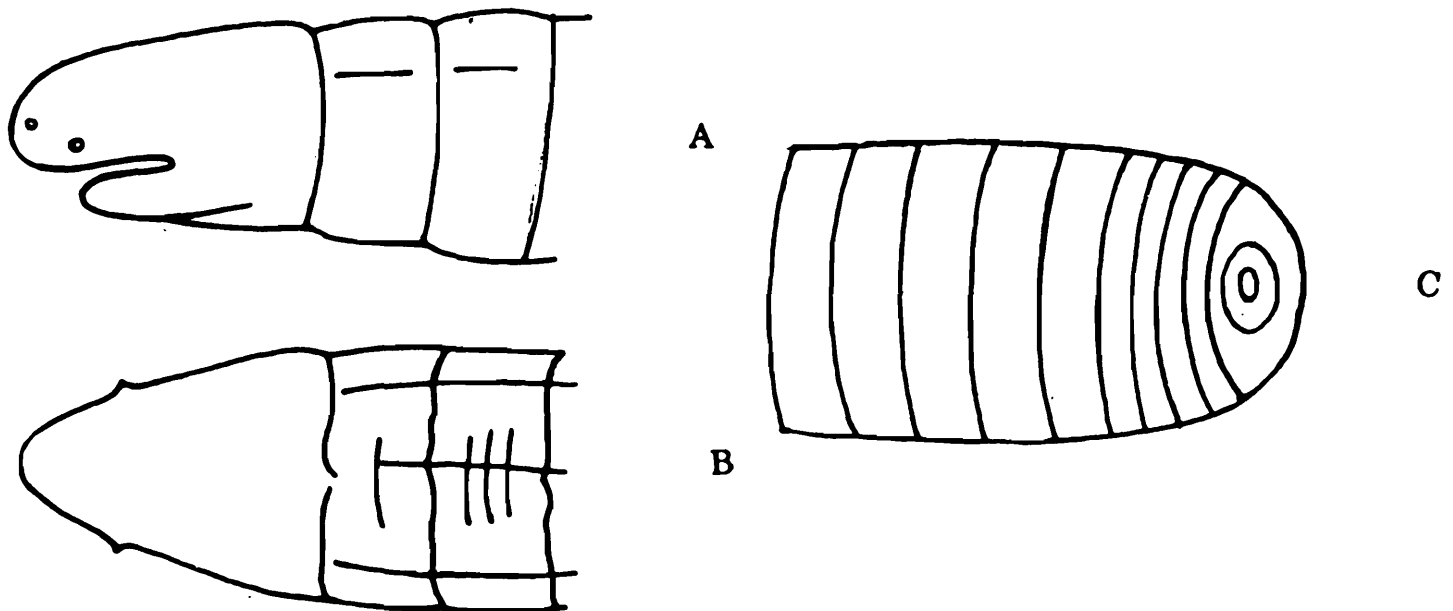


Fig. 20. *Gegeneophis fulleri* (Alcock). A, B, two views of head ; C, subcaudal region.

Head short (8 mm), snout long, pointed, shark-like, its tip exceeding the mouth. Eyes not visible, covered by skull bones. On removal of skin (as has already been done on one side of the specimen) the minute eye is visible lying under the bones. Nostril laterally placed. About half way between the nostril and eye, and below their level is the slightly elevated tentacle which is a little closer to nostril (1.2 mm) than to eye (1.5 mm) and is placed on a vertical line with the tip of the lower jaw.

The two collars are fairly clear. The first nuchal groove is visible on the throat and on sides. The skin on the dorsum being damaged, the condition on the dorsal side could not be established. However Alcock's figure shows that it is distinct dorsally also. Second nuchal groove, though faint could be seen meeting above. The third groove is more distinct and seen all around. Three short transverse dorsal grooves on the second collar while the first has a single groove.

In all, there are 105 annuli on the body. The folds cross straight across both dorsally and ventrally. Terminal shield measures 1.5 mm and is wrinkled. Vent short, transverse with denticulations in front and behind. Area surrounding vent depressed in the form a small basin. The 5 folds preceding the vent are close together.

Dentition Only a few teeth are seen, the rest damaged. The lower jaw is also damaged and hangs loose. I reproduce the dental formula given by Taylor (1968) since the original description by Alcock does not give the number of teeth. Premaxillary-maxillary, 11-11, rather small, recurved, generally smaller than dentary series, prevomers, 5-1-5; palatines, 6-6, dentary, 10-10, the largest and splenials, 4-4.

The tongue is depressed not covering the splenial teeth. Narial plugs visible as bead-like elevations with a moat around. Choanae are placed far forward, close to the prevomeropalatine series of teeth.

Colour Colour given by Alcock in 1904 is as follows. "Snout and lips yellowish, head light brown, the rest of the body chocolate brown, becoming almost black dorsally in its posterior part; the extreme edges of most of the rings are also blackish in most of their extent" Now the specimen is of a uniform chocolate brown with paler snout and lips.

Scales, according to Taylor (1968), are present for 8 or 10 folds prior to the beginning of the secondaries. The skin is profusely areolated. The wrong presumption of Alcock that the areolae corresponded with scales has been set right by Taylor as representing glands on the skin.

Data and measurements are given in the Table.

Distribution Known only from the type locality viz. Kuttal about 10 km south-west of Silchar, in Cachar, Assam, near its border with Manipur (Map VI). The specimen was discovered in a miscellaneous collection of snakes.

Table of data and measurements on *Gegeneophis fulleri*

	Type ZSIC Cachar
Total length.....	220
Head width.....	4
Snout length.....	3.1
Body width (Terminal).....	9
Eye to tentacle	1.5

Tentacle to nostril	1.2
Eye to nostril	2.3
Snout tip to 1st groove	8
To 2nd groove	10.5
To 3rd groove	14
Body folds	105
Premaxillary-maxillary	11-11
Prevomeropalatine	11-12
Dentary	10-10
Splénial	4-4

Remarks Alcock (1904) describing this species originally included it under the genus *Herpele*. Taylor (1968) while reviewing the caecilians of the world has rightly transferred it to the genus *Gegeneophis* and has indicated its relationship to the South Indian species, *G. ramaswamii* Taylor. The single specimen (type) is the only example of the species in existence. It is fragile, damaged and not in any good condition to be subjected to more intensive handling.

The figures of *G. fulleri* are not drawn with the aid of a camera lucida.

***Gegeneophis krishni* sp. nov.**

(Figs. 21, 35)

Type locality Gurpur, Karnataka,

Location of type . Zoological Survey of India, Madras.

Material examined

1. One example No. VAG 32 ZSIM, Krishna Farms, Gurpur, Karnataka, 20.6.92, Surya Addoor (Holotype).

2. One ex. No. VAG 33 ZSIM, with same data as above (Paratype)

Diagnosis A thin, worm-like caecilian of body length below 200mm and body width of 3.5 mm. Hind end not wider than the rest of body , eyes not visible , tentacle below and a little behind nostril , primary and secondary folds 140 , vent transverse, without folds behind it , splenials 2-2 , tongue with narial plugs.

Description (from Holotype) A small, thin species measuring 195 mm in length and 3.5 mm in width. Hind end of body not wider than front end, a trifle narrower (3 mm).

Head about as wide as the body, long , snout blunt, projecting about 1 mm beyond the tip of lower jaw. Eyes not visible , nostrils lateral, barely visible from above. Tentacle a little behind and below the nostril almost on a level with the tip of lower jaw, close to upper lip margin, a little elevated, the elevation visible when viewed from above.

Collars fairly clear, the second collar almost twice wider laterally compared to the first. First nuchal groove, clearly seen on the throat and sides, just cross the dorsum. Second nuchal groove pronounced ventrally, distinct laterally and meet dorsally. Third nuchal groove is comparatively dim above and on sides, not meeting ventrally, the second collar being fused with the first body segment.

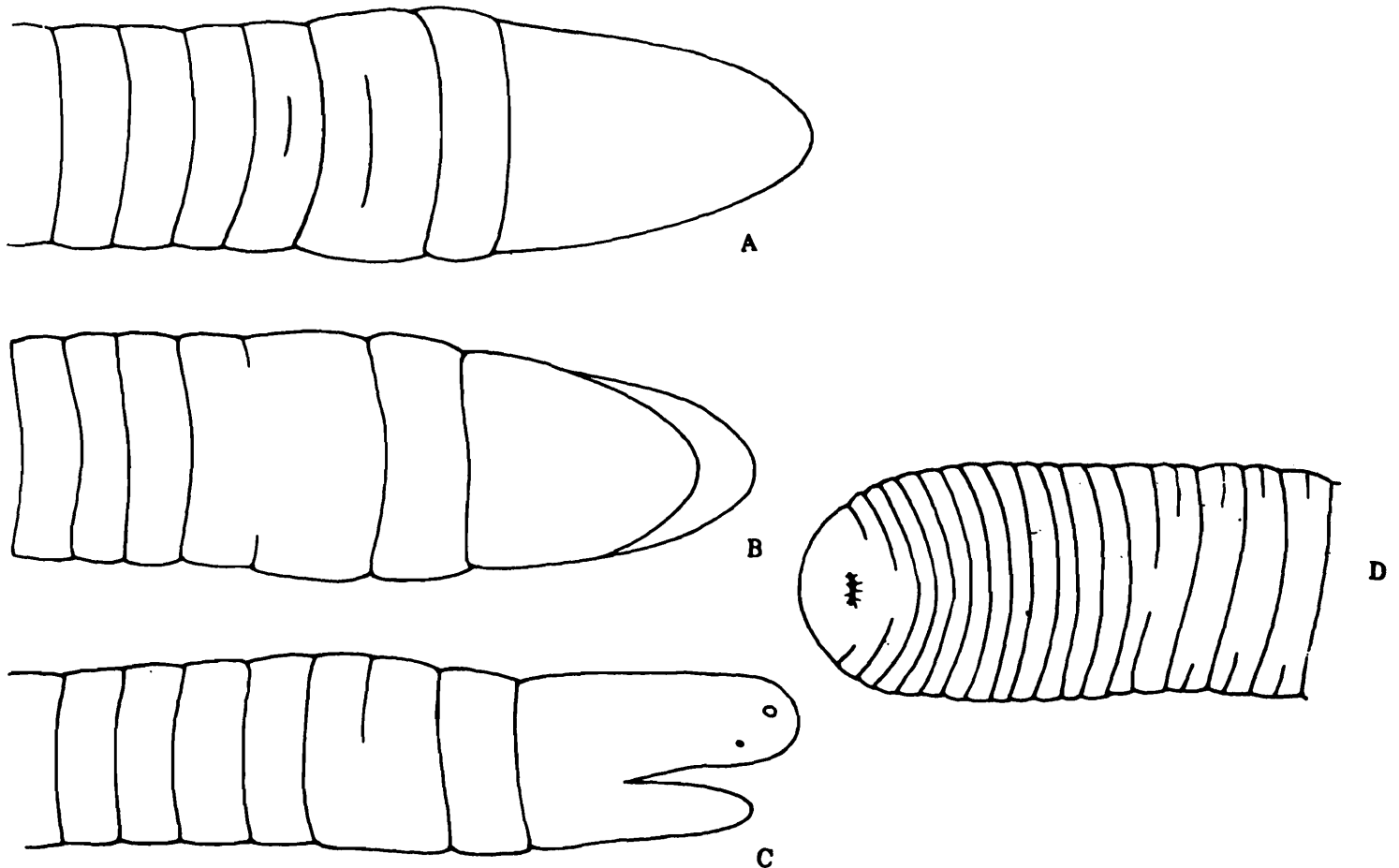


Fig. 21. *Gegeneophis krishni* sp. nov. A, B, C, three views of head ; D, subcaudal region.

Behind collars are 125 primary and 15 secondary folds. 9 or 10 secondary folds are complete. Vent transverse, without folds behind it and with 6 lobules in front and 4 behind. A large circular whitish patch surrounds the vent. Terminal shield bluntly rounded. The terminal part not wider than the rest of the body.

Scales are present right from the anterior folds of the body.

Dentition Four series of teeth. Premaxillary-maxillary, 12-12, prevomeropalatine, 11-11, dentary, 6-6 and splenial, 2-2. The premaxillary-maxillary series are smaller only to the dentaries which are large and recurved. The side profile of jaws and teeth is shark-like. Tongue oval, does not cover the splenial teeth. Two circular narial plugs against the two choanae. The two plugs are separated by a distance equal to roughly twice the diameter of each plug.

Colour In preservative, the dorsal side is brownish with a steel blue tint. Head is paler above, the tip of snout and margin of jaws still paler. The dorsal aspect of the tail end is darker

in comparison with the rest of the body. Ventrally brownish with a pale circular patch around the vent. Skin is profusely dotted with whitish glands both dorsally and ventrally.

The paratype, taken from the same locality is shorter, measuring 142 mm. 127 primary and 13 secondary folds, the latter at the posterior end. First nuchal groove not as clear ventrally as in holotype. Dental formula premaxillary-maxillary, 10-10 , prevomeropalatine, 10-10 , dentary, 8-8 and splenial (not very clear) 2-2. Narial plugs present. Skin profusely areolated, general body colour lighter in comparison with the holotype. In other respects it resembles the holotype.

