

A new species of *Gegeneophis* Peters (Amphibia: Gymnophiona: Caeciliidae) from Maharashtra, India

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Abstract

A new species of caeciliid caecilian (Amphibia: Gymnophiona), *Gegeneophis seshachari*, is described from the Western Ghats of Maharashtra, India. Known only from the type specimen, this distinctive species differs from all other Indian caeciliids in lacking secondary annuli, and in possessing an unsegmented terminal shield. A rediagnosis of *Gegeneophis* is presented, and the caeciliid fauna of India is briefly discussed.

Key words: caecilians, herpetology, Western Ghats, South Asia, systematics

Introduction

Beddome (1870) described *Epicrium carnosum* from two caecilian specimens from Peria Peak, Wynaad (Wayanad), in the Western Ghats of Kerala, South India. This heralded the beginning of scientific knowledge of the caeciliid caecilian fauna of India. *Epicrium* Wagler was later (Gray, 1850) considered a junior synonym of *Ichthyophis* Fitzinger, but Günther (1875) recognised fundamental differences between Beddome's species and *Ichthyophis*, and Peters (1880) established the genus *Gegeneophis*, with *G. carnosus* the type species by monotypy. As currently conceived (Pillai & Ravichandran 1999), *Gegeneophis* includes two additional species from the Western Ghats and a single species from North East India. Here we describe a fifth species of *Gegeneophis*, based on a single, highly distinctive specimen from Maharashtra. The new species differs from all other Indian caeciliids in lacking secondary annuli and in possessing an unsegmented terminal shield, necessitating rediagnosis of *Gegeneophis*.

***Gegeneophis* Peters**

Diagnosis: Caeciliids with eyes under bone; no temporal fossae; mesethmoid not exposed dorsally; splenial teeth present; tentacular opening midway between eye and external naris; small narial plugs present; no diastemata between vomerine and palatal teeth; terminal keel absent.

Type species: *Gegeneophis carnosus* (Beddome 1870) by original monotypy.

Content: Five species: *G. carnosus*, *G. fulleri* (Alcock 1904), *G. krishni* Pillai and Ravichandran 1999, *G. ramaswamii* Taylor 1964, *G. seshachari* sp. nov.

Remarks: The presence of secondary annuli and scales, and the absence of a terminal shield were previously used in diagnoses of *Gegeneophis* (Taylor 1968; Nussbaum and Wilkinson 1989) and, with the exception of the *G. seshachari*, are characteristic of all Indian caeciliids. *Gegeneophis* is diagnosed on the basis of a combination of features, none of which is a unique synapomorphy of the genus. Monophyly of *Gegeneophis* is thus uncertain and merits testing through phylogenetic analysis.

***Gegeneophis seshachari* sp. nov.**

(Fig. 1, Table 1)

Holotype: Zoological Survey of India, Kolkata (ZSIC) A3384. Dorle Village, Ratnagiri District, Maharashtra, India. Collected by P. W. Soman, August 12th 1967. There are no further associated collection or habitat data.

Diagnosis: A *Gegeneophis* differing from all other species in the genus in lacking secondary annuli and scales, and having an unsegmented terminal shield.

Description of the holotype: Some morphometric and meristic data are given in Table 1. ZSIC A3384 is probably an immature adult. No identifiable gonads could be located through midventral incisions into the coelom. It is in good condition, with a few minor exceptions. There are artefactual longitudinal ridges dorsolaterally, probably representing exaggeration through fixation of the position of the *musculus obliquus externus superficialis*. The skin of the posterior quarter of the body bears longitudinal wrinkles that are interpreted as being caused by fixation and/or storage in strong fixative/preservative. The midventral surface bears an artefactual, longitudinal groove throughout most of its length. Anteriorly, this extends across the nuchal region but not onto the ventral surface of the lower jaw. There are two small (c. 5 mm) midventral incisions extending anteriorly from points approximately 21 mm and 50 mm anterior to the posterior terminus of the body. The skin overlying the right side of the cranium has been reflected, remaining attached posteriorly. There is a little damage to the teeth and gingivae, and to the anterior tip of the tongue and lower jaw. The skin at the right side of the vent is slightly damaged.

The natural body shape is probably subcylindrical and slightly dorsoventrally compressed. It is largely uniform in width (2.2 mm at midbody but 2.5 mm a short distance

anterior to this, where the width in life is apparently more faithfully preserved) though slightly narrower anteriorly. Posteriorly, the body tapers strongly towards the terminus for only the ultimate 2 mm.

