



A new species of *Gegeneophis* Peters, 1879 (Amphibia: Gymnophiona: Grandisoniidae) from the Western Ghats of northern Kerala, India

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Abstract

A new species of grandisoniid caecilian amphibian, *Gegeneophis bavali* **sp. nov.**, is described based on two specimens from northern Kerala state in the southern part of the Western Ghats region of peninsular India. This species is distinguished from all other *Gegeneophis* by the combination of lacking an unsegmented terminal shield, having secondary annular grooves, and having more than 132 primary annuli. A new key to the identification of the species of the genus is presented.

Key words: caecilians, herpetology, identification key, morphology, taxonomy

Introduction

The grandisoniid caecilian amphibian genus *Gegeneophis* Peters, 1879 is endemic to the Western and Eastern Ghats of peninsular India (e.g., Kotharambath *et al.* 2015; Frost 2025; AmphibiaWeb 2025). With 13 currently recognised species, *Gegeneophis* is the fourth most speciose of the 32 currently recognised genera of caecilians globally (Frost 2025; AmphibiaWeb 2025). Three of the currently recognised species of *Gegeneophis* were described between 1870 and 1999: *G. carnosus* (Beddome, 1870), *G. ramaswamii* Taylor, 1964 and *G. krishni* Pillai & Ravichandran, 1999. The remaining 10 currently recognised species were described this century, between 2003 and 2025: *G. danieli* Giri, Wilkinson & Gower, 2003, *G. seshachari* Ravichandran, Gower & Wilkinson, 2003, *G. madhavai* Bhatta & Srinivasa, 2004, *G. goaensis* Bhatta, Dinesh, Prashanth & Kulkarni, 2007, *G. mhadeiensis* Bhatta, Dinesh, Prashanth and Kulkarni, 2007, *G. pareshi* Giri, Gower, Gaikwad & Wilkinson, 2011, *G. primus* Kotharambath, Gower, Oommen & Wilkinson, 2012, *G. orientalis* Agarwal, Wilkinson, Mohapatra, Dutta, Giri & Gower, 2013, *G. tejaswini* Kotharambath, Wilkinson, Oommen & Gower, 2015, and *G. valmiki* Dinesh, Shikalgar, Adhav, Jadhav & Kulkarni, 2025. A map of the type localities of the currently recognised species of the genus is presented in Fig. 1. Two described species are no longer considered to be members of the genus, *Gegeneophis fulleri* Alcock, 1904 has been reassigned as *Chikila fulleri* (Kamei *et al.* 2012), and *G. nadkarnii* Bhatta & Prashanth, 2004 has been considered a junior subjective synonym of *G. danieli* (Gower *et al.* 2013).

Here we describe a new species of caecilian from the northern part of Kerala, the southwesternmost state of India. We identify this as an additional *Gegeneophis* primarily based on it having eyes covered by bone—*Gegeneophis* being the only caecilians in peninsular India with this condition (Wilkinson *et al.* 2011; Agarwal *et al.* 2013). The new species is distinguished from congeners primarily by its high count of nearly 140 primary annuli in combination with having secondary annular grooves and lacking an unsegmented terminal shield.

Material and Methods

The new species is described based on two specimens collected from a single locality in northern Kerala in 2021. All specimens were fixed in 4–5% aqueous formaldehyde following anaesthesia (MS222), washed in water after

48 hours, and stored in 70% ethanol. Prior to fixation, a small quantity of liver tissue was collected from both specimens for subsequent molecular analyses.

We have examined the holotypes of all currently recognised and previously proposed species of *Gegeneophis* except for the recently described *G. valmiki*, for which we rely on data presented in the original description (Dinesh *et al.* 2025). Comparative data on congeners were obtained also from Kotharambath *et al.* (2015) and sources listed therein (Giri *et al.* 2003, 2011; Bhatta & Srinivasa 2004; Bhatta *et al.* 2007a, b; Gower *et al.* 2007, 2013; Agarwal *et al.* 2013; Kotharambath *et al.* 2012, 2015), and from Dinesh *et al.* (2025). The types of the new species described here are deposited in the collections of the Bombay Natural History Society, Mumbai, India, with the catalogue number prefix BNHS.