Table of data and measurements on *Gegeneophis krishni*

	Holotype	Paratype
	ZSIM	ZSIM
Total length.....	195	142
Head width.....	3.2	3
Body width.....	3.5	3.6
Tentacle to nostril	0.5	0.5
Snout tip to 1st groove	5.0	4.1
To 2nd groove.....	6.3	5.3
To 3rd groove	8.3	6.9
Body folds	140	140
Premaxillary-maxillary	12-12	10-10
Prevomeropalatine	11-11	10-10
Dentary.....	6-6	8-8
Splenial	2-2	2-2

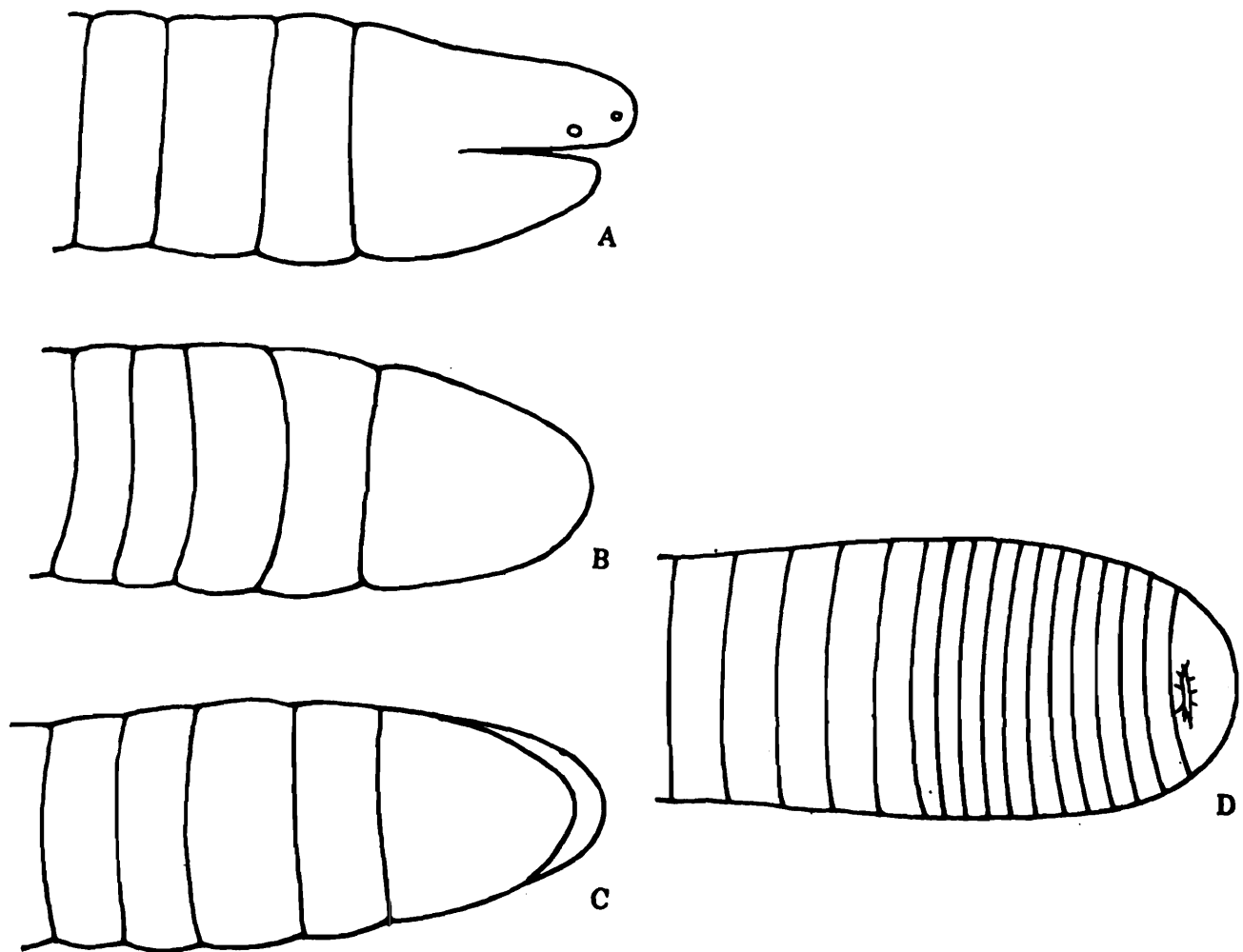
Data and measurements of the holotype and paratype are given in the Table.

Distribution Known only from the type locality viz. Gurlpur, Karnataka (See Map X). The specimens were collected from soil around coconut trees during the rainy season. In shape, size and colour they resemble the blind snake, *Ramphotyphlus brahmia* which inhabits the same biotope.

Remarks Three species are presently known under the genus viz. *G. fulleri*, *G. ramaswamii* and *G. carnosus*. The new species is quite distinct from all the above in respect of the length and width of body, in the number of folds and in the position of tentacle in relation to the nostril.

Gegeneophis ramaswamii Taylor

(Fig. 22)

1943. *Gegeneophis carnosus* : Ramaswami, *J. Mysore Univ.*, B. 3 : 2051943. *Gegeneophis carnosus* : Seshachar and Ramaswami, *J. Mysore Univ.* B. 3 : 111.1964. *Gegeneophis ramaswamii* Taylor, *Senck. Biol.*, Frankfurt Main, 45 : 227.1968. *Gegeneophis ramaswamii* : Taylor, *Caec. World* : 739.*Type locality* Tenmalai forests, Southern India.*Location of type**Type* Museum of Comparative Zoology, Harvard College, Cambridge.*Paratypes* Museum of Comparative Zoology, Harvard College, Cambridge , and E. H. Taylor-H.M.Smith, Herpetological Collections, Lawrence, Kansas.*Material examined* One example No. VAG 34 ZSIM, Tenmalai, Southern India, date? (purchased).Fig. 22. *Gegeneophis ramaswamii* Taylor. A, B, C, three views of head ; D, subcaudal region.

Diagnosis : Tail end wider than elsewhere as in *Gegeneophis fulleri*, longer (340 mm) and thicker body ; width in length 21 to 25 times. Tentacle behind and below nostril, primaries and

secondaries together from 109 to 114. Splenial teeth 2-2 to 4-4. Tongue with narial plugs. Generally ultramarine in colour.

Description (No. VAG 34 ZSIM from Tenmalai) A fairly large specimen measuring 254 mm in total length. Head rather small, narrower than collar. Body stout, terminal region broadest (10mm) while it is 6.5 mm wide behind the collar. Snout projects well beyond mouth by 2mm. Eyes not visible externally. Lower and upper jaws of equal height when viewed from side, tip of lower jaw a little in front of tentacular opening. Tentacle behind and below nostril, its opening small with a large socketlike areola surrounding it, closer to upper lip than the nostril, not visible from above. Nostril small, just visible from above.

Collars distinct, the first collar narrower (2.5 mm) than the second (4 mm) dorsally. Nuchal grooves run all round the body except the third groove which is incomplete midventrally. Each collar partially divided above by an incomplete transverse fold.

Behind the collars are 99 primary and 11 secondary grooves. About 6 secondaries are complete. Grooves cross directly across both ventrally and dorsally. Vent is transverse, almost terminal, with no folds behind. A small blunt apical terminal shield.

Scales are seen only on the posterior folds.

Dentition The specimen has been in preservative for a long period of time. It is extremely fragile and the mouth cannot be opened without damaging the jaws. Though all the four series of teeth are present, only three series could be counted, that too with difficulty since the teeth hardly project out of the fleshy gums. These are premaxillary-maxillary, 17-18, dentary, 13-13 and splenial, 3-3. It is not possible to ascertain the number of prevomeropalatine teeth. Tongue is thick and fleshy, bead-like narial plugs could be seen through the gape of mouth.

Colour After being in preservative for long, it has an overall flesh-colour with a hint of pink. Anterior part of head and lower lips are darker and pinkish. Folds are marked by darker lines. Vent area with a cream patch.

The type is larger (293 mm) with 100 primary and 14 secondary folds. Premaxillary-maxillary, 17-18, prevomeropalatine, 17-1-19, dentary, 14-14 and splenial, 3-3. The body is ultramarine or gray ultramarine, somewhat more grayish ventrally. Head grayish, lower jaw and part of the tip of snout yellowish-gray. Cream white spot at vent.

Data and measurements of the type and two more specimens available with the Museum of Comparative Zoology, Harvard College, Cambridge (Taylor, 1968) are also included in the Table.

Distribution Southern India (See Map X)

Table of data and measurements on *Gegeneophis ramaswamii*

	Vag-34 ZSIM Tenmalai	MCZ Tenmalai	MCZ Pujapura	Type MCZ Tenmalai
Total length	254	340	194	293
Head width	7.4	11	6.8	9.6
Body width (Terminal)	10	13.6	9.4	12
Tentacle to nostril	1.7	—	—	—
Snout tip to 1st groove	9.5	11	7.2	10
To 2nd groove	11.9	14	9	12
To 3rd groove	15.3	18	12.6	15.3
Body folds	110	114	113	114
Premaxillary-maxillary	17-18	18-19	15-15	17-18
Prevomeropalatine	?	15-16	13-14	17-20
Dentary	13-13	16-?	11-11	14-14
Splénial	3-3	3-?	2-2	3-3

Remarks According to Taylor (1964) the specimens collected by Ramaswami (1943) from a plantain garden in Pujapura near Trivandrum belongs to *G. ramaswamii* and not *G. carnosus*. They were collected from among the roots of plantain in wet earth at a depth of 9-10 inches at an elevation of 30 to 50 metres. Much larger specimens were taken by Seshachar and Ramaswami (1943) from Pujapura and Tenmalai from banana, rubber and cardamom plantations along small water courses.

SUMMARY AND CONCLUSIONS

Conceived as a taxonomic treatise on the Gymnophiona of India, the present work incorporates illustrated descriptions of 21 species of caecilians. 16 out of these were known, four species are described as new to science and one constitutes a new record for India. Keys are provided for families, genera and species dealt with.

Introductory chapters that deal with the history of placement and classification of the order, material and methods, review of literature on the taxonomy of Indian Gymnophiona, morphology, terminology, habits, habitats and life history are provided.

Four genera viz. *Ichthyophis*, *Uraeotyphlus*, *Indotyphlus* and *Gegeneophis* under the three families, Ichthyophiidae, Uraeotyphlidae and Caeciliidae are represented in India. Three out of

the four genera are endemic to India; only *Ichthyophis* the most speciose genus has two species distributed in Sri Lanka and in Sikkim.

India has a much larger and generically more diverse caecilian fauna than any other Oriental areas. They make up 11% of the species of Indian Amphibia. 76% of the species are distributed in the peninsular India, only 24% in the northeastern areas. The west peninsular region including the Western Ghats has the entire concentration and diversity of genera and species, 16 of the 21 species occur here (two of these are reported from the Eastern Ghats) and five in northeastern India.

Being of subterranean habits, caecilians are seldom encountered in routine faunistic surveys; special efforts are needed for their procurement. Most of the earlier collections were those taken when heavy rainfall or flooding have forced them to surface or those in low wetlands that habitually live under wet leaves and trash on the forest floor.

In as much as the present study of a modest number of specimens has yielded as many as four new species, there are reasons to believe that Indian Gymnophiona are still incompletely known and more species remain to be discovered.

It has to be admitted that caecilian taxonomy and phylogeny are in a state of flux due to a combination of factors. We lack a clear understanding of the nature and variability of characters that are used in caecilian taxonomy. Many of the characters currently used in the diagnosis of species are to a large extent not fully reliable and variable depending upon age, size etc. Being of restricted distribution and secretive habits, procuring large series of specimens is difficult. This has been the main reason for failing to utilise the cranial characters and characters of other skeletal parts. Studies on visceral organs have also not advanced owing possibly to absence of enough specimens for dissection.

Specimens available in the museums of the world are far too few to establish the validity of existing species. There are a number of species represented by a single or two specimens, many of them collected a century or more ago. Lack of explicit locality data of the available material blurs the pattern of their distribution. Labels giving the locality of collection as vaguely as "Travancore-Cochin" "Malabar" "South India" or even "Lower India" are available. The limits of populations and of species being not defined, the geographical distribution of most of the Indian taxa is not clearly understood. Further explorations and intensive surveys are needed to document their distribution.

The factors which govern the restricted distribution of Indian caecilians and their habitat requirements are not properly understood. There are some indications that the characteristics of the soil are mainly responsible for this. A positively acidic soil that is moist, porous and rich in humus and organic materials appears to be a basic requirement for their survival.

Amphibians with their highly permeable skin and a bimodal life history which expose them to both aquatic and terrestrial environments are considered good indicators of environmental

stress and fluctuations. With their vagile mode of life and dependence on the physico-chemical characteristics of soil, caecilians among amphibians are the best indicators of environmental health. Any disturbance could permanently eliminate them from their isolated and patchy habitats.