TABLE 1. Some morphometric (in mm) and meristic data for the holotype of *Gegeneophis seshachari*, ZSIC A3384.

| | |
|---|-----|
| Total length | 116 |
| Distance between external nares | 0.9 |
| Distance between tentacles | 1.8 |
| Distance between eyes | 1.8 |
| Distance between eye and naris | 1.4 |
| Distance between snout tip and eye | 1.9 |
| Distance between snout tip and tentacle | 1.3 |
| Distance between snout tip and jaw angle | 3.0 |
| Distance between snout tip and midpoint between front of eyes | 1.7 |
| Distance between jaw angle and tip of lower jaw | 2.4 |
| Distance between jaw angle and tentacle | 1.7 |
| Snout tip to lateral part of first nuchal collar groove | 4.0 |
| Head width at level of jaw angles | 2.2 |
| Head width at level of first nuchal collar groove | 2.3 |
| Width of body at level of vent | 2.4 |
| Circumference at midbody | 11 |
| Primary annuli | 122 |
| Premaxillary-maxillary teeth | 21 |
| Vomeropalatine teeth | 20 |
| Dentary teeth | 18 |
| Splential teeth | 3 |

In dorsal view, the posterior of the head is slightly narrower than the nuchal region. The lateral margins are almost straight and subparallel for most of their length. The positions of the tentacular apertures are visible as strong bulges. The snout in front of this is subtriangular, with the tip forming an angle of approximately 60°, gently rounded only at the extreme apex. The snout projects moderately (0.7 mm) beyond the anterior margin of the mouth. In lateral view, the margins of the head are straight, as are the upper and lower lip. The distance between the jaw angle and the top of the head is marginally greater than between the jaw angle and the ventral edge of the lower jaw. In anterior view, the ventral surface of the rostrum of the snout is flat. In ventral view, the anterior margin of the lower jaw is much more broadly rounded than the anterior margin of the snout.



FIGURE 1. *Gegeneophis seshachari* n. sp., holotype, Dorle Village, Maharashtra, India, ZSIC A3384, total length 116 mm.

The well-developed eye, within which a lens is visible, is covered by the anterior limit of the squamosal, and is very faintly visible through the skin externally. The surface of the eye region is level with the surrounding surface of the head. In lateral view, it is about halfway between the margin of the upper lip and the dorsal edge of the head, slightly higher on the right side than on the left. The eye is about as far from the jaw angle (1.2 mm) as the jaw angle is from the first nuchal groove. The tentacular canal is within the maxillopalatine, and is uncovered by bone for its anterior half. The maxillopalatine extends far posteriorly, well beyond the eye. The nasal has a pointed, posteromedial projection in dorsal view, where the mesethmoid is not exposed.

The globular tentacle is associated with a horseshoe-shaped aperture (concave posteriorly). It is behind the anterior margin of the mouth, below an imaginary line passing through the midline of the cranium, seen in lateral view (0.4 mm from the margin of the upper lip). It is distinctly below an imaginary line passing from eye to naris, and about as far from the eye (0.6 mm) as from the naris (0.7 mm). The tentacles are visible in dorsal, ventral, and lateral views. The anteriorly positioned, subcircular naris is a short distance dorsal and anterior to the tentacle, approximately halfway between the snout tip and the anterior margin of the mouth. The nares are visible in dorsal and anterior views, but not ventral view.

The small size of the specimen made examination of the inside of the mouth extremely difficult with the available microscope and lighting equipment, particularly without damaging the specimen by breaking or cutting the jaws apart. The teeth were especially difficult to examine, and our observations might be checked with better equipment. A concerted effort was made to examine the tips of the tooth crowns. The 18 dentary and 21 premaxillary-maxillary teeth appear to be monocusped. A second cusp is faintly indicated on the vomeropalatine teeth, of which 10 were counted on the left side. Three splenial teeth were counted, one right and two left. The teeth in the outer rows are notably larger than the inner rows of both upper and lower jaw, and the dentaries are the largest overall. They increase in size anteriorly, except that the anteriormost dentaries are smaller than those situated anterolaterally. The premaxillary-maxillary and vomeropalatine tooth rows clearly extend posterior to the choanae. The choanae appear quite large, and are separated by a distance that is approximately a little less than twice the transverse width of each choana.

The tongue is not attached anteriorly, where it is broadly rounded in dorsal view. The raised narial plugs are positioned far laterally, close to the tongue edge, and demarcated by an encircling groove. Posterior to the plugs, a longitudinal groove lies on either side of the midline of the tongue. A groove separates the tongue from the gingivae. The posterior part of the tongue's dorsal surface, behind the narial plugs, is slightly darker than anteriorly.

The nuchal region is broader and higher than the adjacent part of the body, but barely thicker than the back of the head. The two nuchal collars are clearly marked by the three nuchal grooves. The anterior collar (1.2 mm) is shorter than the second (1.5 mm). The anteriormost two nuchal grooves are completely marked around the circumference of the body. Middorsally, the first is gently sinusoidal (slightly deflected posteromedially), and the second bends slightly anteriorly. The straight posteriormost nuchal groove is broadly incomplete midventrally. The first collar bears a short transverse dorsal groove at approximately one-third the distance from the first nuchal collar groove to the second. The second collar bears a longer transverse dorsal groove, slightly closer to the third nuchal groove than the second.