We follow Kotharambath *et al.* (2015) and references cited therein for abbreviations for morphological features as follows: AG = annular groove; AM = anteromedial limit of the mouth on the upper jaw; CM = corner of the mouth; C1 = first collar; C2 = second collar; IM = inner mandibular tooth; L = lip; LH = head length (ST–NG1); N = naris; NG1 = first nuchal groove; NG2 = second nuchal groove; NG3 = third nuchal groove; OM = outer mandibular (i.e. dentary) tooth; PA = primary annulus; PAG = primary AG; PM = premaxillary-maxillary tooth; SAG = secondary AG; ST = snout tip; TA = tentacular aperture; TG = dorsal transverse groove; TP = tentacular papilla; TT = terminus tip; VP = vomeropalatine tooth; WH = maximal width of head. An “s” added to these abbreviations indicates plural structures, for example AGs = annular grooves. All distances involving nuchal grooves were measured to points directly behind the CM. We follow Kotharambath *et al.* (2012) for the definition of “terminal shield”. Sex was determined by examination of gonads. We follow Wilkinson *et al.* (2013) in examination of scales within annular scale pockets. We used a Mitutoyo dial calliper for all measurements, to 0.1 mm, except total length, which was measured to the nearest 1 mm using a ruler, and midbody circumference, which was measured to the nearest mm with string and a ruler.

The paratype specimen of the new species was subjected to high-resolution X-ray computed tomography (micro-CT) scanning for detailed examination of the teeth. The scanning was performed using a Zeiss Xradia Versa 520 at the Four-Dimensional X-ray Microscopy facility at Indian Institute of Technology (IIT), Mumbai, India. The scan was conducted in 360°, with 2001 projections for 2 h, 04 min, 42 s, exposures of 2s and a pixel size of 10.285 µm. Scanning was performed at a source voltage of 100.03 kV and a power of 9.0W. Reconstruction and visualisation of tooth morphology was carried out using Dragonfly 3D World Workstation (Version 2024.1 Build 1627).

***Gegeneophis bavali* sp. nov.**

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(Figs. 1, 2, 3; Table 1)

Holotype. BNHS 6840 (field tag RAM 0945) (Figs. 2, 3), adult female collected from near Valathode, Iritty, Kannur District, Kerala state, India (12° 3' 1" N, 75° 46' 39" E, c. 332 m a.s.l.; Fig. 1) by Ranjith Vengot and Ramachandran Kotharambath on 23 October 2021.

Paratype (n = 1). BNHS 6841 (field tag RAM 0947), adult male. Same collection data as for holotype.

Diagnosis. *Gegeneophis bavali* sp. nov. differs from *G. primus*, *G. seshachari*, *G. pareshi* and *G. valmiki* in having secondary annular grooves (12 and 13 in the two known specimens) and differs from the latter three species, additionally, in lacking an unsegmented terminal shield (*sensu* Kotharambath *et al.* 2012). The new species differs from all other congeners, that have secondary annular grooves, in having > 135 primary annuli (136 and 138 in the two known specimens) versus < 132 primary annuli.

Additional comparisons. *Gegeneophis bavali* sp. nov. is an attenuate *Gegeneophis* with many primary annuli and relatively few secondary annular grooves. The two known specimens of *G. bavali* sp. nov. have 136 and 138 primary annuli, more than reported for any other congeners except *G. pareshi* (145–151; Giri *et al.* 2011) and *G. valmiki* (137–145; Dinesh *et al.* 2025). The new species differs from *G. pareshi* and *G. valmiki* not only in having fewer primary annuli, but also in having (versus lacking) secondary grooves, and in lacking (versus having) an unsegmented terminal shield. No caecilians are known to exhibit both an unsegmented terminal shield and secondary annular grooves. Among the eight other congeners with secondary annular grooves, only *G. tejaswini* has primary annular counts reported to exceed 130 (125–131, n = 8; Kotharambath *et al.* 2015).