Some major threats to their survival are the following. Large scale felling of trees and opening up of canopy would alter the microclimate and desiccate the forest floor leading to their mortality. Soil erosion, flooding and flushing away of organic nutrients will also be detrimental to them. Use of chemical fertilisers and pesticides in plantations and agricultural areas uphill would alter the hydrogen-ion-concentration of the soil and pollute it with toxic residues making it unsuitable for caecilians downhill. As a queer "snake-like frog", caecilians are in great demand as exhibits for college museums. To cater to the large number of colleges that have sprung up in the southern states, specimen suppliers have mercilessly depleted them. They have also been exterminated in large numbers by University and Research Departments for biochemical analysis and tissue-assay studies. I have seen extensive area that have been dug up for caecilians to be collected in hundreds. I am told that for every ten specimens dug out, two or three are accidentally cut through by the spade and these are left to die. Massive collecting expeditions organised by foreign museums and universities have also depleted them from some pockets. During the course of the present study, we have failed to procure even a single caecilian at certain localities from where they were reported earlier. We could see that the habitats have drastically been degraded making it totally unfit for caecilian habitation.

To sum up Caecilians present some clear advantages for the evolutionary biologist, and India has a rich caecilian fauna. Indian Gymnophiona however, are still not fully known, there is need for further systematic surveys. More material also needs to be studied for osteological, visceral, vent and penial characters, cutaneous glands etc. to evolve more stable characters. The morphological parameters presently used in the taxonomy of caecilians are not fully reliable. Developmental biology and larval studies also need special attention. Habitat requirements and factors which govern their restricted distribution require investigation. Environmental degradation brought about by destruction of forest canopy, removal of leaf litter from forest floor for agricultural purposes, use of pesticide and chemical fertiliser in estates and plantations need detailed assessments for the habitat management of these little known, primitive and strange "earthworms with backbones"

ACKNOWLEDGEMENTS

This work was carried out at the Southern Regional station, Zoological Survey of India, Madras from 1992 to 1994, after my superannuation. I am grateful to Prof. M. S. Jairajpuri, former Director, Zoological Survey of India, for the award of the position of Scientist Emeritus, and to Dr. A. K. Ghosh, former Director for continued patronage. Dr. J. R. B. Alfred, Director had always been a source of help.

I am beholden to Dr. K. V. Lakshminarayana for the innumerable courtesies extended to me. Dr. P. T. Cherian was most generous in providing all facilities and freedom for pursuing this work. I acknowledge with thanks the loan of equipments by Dr. A. N. T. Joseph and later by Shri P. Dhandapani. I thank Dr. S. K. Chanda for help rendered while studying the caecilian collections at the Zoological Survey of India, Calcutta.

It is a pleasure to thank Dr. G. S. Arora and Dr. Arun Kumar, Zoological Survey of India, Dehra Dun , Dr. G. M. Yazdani, Zoological Survey of India, Pune and Shri. K. C. Gopi, Zoological Survey of India, Kozhikode for making caecilian material available for study. I name one species of *Ichthyophis* for Dr. A. Husain, Zoological Survey of India, Dehra Dun in acknowledgement of the interest taken in this work and in caecilian taxonomy.

I am extremely grateful to Dr. H. V. Ghate, Modern College, Pune for the unstinted help in sending specimens and literature. I am equally obliged to Prof. Jai Singh, Christian College, Martandam for accompanying me to the field for caecilian collection.

I am very much indebted to Shri Surya Addoor who has in addition to providing two rare specimens, taken me to the Agumbe forests for field work. Shri. B. K. Sharath has also obliged me by making collections and assisted in my survey work at Neria. Shri Thomas Velanparampil, S. B. College, Changanacherry has provided valuable material and I thank him for that.

To the Director, Bombay Natural History Society, Bombay, I am grateful for permitting me to study the caecilian collection of the society. Shri A. G. Sekar was of considerable help to me in that laboratory.

The caecilian collection available at the Madras Government Museum, Madras was also made available for study and I acknowledge the help rendered by Shri Jawahar, Curator in Zoology.

Dr. Ronald A. Nussbaum, University of Michigan has presented some essential literature on caecilian taxonomy. I am grateful to him for this and to Dr. Carl Gans of the same institution for valuable literature.

This work would not have been possible but for the encouragement and inspiration provided by my wife. Suresh and Gita incited and motivated me to accept this work as a post-retirement exercise and to them I say "Thank you, my Children"

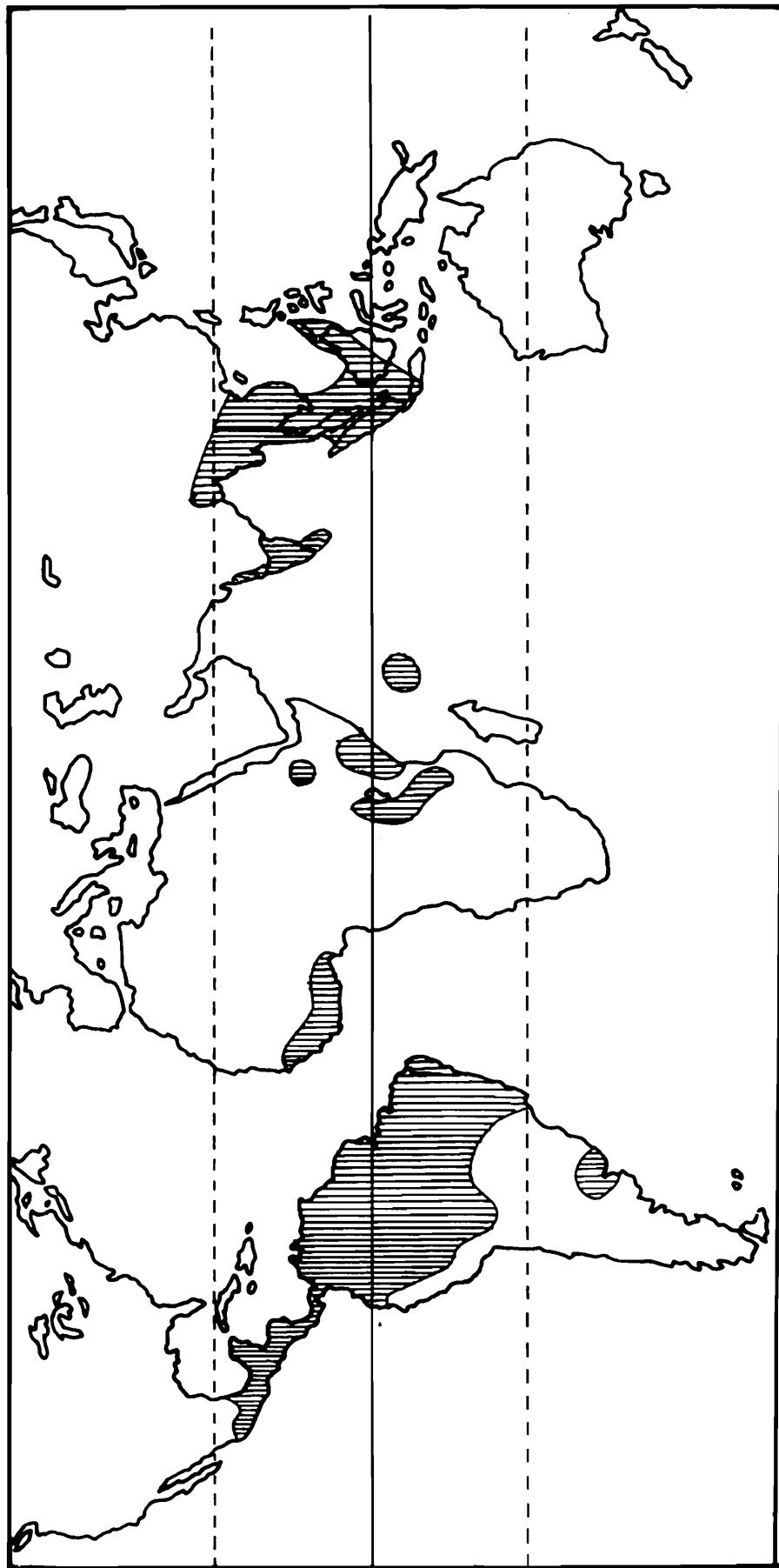
BIBLIOGRAPHY

- Abdulali, H. 1954. Distribution and habits of the Batrachian, *Ichthyophis glutinosus* Linn. *J. Bombay nat. Hist. Soc.*, **52** : 639-640.
- Alcock, A. W. 1904. Descriptions and reflections upon a new species of apodous Amphibian from India. *Ann. Mag. Nat. Hist.*, ser. 7, **14** : 267-273
- Annandale, N. 1909. Notes on Indian Batrachia. *Rec. Indian Mus.*, **3** : 282-286.
- Annandale, N. 1913. Some new and interesting Batrachia and Lizards from India, Ceylon and Borneo. *Rec. Indian Mus.*, **9** : 301-310.
- Annandale, N. 1915. Herpetological notes and descriptions. *Rec. Indian Mus.*, **11**: 341-347.
- Balakrishna, T. A., Gundappa, K. R. and Katre Shakuntala, 1982. A note on the occurrence and habitat features on *Ichthyophis beddomi* (Peters) and *Uraeotyphlus narayani* (Seshachar). *Curr. Sci.*, **51** : 415-416.
- Balakrishna, T. A., Gundappa, K. R. and Katre Shakuntala, 1983. Observations on the eggs and embryo of *Ichthyophis malabarensis* (Taylor) (Apoda Amphibia). *Curr. Sci.*, **52(20)**: 990-991.
- Balakrishna, T. A., Katre Shakuntala and Gundappa, K. R. 1982. Taxonomy and myogen patterns of some caecilians of the Indian subcontinent. *Curr. Sci.*, **51(17)** : 848-849.
- Beddome, R. H. 1870. Descriptions of new reptiles from the Madras Presidency. *Madras Month. Journ. Med. Sci.*, **2** : 169-176.
- Blandford, W. T. 1881. Notes on an apparently undescribed *Varanus* from Tenasserim and on other Reptilia and Amphibia. *Journ. Asiat. Soc. Bengal.* **50** (4) : 239-243.
- Bleeker, P. 1858. Eije verzameling reptilien an visschen van Sinkawang ontvangen heeft. *Naturk. Tijd. voor Nederlandisch Indie*, Batavia, Vierde Serie, **16** : 183-188.
- Boulenger, G. A. 1882. *Catalogue of the Batrachia Gradientia s. Caudata and Batrachia Apoda in the collections of the British Museum*, 1-27.
- Boulenger, G. A. 1890. *The Fauna of British India, including Ceylon and Burma. Reptilia and Batrachia*, (London) 1-541.
- Daniel, J. C. 1963. Field Guide to the Amphibians of Western India , Part 1. *J. Bombay nat. Hist. Soc.*, **60** (2) : 415-438.
- Duellman, W. E. and L. Trueb. 1986. *Biology of Amphibians*. McGraw Hill Book Co., New York.
- Dumeril, A. M. C., and Bibron, G. 1834-1854. *Erpetologie General ou histoire naturelle complete des reptiles*, volumes 1-9.
- Gundappa, K. R., Balakrishna, T.A., and Katre Shakuntala, 1981. Ecology of *Ichthyophis glutinosus* (Linn.) (Apoda Amphibia). *Curr. Sci.*, **50** (11) 480-483.