The annular grooves are generally orthoplicate throughout, and well marked, being darker than the background body colour. There are 122 primary annuli, that nowhere bear any indication of being divided by secondary grooves. The annular grooves are incomplete midventrally, except for approximately the last 10 annuli, and faintly indicated on the dorsum throughout. The grooves of the first 15 annuli are complete middorsally. Behind this, the grooves appear to be mostly incomplete middorsally, except posteriorly, where they are complete but very faint. The last two annular grooves are widely incomplete middorsally and midventrally, and are more faint than the preceding grooves. Posterior to the last groove, there is a long (3.7 mm) unsegmented terminal shield. There is no sign of scales, or of the development of scale pockets in association with annular grooves, at a position approximately 10 annuli anterior to the terminal shield.

The terminal shield is slightly bulbous in dorsal view, it lacks a posterior terminal keel, and the ventral surface is flat. The approximately circular disc (diameter 0.9 mm) surrounding the vent is slightly elevated. The transverse vent is only 0.7 mm from the tip of the terminus. It has six anterior and seven posterior denticulations that are irregular in size and arrangement.

The specimen is strongly bicoloured, with a dull grey dorsum and a paler grey-brown ventral surface. The darker dorsal area extends down about halfway around the body, reaching just below the artefactual longitudinal dorsolateral ridge. The terminus, nuchal region, and underside of the lower jaw are a little paler than the rest of the body, approaching a cream-tan colour. Dorsally, the head is less grey and more olive than most of the body. The upper lip has a narrow border paler than most of the head. Eye and tentacle are connected by a broad, slightly paler stripe. The naris is surrounded by a similarly pale halo. Anterior to the level of the tentacles, the tip of the lower jaw is pale. The lower jaw also has pale, narrow lateral borders. The vent and disc are the same colour as the surrounding region.

Remarks: *Gegeneophis seshachari* is unique among Indian caeciliids in possessing an unsegmented terminal shield and in lacking secondary annuli and scales. Although these have been considered 'generic characters' (Taylor 1968), some other, non-Indian caeciliid genera include species with and without secondary annuli and scales (e.g. *Caecilia*, *Microcaecilia*) or an unsegmented terminal shield (e.g. *Caecilia*). In other respects, ZSIC A3384 corresponds with the existing generic diagnosis of *Gegeneophis* (e.g. Taylor 1968, Nussbaum & Wilkinson 1989). We prefer to expand the content and modify the concept of *Gegeneophis* than to establish a new genus to accommodate this single, incompletely studied specimen. All non-Indian caeciliids that, like *G. seshachari*, lack secondaries and scales and have the eye under bone, lack narial plugs and either have a terminal keel and the eye not visible externally (*Boulengerula* Tornier) or lack splenial teeth (*Microcaecilia taylori* Nussbaum and Hoogmoed). Pillai and Ravichandran (1999) reported ZSIC A3384 as *Indotyphlus battersbyi* - a species that has numerous secondary annuli and scales, and lacks a terminal shield.

Etymology: The species is named for B. R. Seshachar in recognition of his pioneering studies of the cytogenetics, reproductive biology, and natural history of Indian caecilians. Seshachar conducted several successful and influential projects on caecilians with L. S. Ramaswami, for whom Taylor (1964) named another species of *Gegeneophis*.

Discussion

We share Dutta's (2002) scepticism regarding Pillai & Ravichandran's (1999) identification of an Indian *Ichthyophis glutinosus*, and consider the Indian caecilian fauna to comprise 21 species, 10 *Ichthyophis* (Ichthyophiidae), five *Uraeotyphlus* (Uraeotyphlidae), one *Indotyphlus* (Caeciliidae), and five *Gegeneophis* (Caeciliidae) (Pillai & Ravichandran

1999, this paper). All 21 species are endemic, and India represents one of the global hotspots of caecilian diversity. The Ichthyophiidae and Uraeotyphlidae are endemic to Asia and India, respectively, while the Caeciliidae are more cosmopolitan, occurring also in Africa, the Seychelles, and Central and South America (e.g. Taylor 1968, Nussbaum & Wilkinson 1989). The Indian endemics *Indotyphlus* and *Gegeneophis* are the only Asian caeciliids. The monophyly of Indian caeciliids and of *Gegeneophis* have yet to be thoroughly tested.

The description of *Gegeneophis seshachari* expands the known morphological diversity and distribution of Indian caeciliids. *G. seshachari* is the only Indian caeciliid (and caecilian) lacking secondary annuli and scales and possessing an unsegmented terminal shield, features that are known in some non-Indian caeciliids (e.g. Taylor 1968, Nussbaum & Wilkinson 1989). The type locality of *G. seshachari* lies in the previously large gap (> 600 km) along the Western Ghats between occurrences of *G. ramaswamii*, *G. carnosus*, and *G. krishni* in Kerala, Tamil Nadu, and Karnataka in the South, and *Indotyphlus* in northern Maharashtra in the North. Two of the five species of *Gegeneophis* have been described in the last four years, and this suggests that the diversity of Indian caecilians is far from completely known. Supporting evidence lies in the fact that two of the species, *G. fulleri* and *G. seshachari*, are known only from a single specimen collected by 1904 and in 1967, respectively. The herpetology of the northern part of the Western Ghats, including the region of the type locality of *G. seshachari*, is much less studied than in the South, and this area might be especially profitably explored for hitherto unrecognised diversity.

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