Description of holotype. Some meristic and morphometric data are given in Table 1. Condition good; c. 6 mm ventral incision into coelom is present c. 78 mm anterior to vent; mouth preserved slightly open; skin slightly

cut and a scale pocket open on dorsum c. 52 mm from snout at a point where the vertebral column is broken. An additional scale pocket was opened dorsally, c. 6.9 mm from the posterior terminus for examining the scales. Overall shape generally cylindrical, slightly dorsoventrally compressed and uniform throughout. In dorsal view, head neither notably U- nor V-shaped; its sides straight and converging from back of head to distinct bulges of TPs, then converging more substantially in front of TAs to a blunt snout tip.

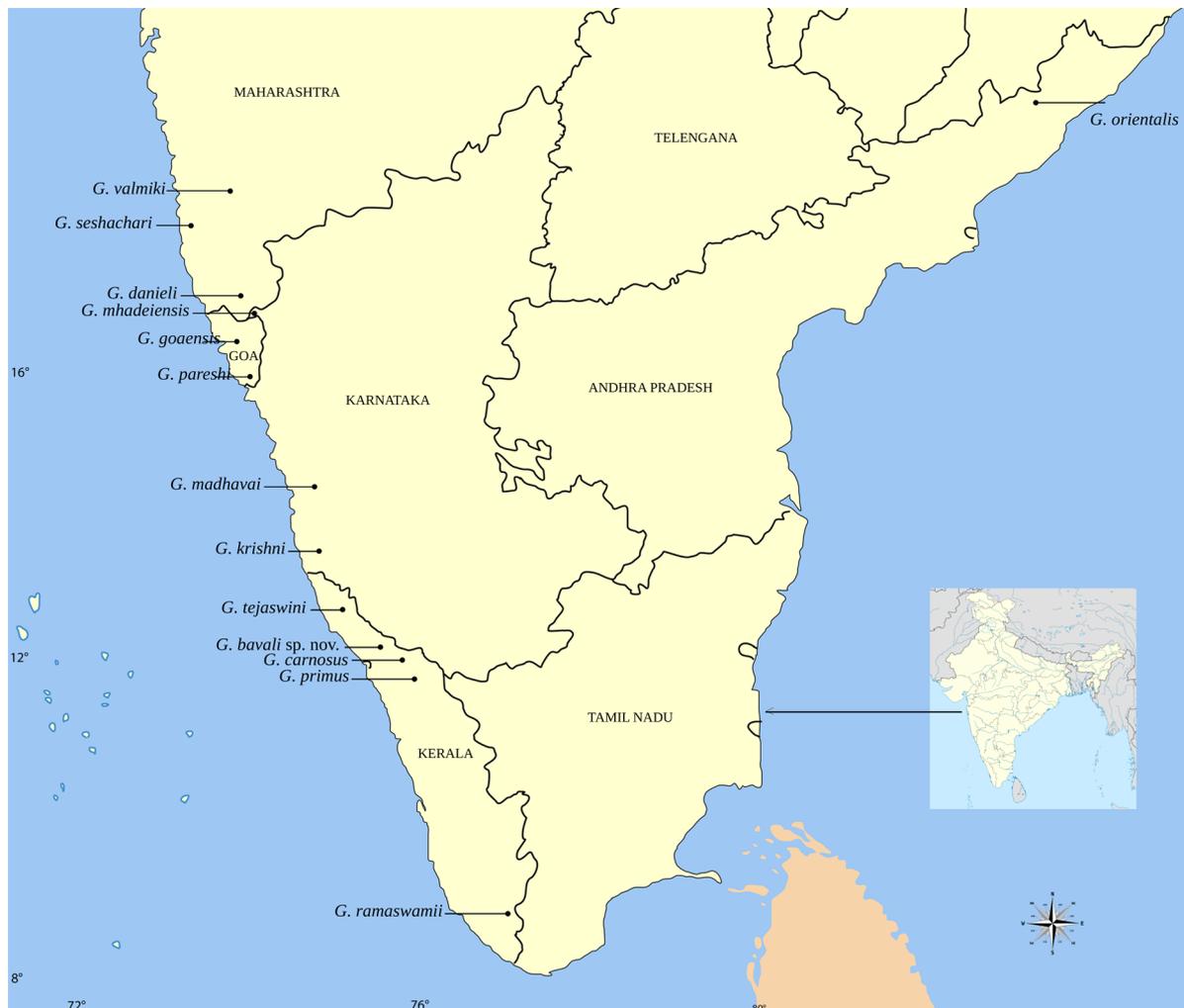


FIGURE 1. Map of peninsular India showing type localities of the 14 currently recognised species of *Gegeneophis*.