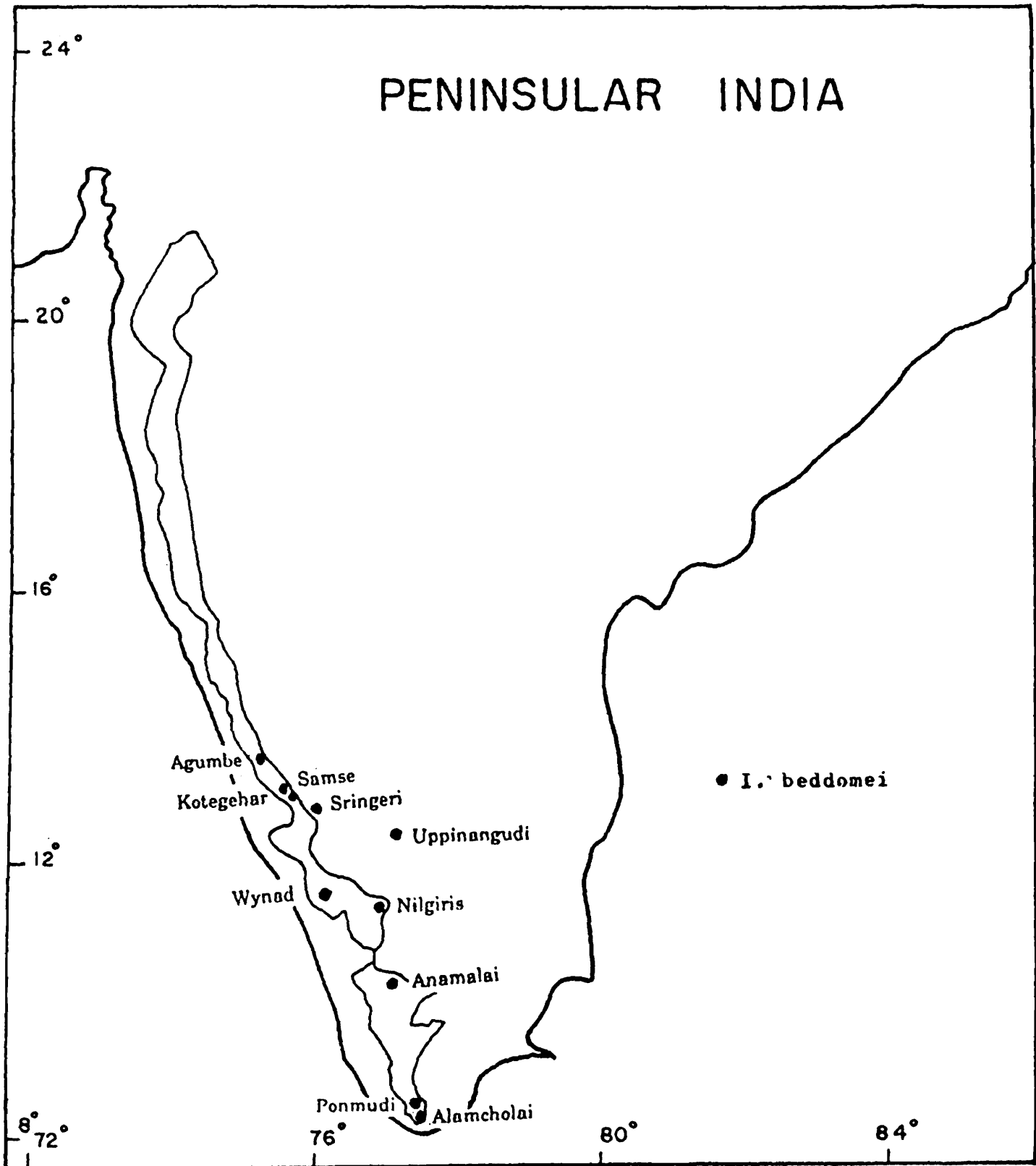
- Gunther, A. 1864. *The Reptiles of British India*. Taylor and Francis, London. 1-444.
- Indraneil Das. 1990. Amphibians from India. Some further species. *J. Bombay nat. Hist. Soc.*, **87** : 310-312.
- Inger, R. F., and Dutta, S. K. 1986. An overview of the Amphibian fauna of India, *J. Bombay nat. Hist. Soc.*, **83** : 135-146.
- Inger, R. F., Shaffer, H. B., Koshy, M., and Bakde, R. 1984. A report on a collection of Amphibians and reptiles from Ponmudi, Kerala, South India. *J. Bombay nat. Hist. Soc.*, **81** (2 & 3) 406-427, 551-570.
- Jaisingh, P. 1978. On the occurrence of *Ichthyophis peninsularis* Taylor (Gymnophiona Caeciliidae) from Alamcholai (District Kanyakumari, Tamilnadu, India). *J. Bombay nat. Hist. Soc.*, **75** (2) 501-502.
- Laurant, R. F. 1984. Heterogeneidad de la familia Caeciliidae (Amphibia-Apoda). *Acta Zool. Lilloana*, **37** : 199-200.
- Linnaeus, C. 1749. *Amoenitates academicae seu dissertationes variae physicae medicae botanicae antehac seorsim editae, nine collectae et auctae cum tabulis aeneis, accedit hypothesis nova de februm intermittetium causa*, Lugduni Batavorum, 498.
- Linnaeus, C. 1754. *Museum S. R. M. Adolphi Friderici Regis Svecorum Holmiae*.
- McCann, C. 1927. The occurrence of the wormlike batrachian, *Ichthyophis monochrous* Boul. at Khandala, Poona District. *J. Bombay nat. Hist. Soc.*, **31** : 1039.
- Moll, E. O., and Smith, H. M. 1967. Lizards in the diet of an American caecilian (Amphibia Gymnophiona) *J. Morph.*, **166** : 259-273.
- Mullan, J. P. 1929. Occurrence of the 'slimy' caecilian (*Ichthyophis glutinosus* Boulenger) in Panchgani. *J. Bombay nat. Hist. Soc.*, **33** : 723-724.
- Muller, L. 1831. Kiemenlocher an einer Jungen *Coecilia hypocyanea* in Museum der Naturgeschichte zu Leyden beobachtet, etc. *Isis von Oken*, Bd. **24** : 709-710.
- Noble, G. K. 1924. Contributions to the herpetology of the Belgian Congo based on the collection of the American Museum Congo Expedition 1909-1915. Part III Amphibia. *Bull. American Mus. Nat. Hist.*, **49** : 147-347.
- Nussbaum, R. A. 1977. Rhinatrematidae A new family of caecilians (Amphibia Gymnophiona). *Occ. Pap. Mus. Zool. Univ. Michigan*, **682** : 1-30.
- Nussbaum, R. A. 1979. The taxonomic status of the caecilian genus *Uraeotyphlus* Peters. *Occ. Pap. Mus. Zool. Univ. Michigan*, **687** : 1-20.
- Nussbaum, R. A., and Gans, C. 1980. On the *Ichthyophis* (Amphibia Gymnophiona) of Sri Lanka. *Spolia Zeylanica*, **35** (1&2) 137-154.
- Nussbaum, R. A., and Wilkinson, M. 1989. On the classification and phylogeny of caecilians (Amphibia Gymnophiona), a critical review. *Herpetological Monographs*, **3** : 1-42.

- Peters, W. 1879. Uber die Eintheilung der Caecilian und insbesondere uber die Gattungen *Rhinatrema* und *Gymnopsis*. *Monatsb. Akad. Wiss. Berlin*, 924-943.
- Pillai, R. S. 1986. Amphibian fauna of Silent Valley, Kerala, S. India. *Rec. zool. Surv. India*, **84** : 229-242.
- Rahman, M. F. and Rajagopal, K. V. 1978. Occurrence of *Ichthyophis beddomii* Peters in South Canara, Karnataka State. *Sci. Cult.*, **44** : 187.
- Ramaswami, L. S. 1943. An account of the head morphology of *Gegenophis carnosus* (Beddome), Apoda, *J. Mysore Univ.*, (B), **3** (24) 205-222.
- Ramaswami, L. S. 1947. Apodous Amphibia of the Eastern Ghats, South India. *Curr. Sci.*, **16** (1) 8-10.
- Satyamurthi, T. S. 1967. The South Indian Amphibia in the collections of the Madras Government Museum. *Bull. Madras Govt. Mus.*, (New Series), **8** (2) 1-87.
- Seba, A. 1735. Thesaurus (1734-63). Locupletissimi naturalium thesauri accurata descriptio et iconibus artificiosissimus expressio per universam physices historiam vol. 1-4.
- Seshachar, B. R. 1939. On a new species of *Uraeotyphlus* from South India. *Proc. Ind. Acad. Sci.*, **9** (B) 224-228.
- Seshachar, B. R. 1942. The eggs and embryos of *Gegenophis carnosus* Bedd., *Curr. Sci.*, **11** : 439-441.
- Seshachar, B. R., Balakrishna, T. A., Katre Shakuntala and Gundappa, K. R. 1982. Some unique features of egg laying and reproduction in *Ichthyophis malabarensis* (Taylor) (Apoda Amphibia). *Curr. Sci.*, **51** (1) 32-34.
- Seshachar, B. R. and Ramaswami, L. S. 1943. *Gegenophis carnosus* (Beddome) from South India. *Half year Journ. Mysore Univ.*, (N. S.), **4** (6) 111-113.
- Taylor, E. H. 1960 a. On the caecilian species *Ichthyophis monochrous* and *Ichthyophis glutinosus* with descriptions of related species. *Univ. Kansas Sci. Bull.*, **40** : 37-120.
- Taylor, E. H. 1960b. A new caecilian genus in India. *Univ. Kansas Sci. Bull.*, **40** : 31-36.
- Taylor, E. H. 1961. Notes on Indian caecilians. *J. Bombay nat. Hist. Soc.*, **58** : 355-365.
- Taylor, E. H. 1964. A new species of caecilian from India (Amphibia Gymnophiona). *Senck. Biol. Bd.* 45, Heft 3/5 227-231.
- Taylor, E. H. 1968. *The Caecilians of the World : A Taxonomic Review*. Kansas University Press, Lawrence. 1-846.
- Taylor, E. H. 1969 a. A new family of African Gymnophiona. *Univ. Kansas Sci. Bull.*, **48** : 31-36.
- Taylor, E. H. 1969 b. Skulls of Gymnophiona and their significance in the taxonomy of the group. *Univ. Kansas Sci. Bull.*, **48** : 585-687.

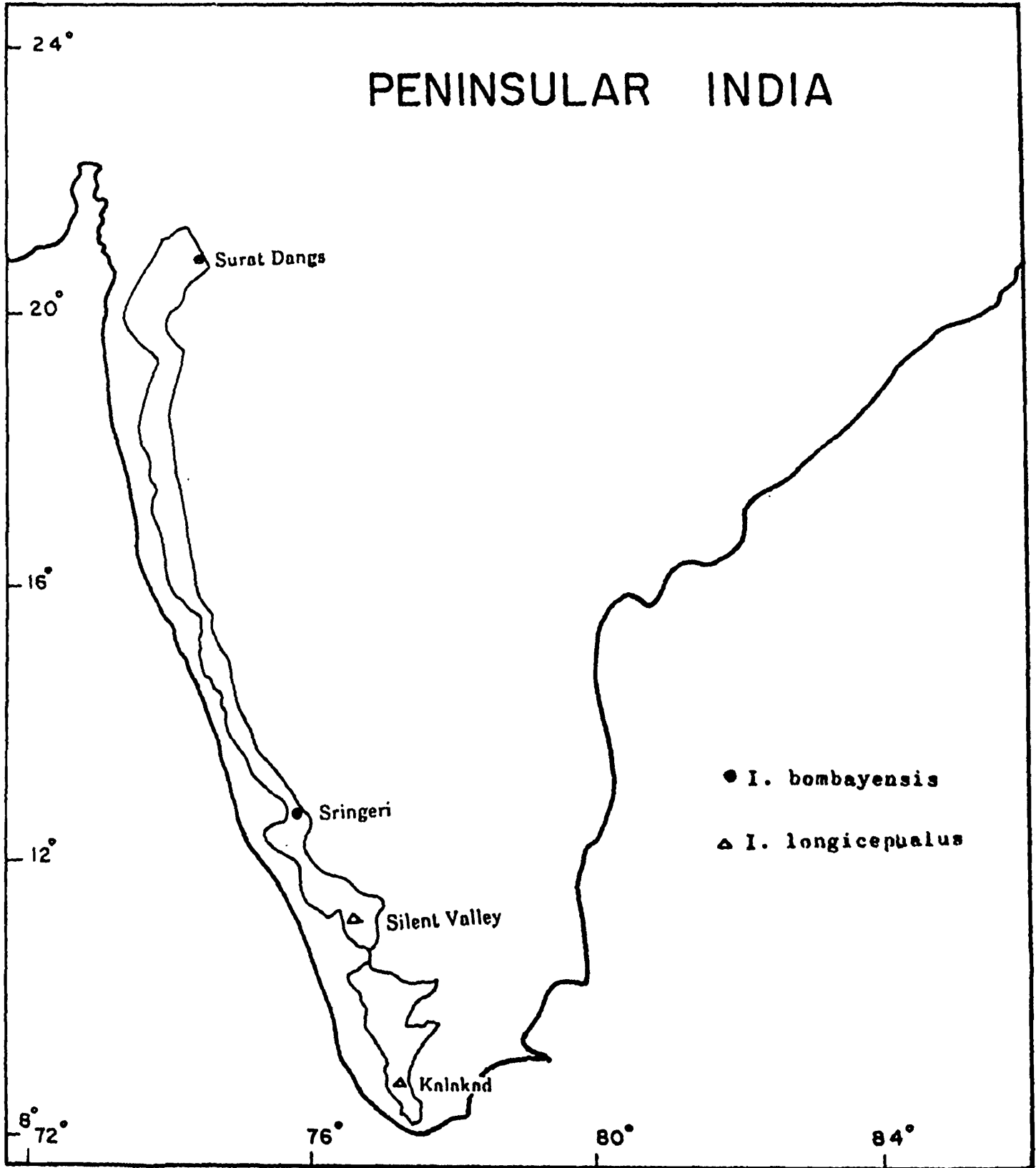
- Taylor, E. H. 1970. On the status of the caecilian, *Indotyphlus battersbyi* Taylor. *Univ. Kansas Sci. Bull.*, XLIX (5) 337-344.
- Thurston, E. 1888. Catalogue of the Batrachia Salientia and Apoda of Southern India. *Bull. Madras Govt. Mus.*, (Old Series) 1-54.
- Tikader, B. K. 1965. Observations on the caecilian, *Ichthyophis, beddomii* Peters from Kotegehar, District Chikmagalur, Mysore. *J. Bombay nat. Hist. Soc.*, 61 (3) 697.
- Wake, M. H. 1978. Ontogeny of *Typhlonectes obesus*, with emphasis on dentition and feeding. *Papeis Avulsos Zool.*, 12 : 1-13.
- Wake, M. H. 1986. A perspective on the systematics and morphology of the Gymnophiona (Amphibia). *Soc. Zool. France Mem.*, 43 : 21-38.
- Wall, F. 1922. Notes on some lizards, frogs and human beings in the Nilgiri Hills. *J. Bombay nat. Hist. Soc.*, 28 : 493-499.
- Wallace, A. R. 1876. *The Geographical Distribution of Animals*. Harper and Brothers, New York.