In ventral view lower jaw and upper lip more rounded than snout, upper jaws visible anterior to CMs. In lateral view upper lip very slightly concave, teeth of outer series visible in lateral and ventral views. Eyes not visible externally. TAs almost along the imaginary lines between nares and CMs. In lateral views, CMs very slightly closer to bottom than to top of head, nares approximately equidistant from top, front of snout, and bottom. In dorsal view nares barely visible, very slightly inset, not visible in ventral view. TAs approximately same size as nares, marginally visible in ventral but not in dorsal view; TPs visible in dorsal and ventral views. Midventral crease extends anteriorly from NG1, stops well before the tip of lower jaw.

PMs strongly recurved, decreasing in size posteriorly, largest at the antero-medial position; second anterior tooth missing on the right side. VPs strongly recurved, smaller than PMs, decreasing in size towards posterior. OMs mostly large, second and third from anterior the largest, with less pronounced size reduction than in the upper jaw, teeth moderately recurved except for slightly recurved anteriormost teeth. Gap present anteromedially between two OM halves. IMs small, anteromedial tooth is slightly bigger. Tooth cusps across all tooth rows could not be clearly observed under light microscopy.

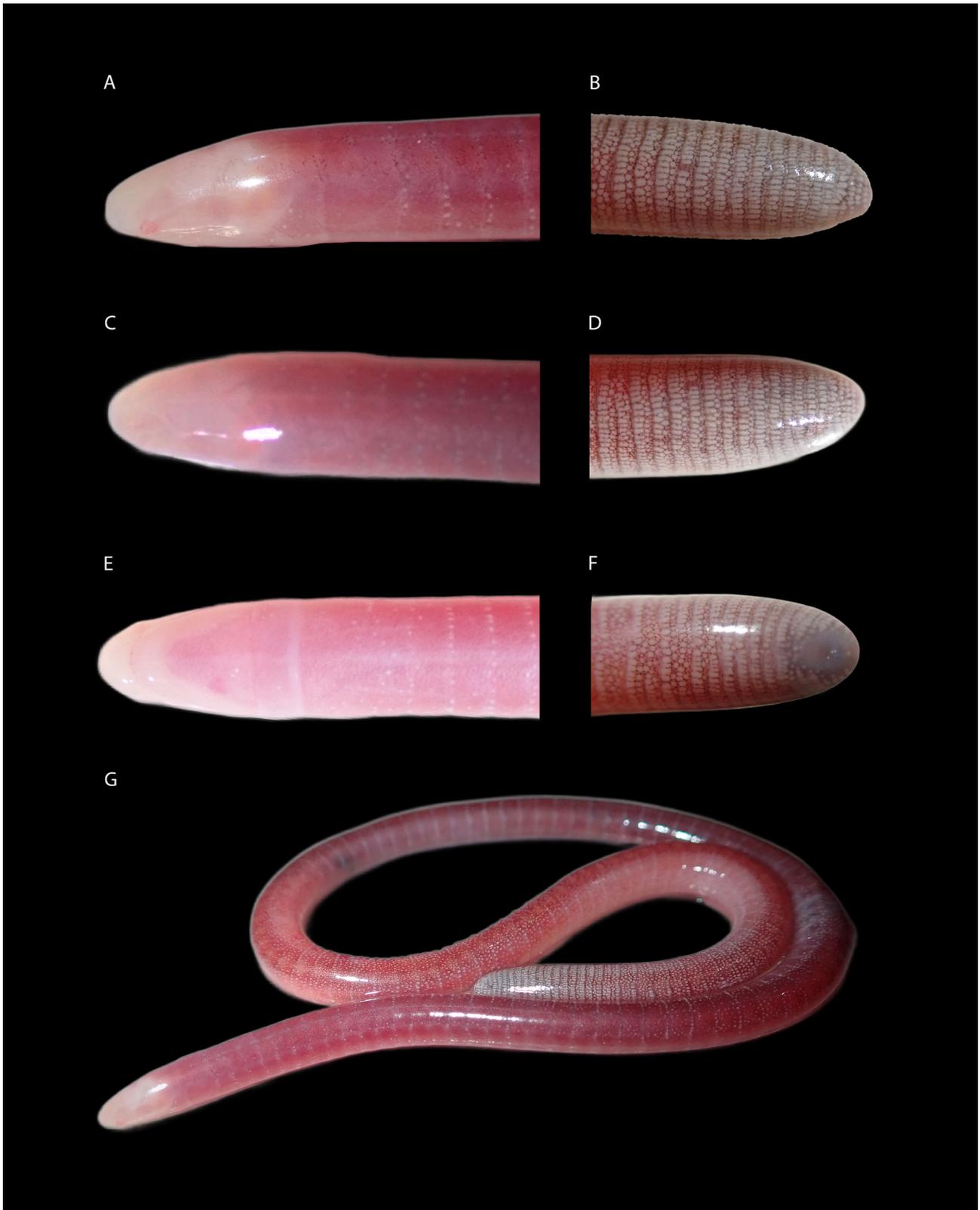


FIGURE 2. Holotype specimen (BNHS 6840) of *Gegeneophis bavali* **sp. nov.** in life. Head, collars and first few annuli in left dorsolateral (A), dorsal (C) and ventral (E) views, posterior end in left lateral (B), dorsal (D) and ventral (F) views, and whole animal (G). See Table 1 for dimensions. Photos by R. Kotharambath.

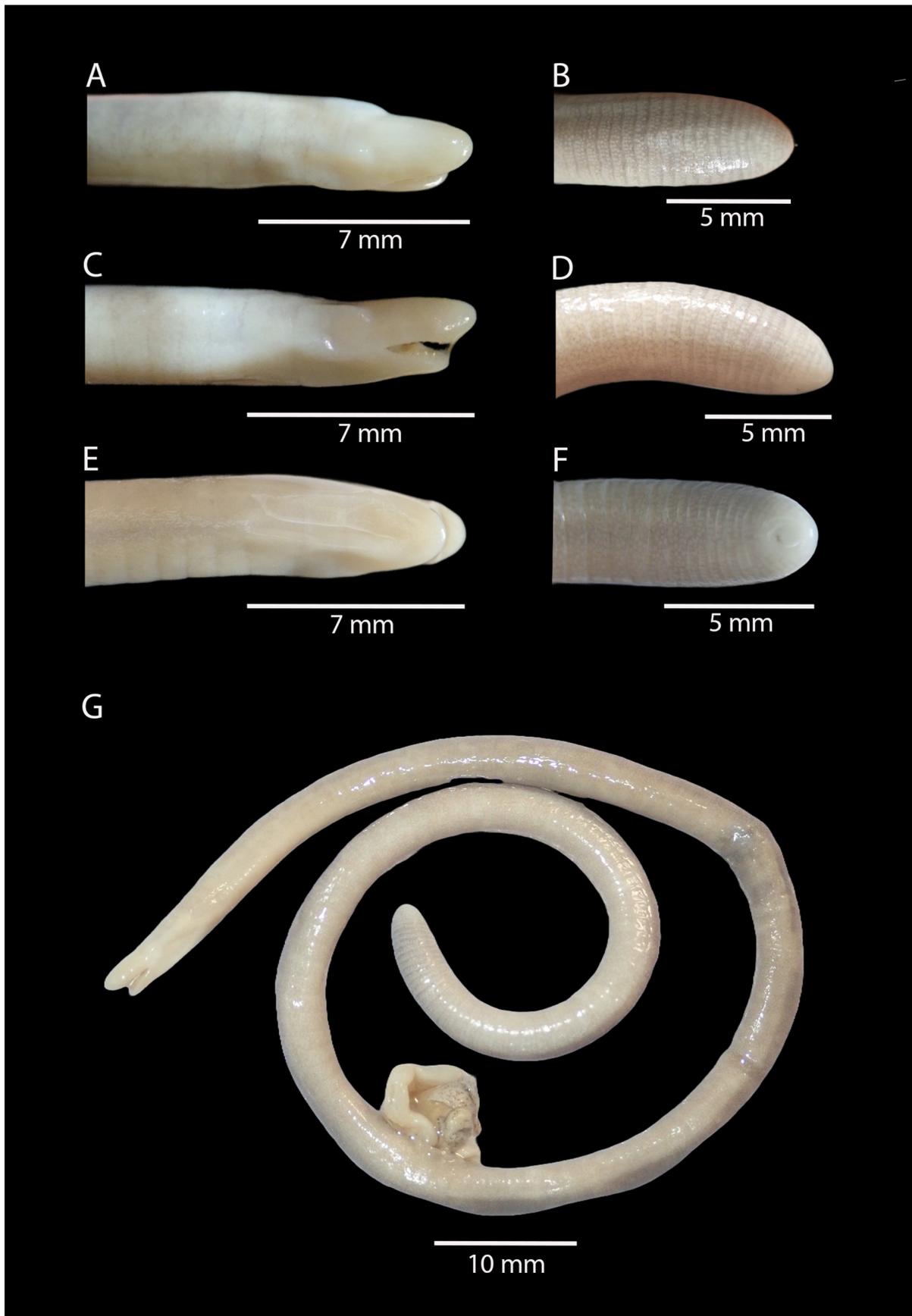


FIGURE 3. Preserved holotype (BNHS 6840) of *Gegeneophis bavali* **sp. nov.** Head, collars and first few annuli in dorsal (A), right lateral (C) and ventral (E) views, body terminus in dorsal (B), left lateral (D) and ventral (F) views, and whole body in dorsal view (G).

TABLE 1. Some morphometric (in mm) and meristic data for the holotype (BNHS 6840) and paratype (BNHS 6841) of *Gegeneophis bavali* **sp. nov.** Teeth of female holotype counted under dissecting microscope; teeth of male paratype counted from micro-CT data.

	BNHS 6840	BNHS 6841
Sex	f	m
Length	172	143
PAs	138	136
SAGs	11	13
First PA with dorsally complete SAG	127	126
PAs with ventrally complete SAGs	2 or 3	3
TGs on C1, C2	1,1	1,0
ST–NG1 dorsally	4.3	4.1
Length of C1 (N1–N2) laterally	1.3	1.0
Length of C2 (N2–N3) laterally	1.6	1.6
ST–CM	3.5	3.0
CM–N1	1.3	1.3
WH at NG1	3.5	3.0
WH at CM	3.1	2.7
N–N	1.4	1.0
TA–TA	2.2	1.9
N–TA	0.8	0.6
TA–L	0.6	0.4
N–L	0.8	0.6
N–CM	2.8	2.4
TA–ST	1.5	1.4
TA–CM	2	1.7
ST–AM	1.1	0.9
Width at midbody	3.7	3.6
Circumference	13	13
Width at level of vent	2.9	2.8
Vent–TT	1.4	1.3
Width of disc surrounding vent	1.5	1.2
Vent denticulations	12	12
PMs	22	21
VPs	16	21
OMs	14	16
IMs	4	4