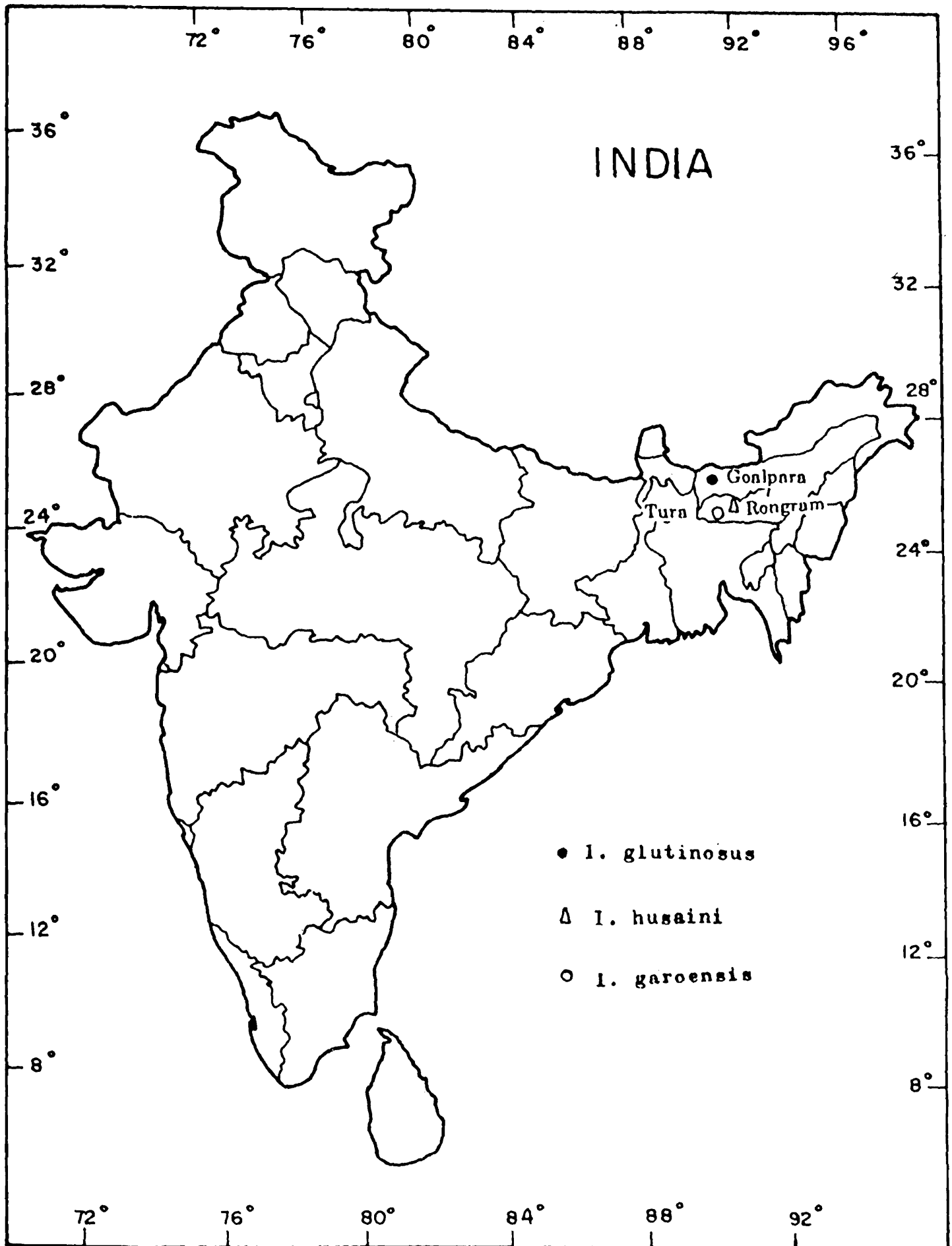
Map I. World distribution of Gymnophiona.



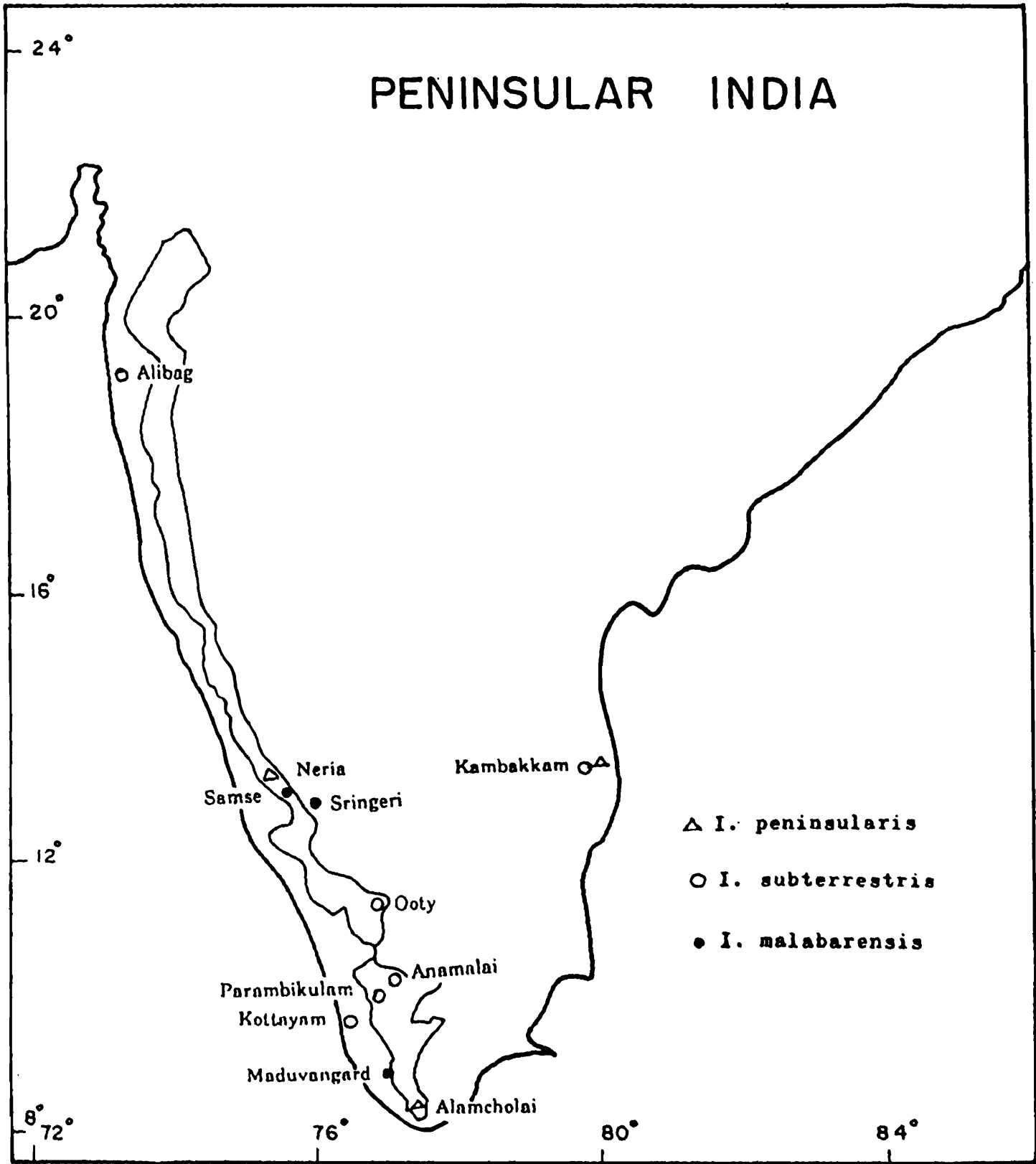
Map II. Distribution of *Ichthyophis beddomei*



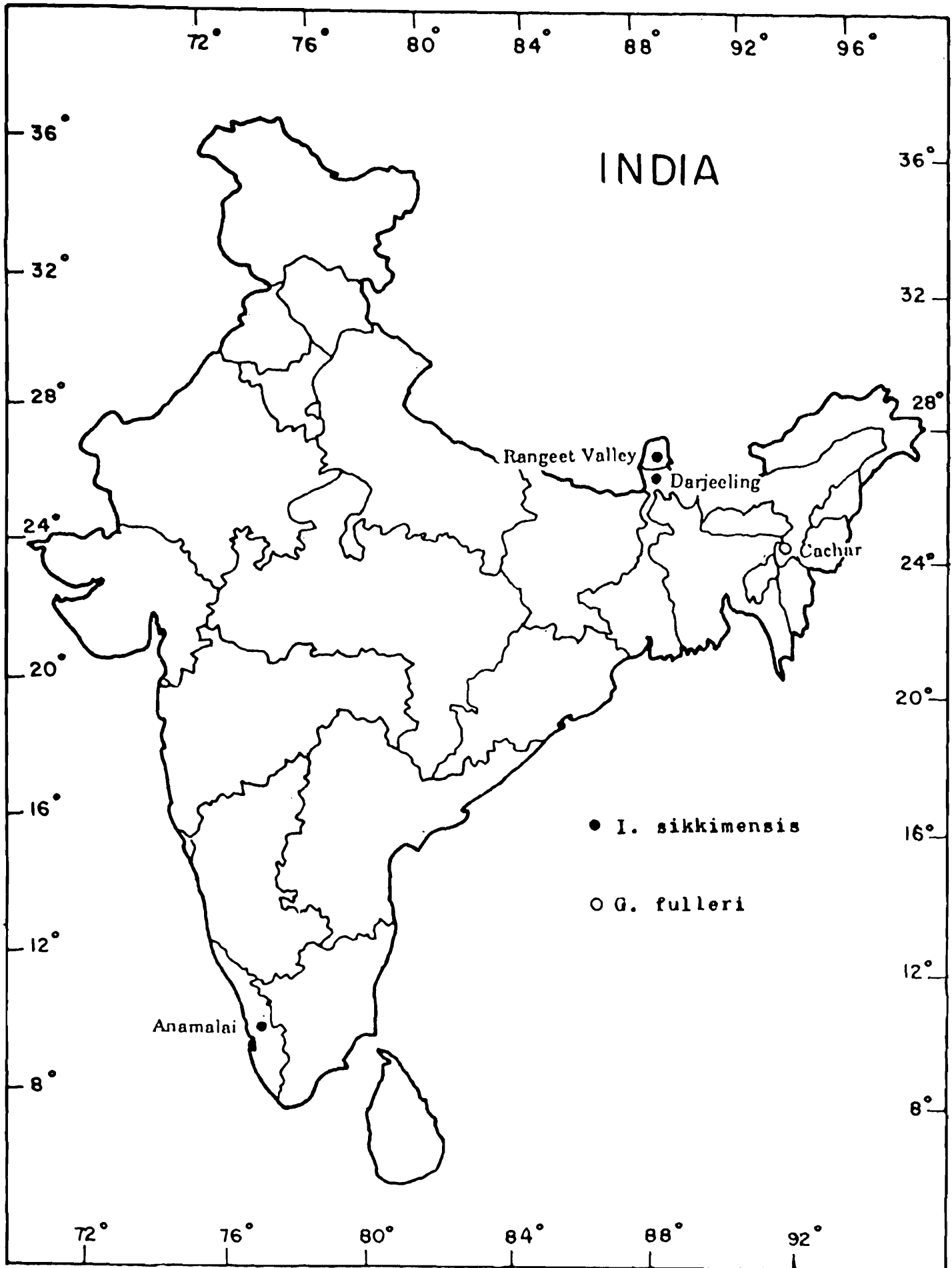
Map III. Distribution of *Ichthyophis bombayensis* and *Ichthyophis longicephalus*



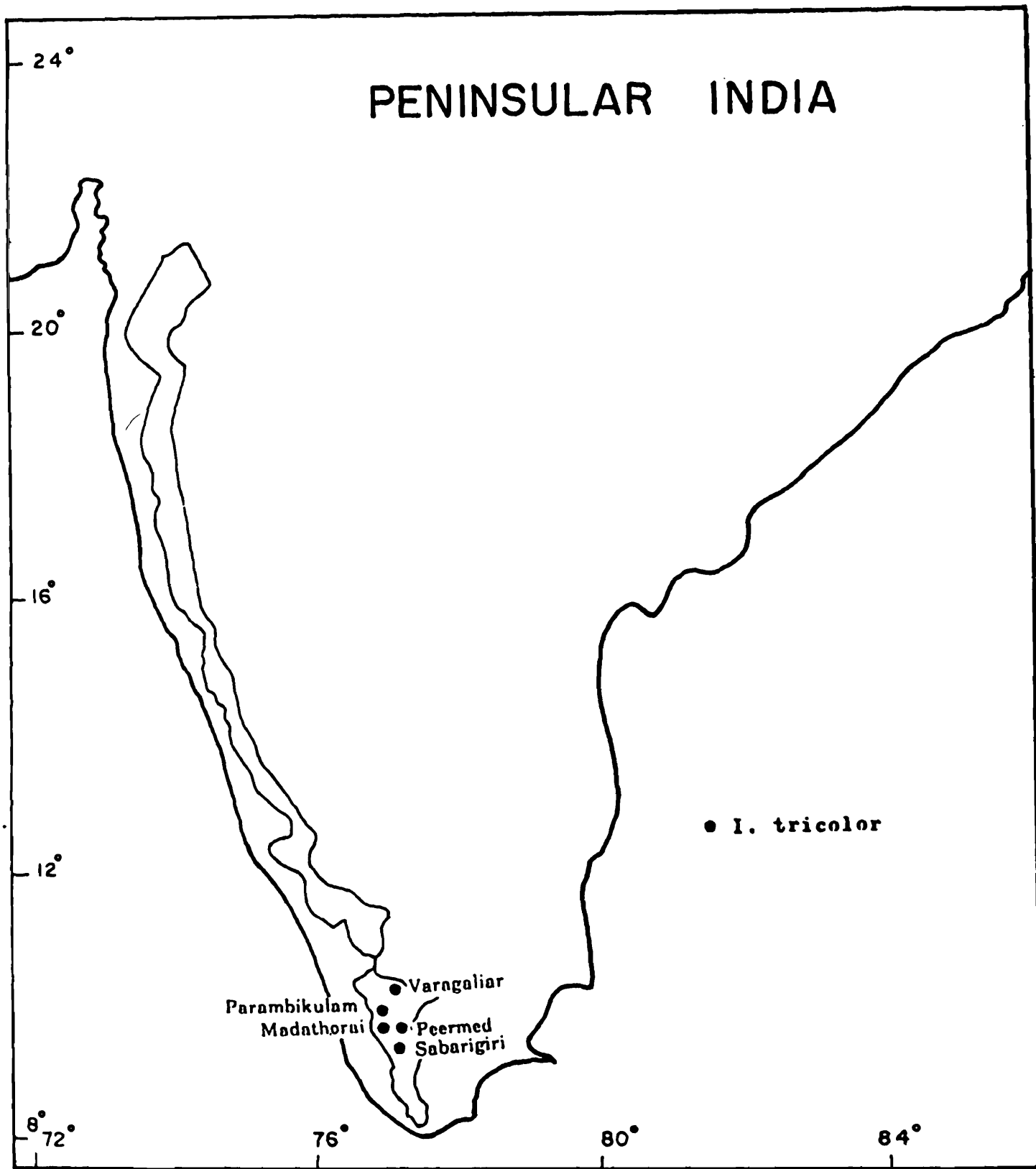
Map IV. Distribution of *Ichthyophis glutinosus*, *Ichthyophis husaini* and *Ichthyophis garoensis*.



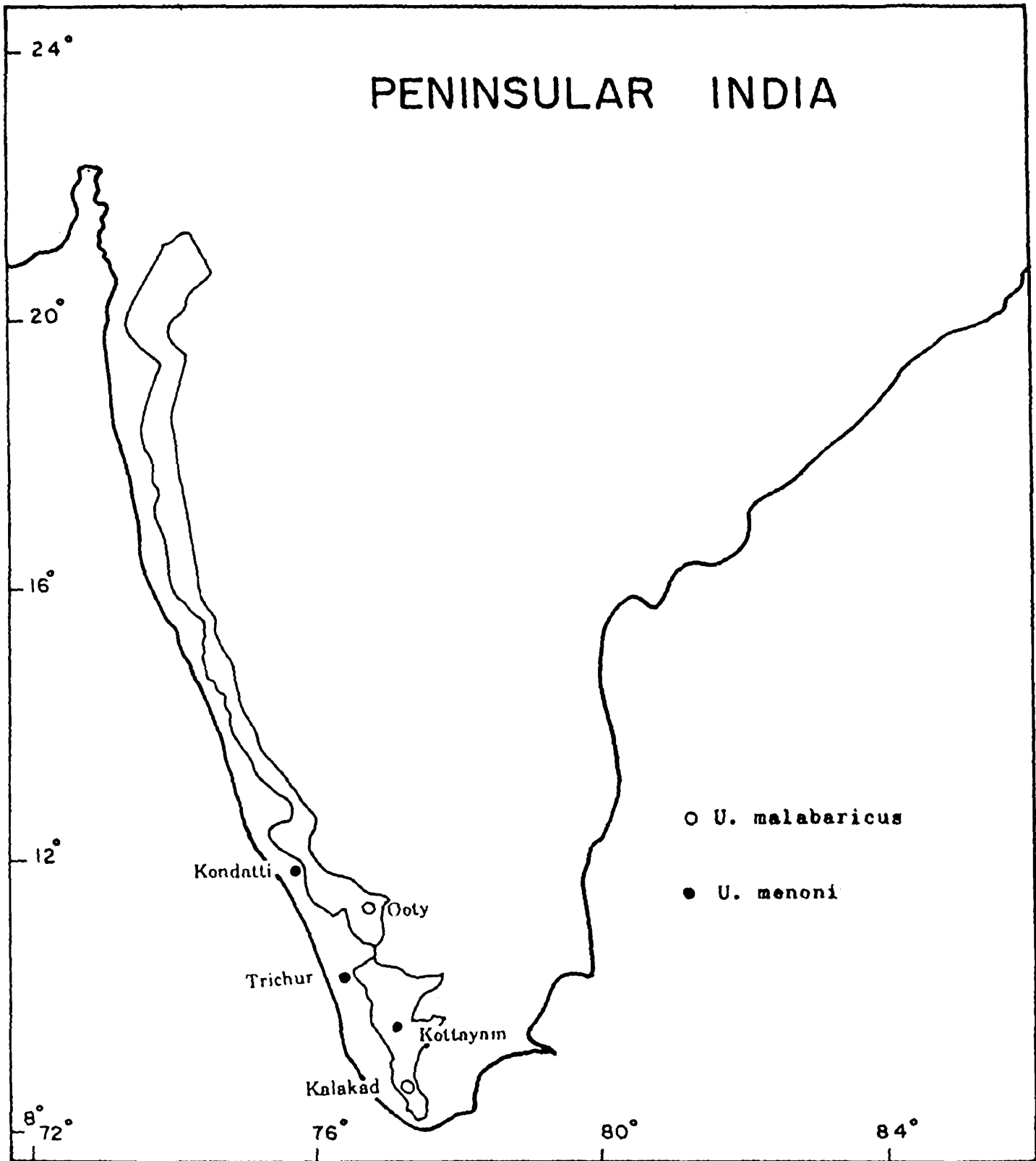
Map V. Distribution of *Ichthyophis peninsularis*, *Ichthyophis subterrestris* and *Ichthyophis malabarensis*.



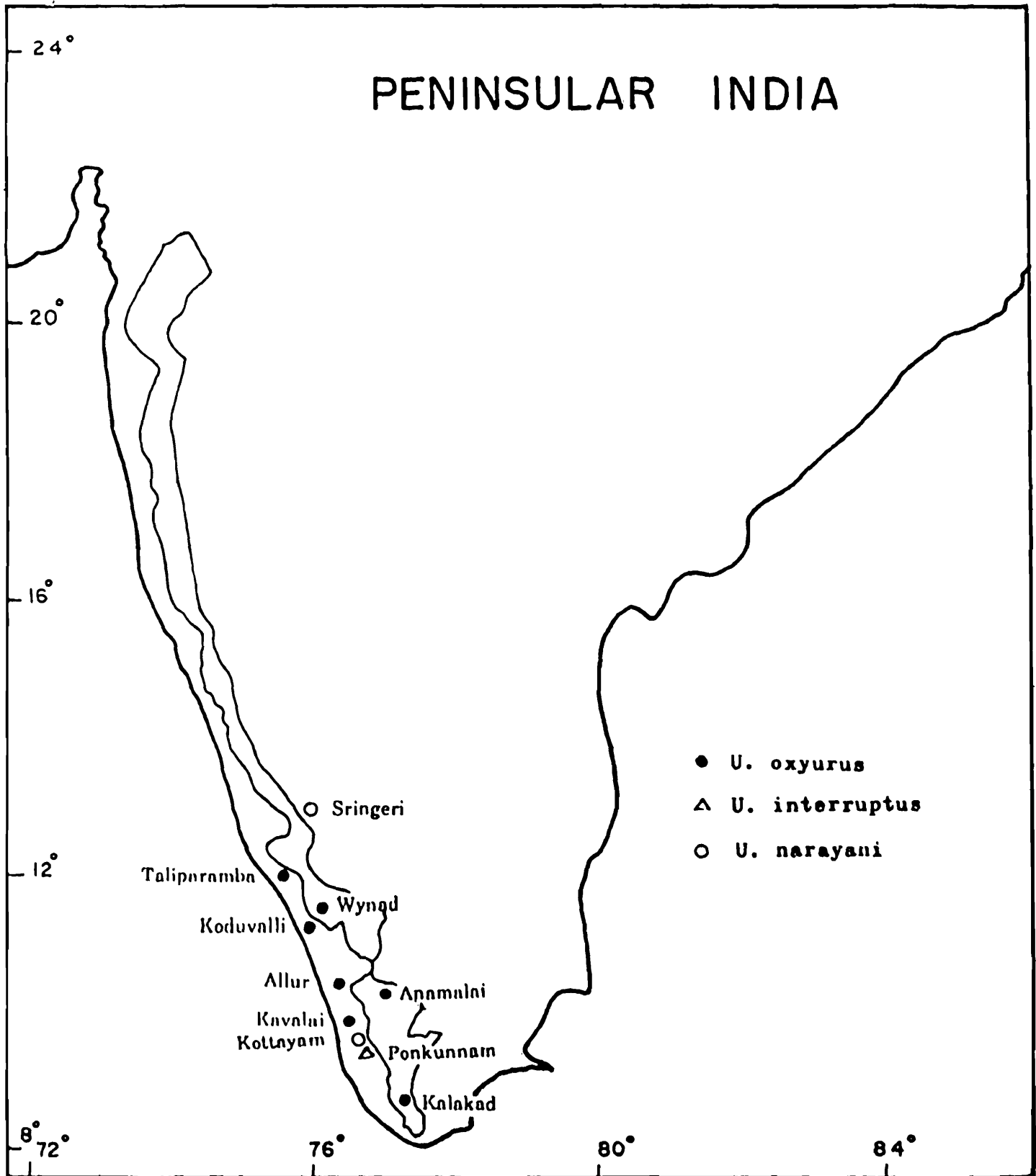
Map VI. Distribution of *Ichthyophis sikkimensis* and *Gegeneophis fulleri*



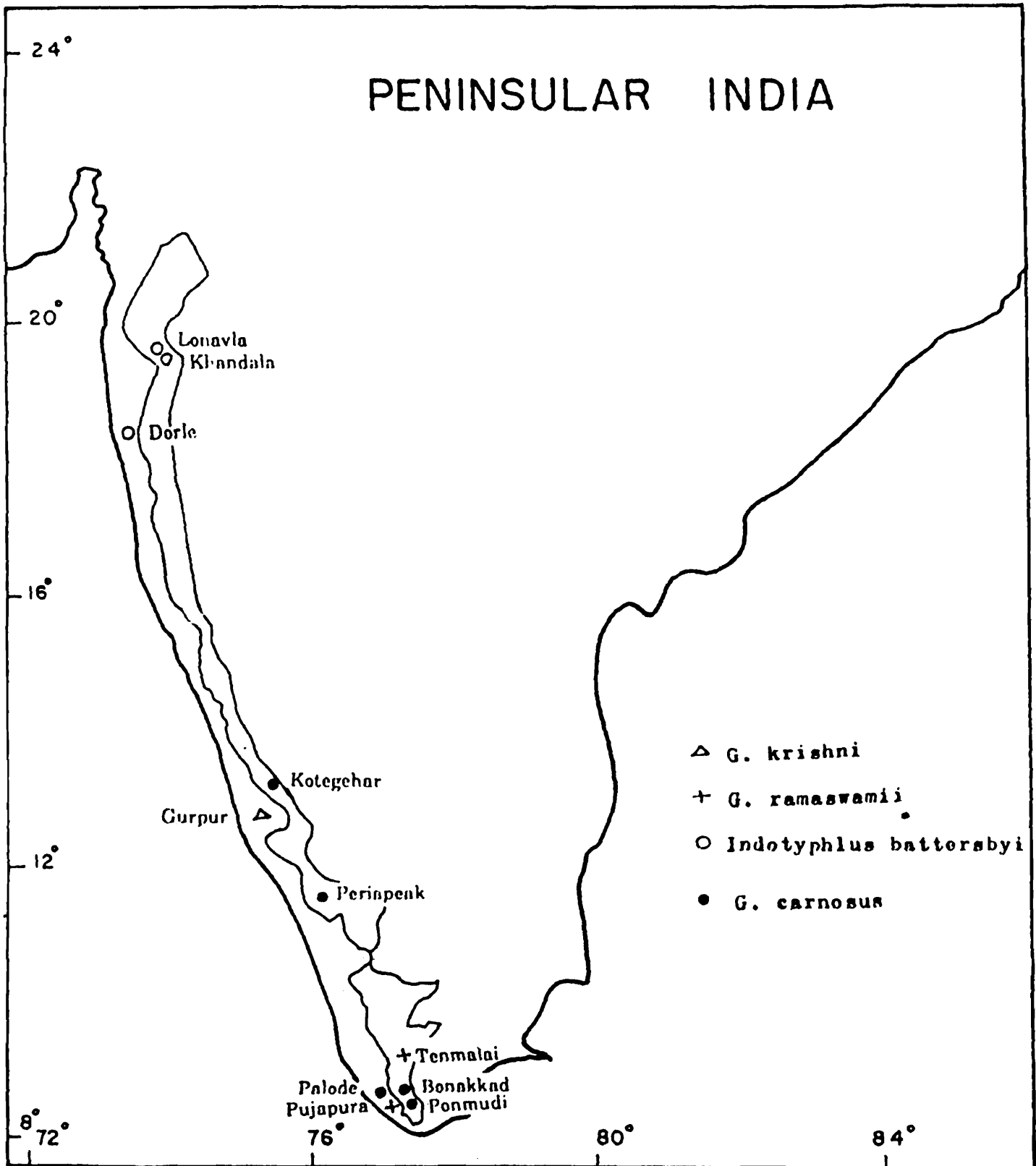
Map VII. Distribution of *Ichthyophis tricolor*.