No diastema between vomerine and palatine teeth; palate moderately concave transversely; tongue unattached anteriorly; narial plugs well developed; choanae subcircular, interchoanal distance approximately twice the width of each choana.

C1 and C2 approximately same width. C1 longer than first PA, not much shorter than (approximately 2/3 length of) C2. NG1 faint, more evident laterally, complete ventrally and dorsally. NG2 conspicuous, complete. NG3 as clear as NG2, very faint and widely incomplete ventrally. Dorsal margins of NG2 pigmented dorsolaterally on both sides. All NGs orthoplicate, with no obvious curvature. Single TGs on both collars, that on C2 clear and longer, that on C1 very faint.

AGs generally faint, except posteriorly where well-marked on all sides; AGs complete; no substantial regional variation in lengths of PAs, except some slightly shorter immediately before vent. Each AG with single row of pale enlarged granular glands posterior to less conspicuous narrow dark band, less clear along the first few PAs.

First SAG visible dorsolaterally on 125th PA, middorsally complete from 127th PA, ventrally complete on 131st to 135th PAs. Posteriorly one row of scales dorsally in pocket as deep as length of PA. Scales are semicircular or oblong. Small terminal cap, approximately same length as one adjacent PA. Posteriormost AG approximately at the level of posterior margin of disc.