Map VIII. Distribution of *Uraeotyphlus malabaricus* and *Uraeotyphlus menoni*.



Map IX. Distribution of *Uraeotyphlus oxyurus*, *Uraeotyphlus interruptus* and *Uraeotyphlus narayani*.



Map X. Distribution of *Indotyphlus battersbyi*, *Gegeneophis krishni*, *Gegeneophis ramaswamii* and *Gegeneophis carnosus*.

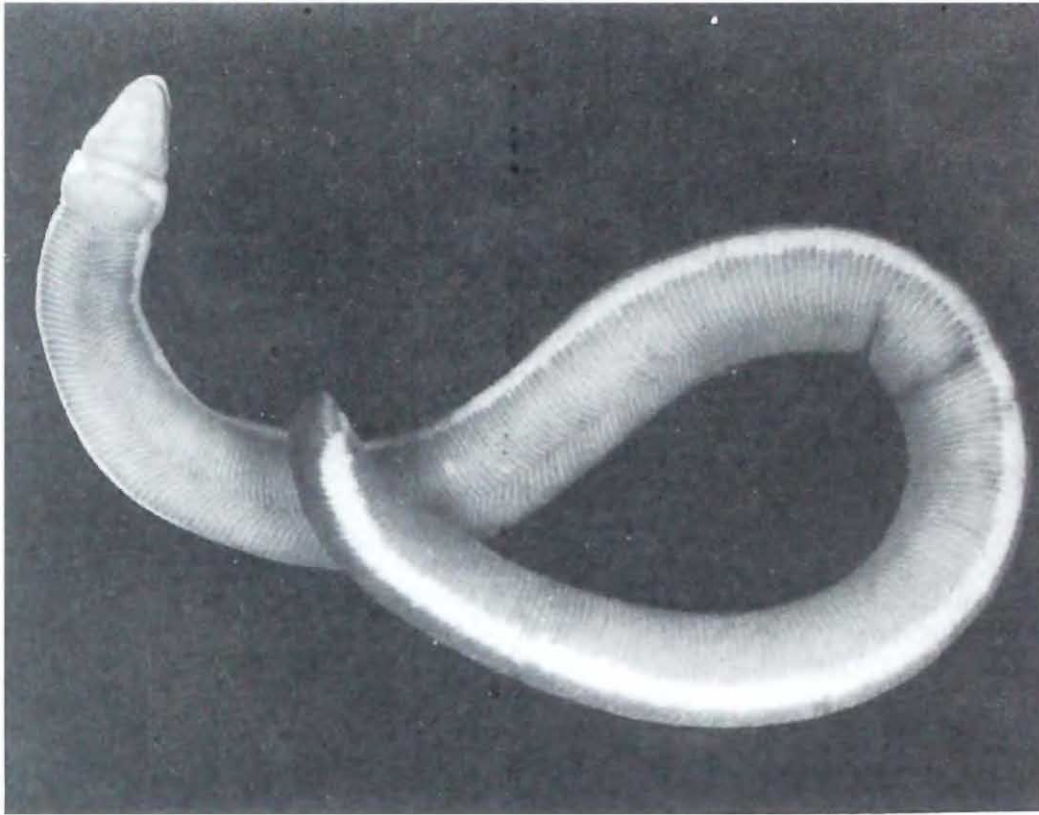


Fig. 23. *Ichthyophis beddomei* Peters, ventral view.

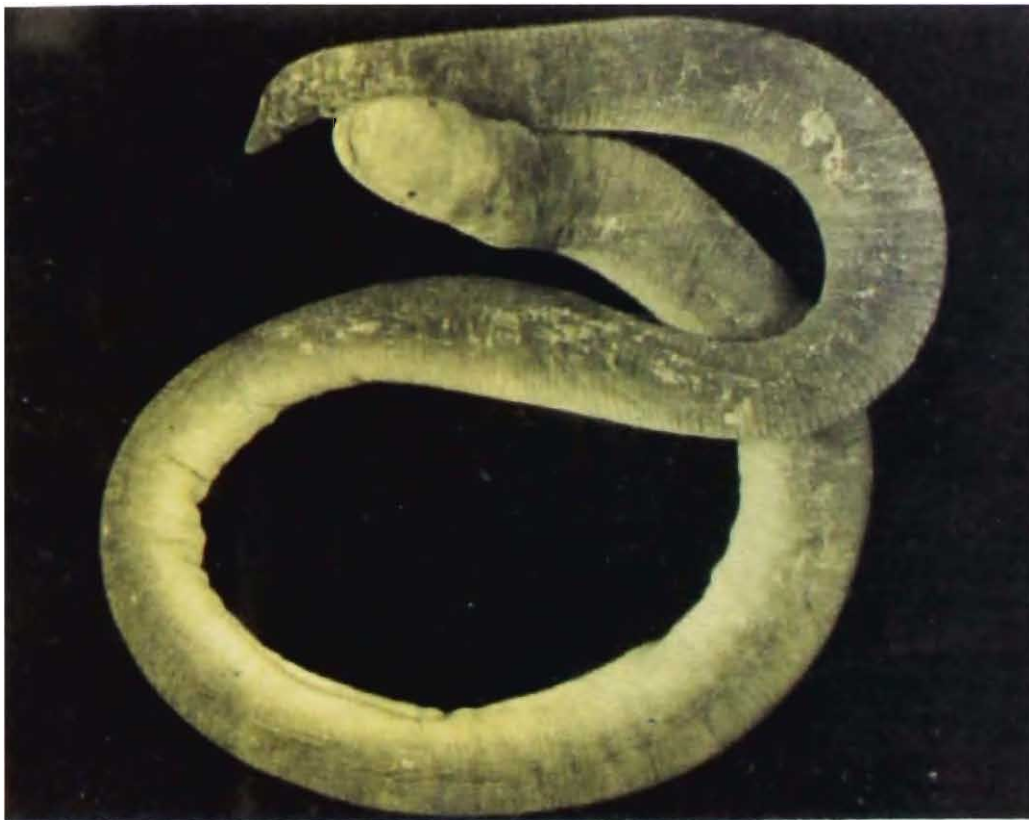


Fig. 24. *Ichthyophis bombayensis* Taylor, dorsal view.



Fig. 25. *Ichthyophis glutinosus* (Linnaeus), ventral view

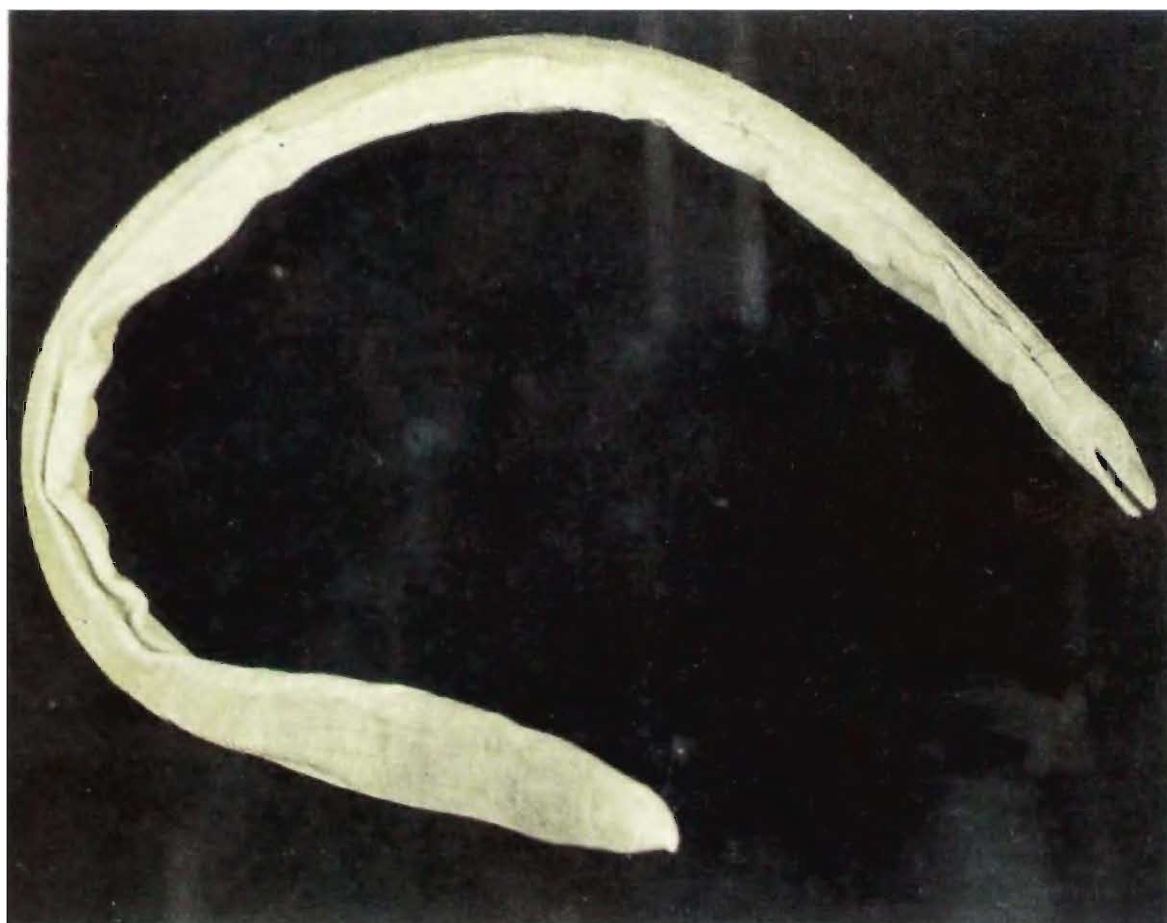


Fig. 26. *Ichthyophis husaini* sp. nov., lateral view



Fig. 27. *Ichthyophis sikkimensis* Taylor

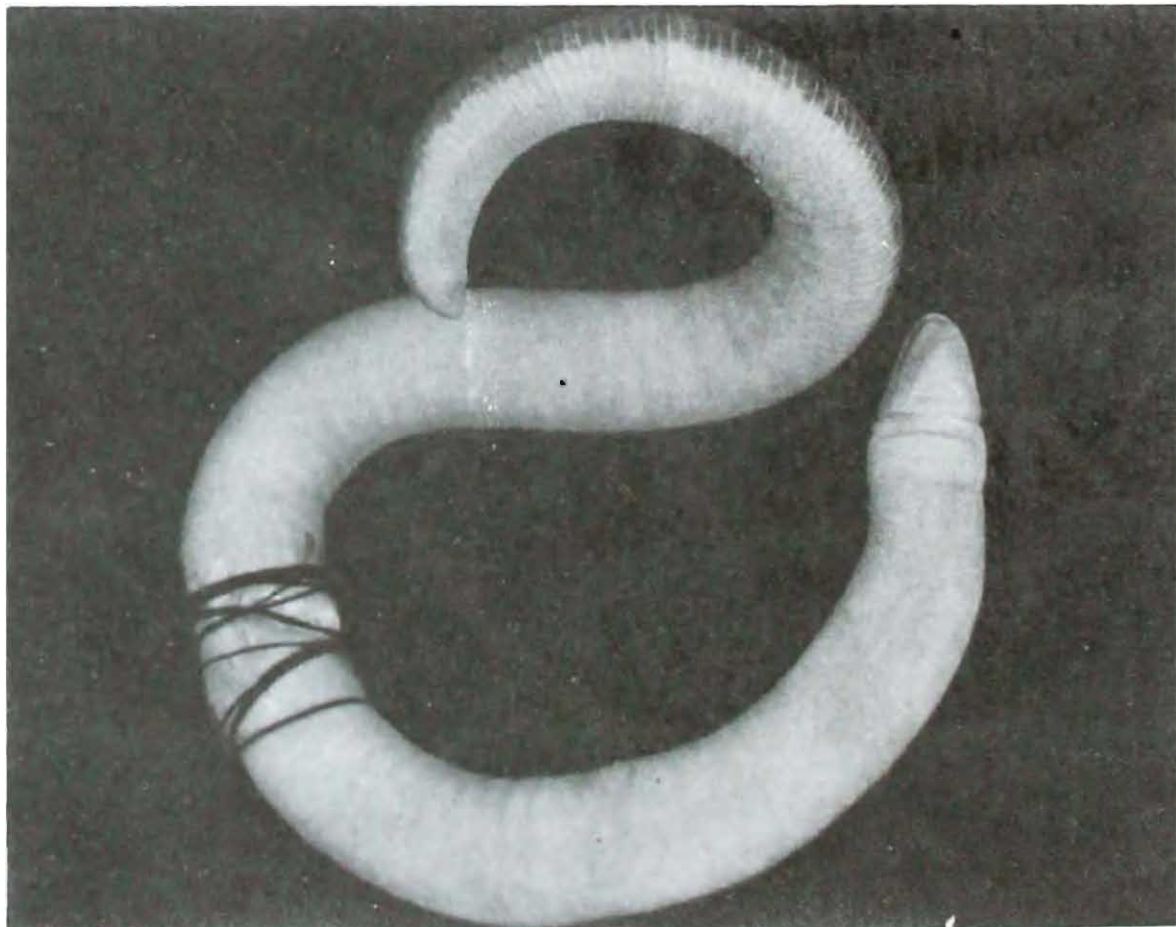


Fig. 28. *Ichthyophis tricolor* Annandale, ventral view.

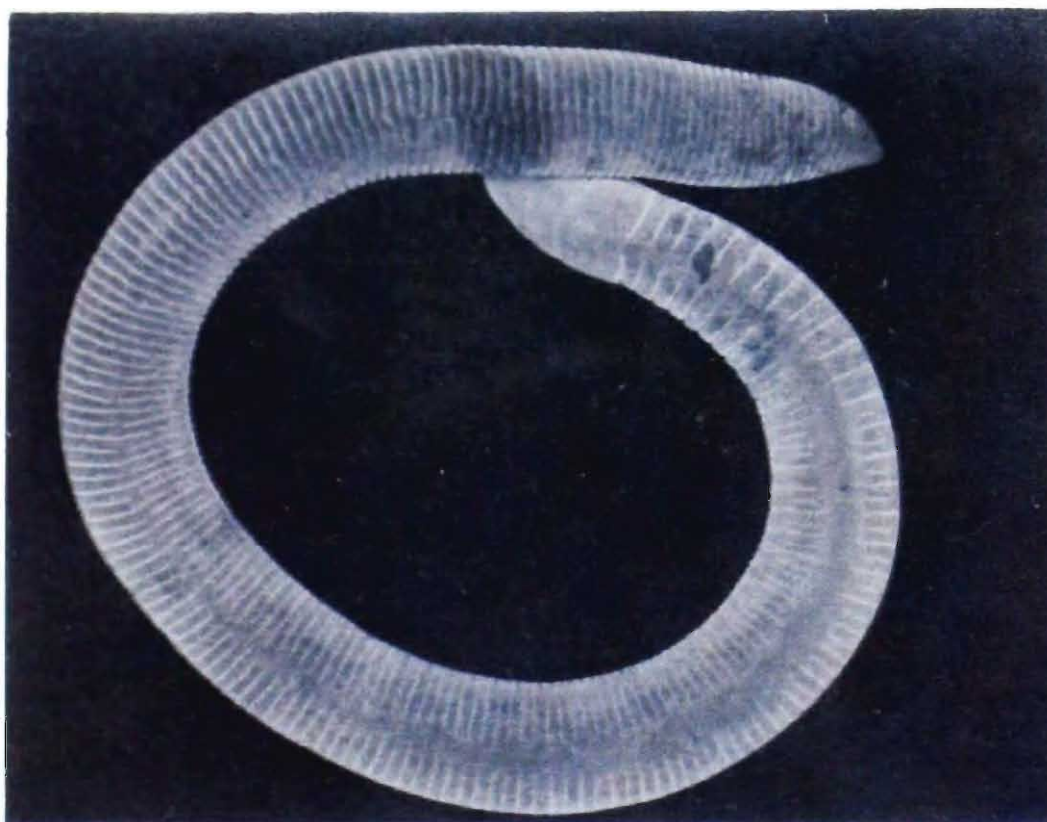


Fig. 29. *Uraeotyphlus interruptus* sp. nov., dorsal view

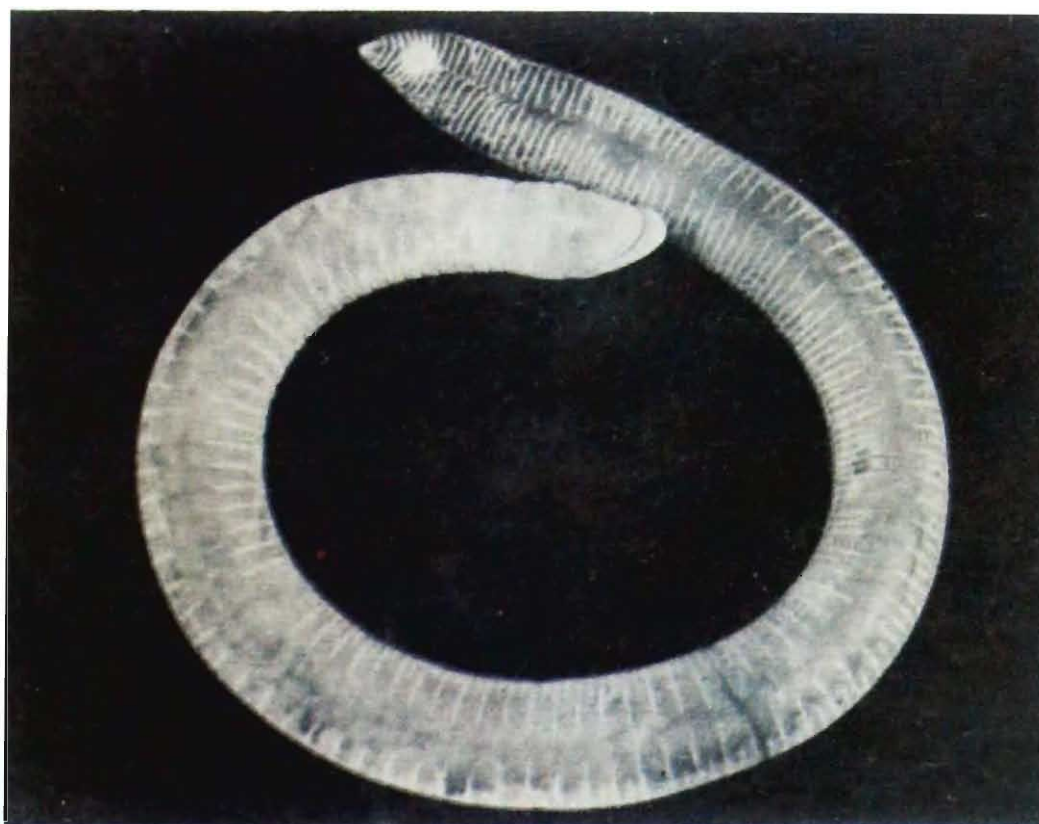


Fig. 30. *Uraeotyphlus interruptus* sp. nov., ventral view

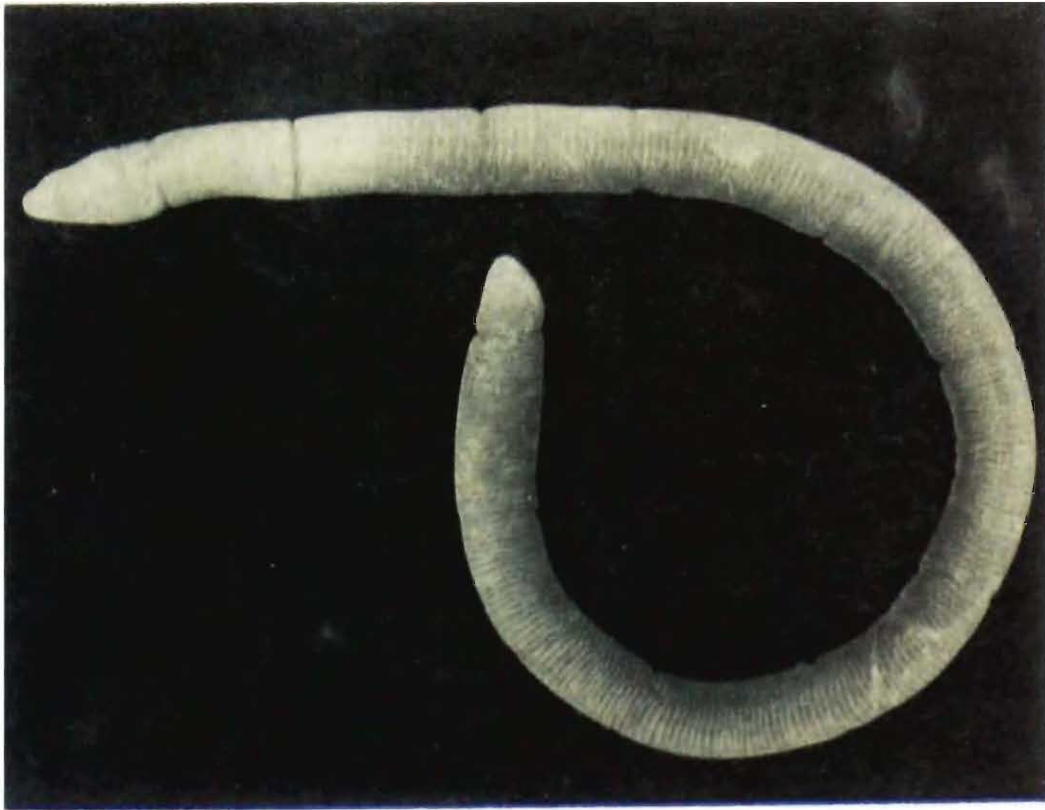


Fig. 31. *Uraeotyphlus malabaricus* (Beddome), dorsal view



Fig. 32. *Uraeotyphlus menoni* Annandale, ventral view.



Fig. 33. *Uraeotyphlus narayani* Sheshachar, lateral view.



Fig. 34. *Uraeotyphlus oxyurus* (Dumeril & Bibron)

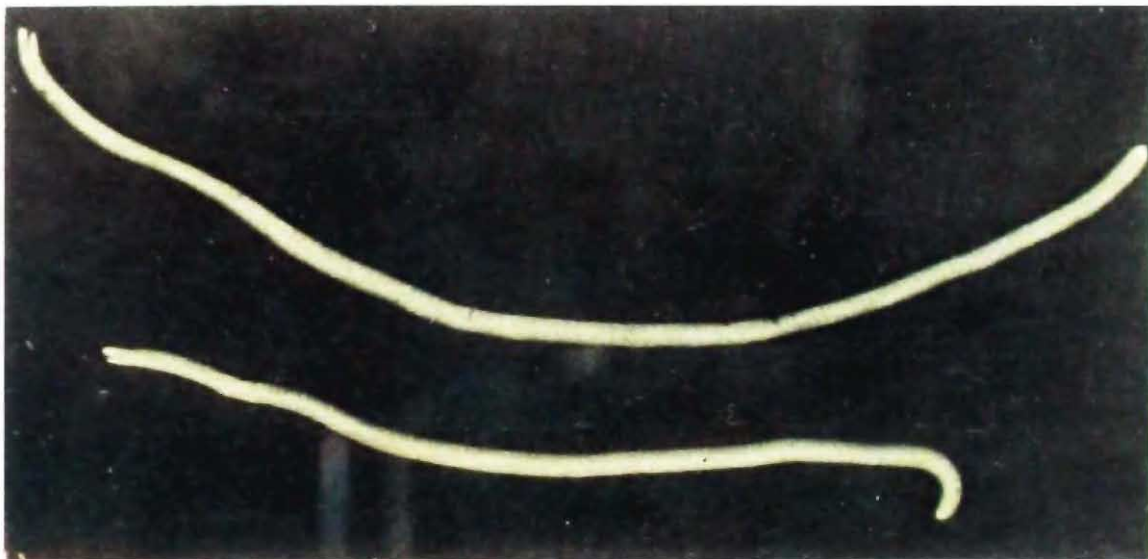


Fig. 35. *Gegeneophis krishni* sp nov., lateral view of holotype and paratype



Fig. 36. *Ichthyophis beddomei* Peters.



Fig. 37. *Ichthyophis malabarensis* Taylor



Fig. 38. *Ichthyophis peninsularis* Taylor



Fig. 39. *Gegeneophis carnosus* (Beddome).