Terminus bluntly rounded, slightly more so than head; no terminal keel. Disc around vent fairly well circumscribed, subcircular, slightly wider than long, with 11 (eight posterior, three anterior) slightly irregular denticulations, posterior ones longer than those anterior; vent somewhat subcircular.

In life (Fig. 2), body distinctly pinkish, except posteriormost end moderately dark grey. Head notably pale, margins of some bones somewhat visible externally through translucent skin. Eyes not visible externally. In preservative (Fig. 3), body grey, paler anteriorly and ventrally, darker posteriorly. A thin, dark line along the body midventrally, less conspicuous along the posterior half. Head creamy whitish in colour, paler than adjacent body, no pigmentation anywhere on the head region, upper lip margin creamy, lower lip margin whitish, first collar more whitish than second, naris and TAs not particularly more whitish than the surrounding areas.

AGs mostly inconspicuous, except posteriorly where SAGs complete dorsally. TT whitish. Disc surrounding the vent whitish, numerous closely spaced glands present along the posterior margin. Five AGs interrupted by disc surrounding the vent. No AGs posterior to disc. No terminal shield.

Variation and additional information from paratype. Condition generally good, except for internal break of vertebral column at midbody. Male (phallosome partly everted) with c. 5.6 mm ventral incision into coelom c. 66 mm anterior to vent. No substantial difference from external morphology of holotype. Morphometric and meristic data in Table 1. Colour pattern same as holotype. Three and four bicusped premaxillary teeth on right and left halves, respectively; one replacement tooth present on each side. Maxillary with seven monocusped teeth on each side, one missing on left (empty socket is included in the total count); four teeth on right maxillary and one on left detached from sockets. Maxillary teeth become smaller towards posterior end of row. Ten and eleven vomeropalatine teeth (three or four on the vomer, seven on the palatine) on right and left halves, all monocusped, smaller posteriorly. Eight dentary and two inner mandibular teeth on each side, all monocusped. Inner mandibular medial teeth much larger. Dentary teeth, second and third from anterior largest.

Etymology. The specific epithet *bavali*, pronounced “baavali”, derives from the name of the Bavali River, which flows through the geographic area of the type locality. The name “Bavali” is believed to have originated from the Malayalam term “Vavu Bali” which refers to ritualistic offerings made to ancestors during the Vaishakha Mahotsavam at the Kottiyoor Shiva Temple held annually on the banks of the Bavali river. The type locality lies within one of the numerous feeder rivulets of a tributary in the Bavali catchment. Originating in the Brahmagiri slopes in Wayanad and fed by multiple tributaries, the Bavali flows westward, eventually discharging into the Arabian Sea as the Valapattanam River. For nomenclatural purposes the specific epithet is considered a noun in apposition.

Suggested vernacular name. Bavali Gegeneophis or Bavali Geg (English), ബാവലി ഗെഗെനിയോഫിസ് (Malayalam).

Distribution, Natural History and Conservation Status. *Gegeneophis bavali* **sp. nov.** is currently known only from its type locality. The site lies within an undulating landscape dominated by terraced plantations interspersed with streams and rivulets, predominantly cultivated with rubber and coconut. The immediate habitat consists of a small, actively managed mixed terraced plantation composed of coconut trees and various domesticated fruiting trees, bordered on the western elevated side by a rubber plantation (Fig. 4). A minor tributary, averaging 3 m in channel width, flows along the northern boundary of the collection site.

The precise collection location was at an elevation of 332 m and exhibited the following microhabitat characteristics: 87% canopy cover, 90% ground vegetation, 40 mm humus layer, 40% leaf litter surface coverage, a sandy clay loam soil (determined using the hand texturing method of, e.g., Dubbin 2001) with penetrability of 0.5 kg/cm², pH of 6.7, and soil temperature of 25.6 °C. Sampling (digging) effort at the site comprised two person-hours, resulting in a search area of 24.5 m². The specimens were found in moist soil, approximately 2m apart. Our fieldwork of c. 60 person-hours within a c. 30 km radius of the type locality did not yield in additional localities or specimens of *Gegeneophis bavali* **sp. nov.**

Gegeneophis bavalis **sp. nov.** is known only from two specimens from a single locality. Although it appears to tolerate some low-intensity agriculture at this locality, very little is known of its general ecology and nothing of its reproductive biology, and it is likely to qualify as ‘Data Deficient’ under IUCN Red List criteria.



FIGURE 4. Habitat at the type locality of *Gegeneophis bavalis* **sp. nov.** (photographed in January 2026). Note that the habitat in the photograph is drier than when the type specimens were collected in October 2021.

Key to the identification of species of *Gegeneophis*

The most-recently published key to the species of *Gegeneophis* was presented by Giri *et al.* (2003) for the then six recognised species. Since then, 10 additional species have been described (including *G. bavalis* **sp. nov.**), one species (*G. fulleri*) transferred to a different genus (*Chikila*: Kamei *et al.* 2012), and one species, *G. nadkarnii*, considered a junior subjective synonym of *G. danieli* (Gower *et al.* 2013). The key is based largely on (mostly external) morphology, but geographical information is also included to distinguish *G. pareshi* and *G. valmiki* because these two species have slightly overlapping numbers of primary annuli (Giri *et al.* 2016; Dinesh *et al.* 2025).

1	Primary annuli lacking secondary annular grooves	2
-	Some primary annuli with secondary annular grooves	4
2	Unsegmented terminal shield absent; < 120 primary annuli	<i>G. primus</i>
-	Unsegmented terminal shield present; > 120 primary annuli	3
3	Primary annuli < 130	<i>G. seshachari</i>
-	Primary annuli 145–150, South Goa, ca. 15° N.	<i>G. pareshi</i>
-	Primary annuli 137–145, Maharashtra, ca 17.7° N	<i>G. valmiki</i>
4	Primary annuli > 135	<i>G. bavalis</i> sp. nov.
-	Primary annuli < 135.	5
5	Primary annuli < 115	6
-	Primary annuli > 115	7
6	All teeth bicusped; central Eastern Ghats distribution; anteriormost secondary annular grooves occurring 6–10 primary annuli from terminus.	<i>G. orientalis</i>
-	Some (some premaxillary-maxillary and most outer mandibular) teeth monocusped; southern Western Ghats distribution; anteriormost secondary annular grooves occurring 7–17 primary annuli from terminus	<i>G. ramaswamii</i>
7	Primary annuli bearing secondary annular grooves > 50.	8
-	Primary annuli bearing secondary annular grooves < 50.	9
8	Primary annuli < 120	<i>G. danieli</i>
-	Primary annuli > 120	<i>G. goaensis</i>
9	Primary annuli > 124	10
-	Primary annuli < 124	11
10	Primary annuli 125–131, 18–28 of which bear secondary annular groove	<i>G. tejaswini</i>
-	Primary annuli 125–127, 13–15 of which bear secondary annular grooves.	<i>G. krishni</i>
11	Primary annuli < 100	<i>G. madhavai</i>

-	Primary annuli > 110	12
12	Primary annuli bearing secondary annular grooves > 25.....	<i>G. mhadeiensis</i>
-	Primary annuli bearing secondary annular grooves < 25.....	<i>G. carnosus</i>

Discussion

The description of *G. bavali* **sp. nov.** brings the total number of species in the genus to 14. *Gegeneophis bavali* **sp. nov.** is the fourth species in the genus recorded from northern Kerala, alongside *G. primus*, *G. tejaswini* and *G. carnosus*. Those three latter species are closely related within *Gegeneophis* (Gower *et al.* 2011). *Gegeneophis bavali* **sp. nov.** is at least superficially similar to *G. tejaswini* in being largely unpigmented, attenuate and having >124 primary annuli. However, profound attenuation and high numbers of primary annuli appear to be homoplastic within the genus (occurring, for example, also in *G. krishni*, *G. goaensis* and *G. mhadeiensis* among those species that have SAGs), such that molecular and/or additional anatomical data are required to more thoroughly assess the new species' phylogenetic relationships. Although phylogenetic relationships within *Gegeneophis* based on DNA sequence data remain incompletely resolved there are some biogeographic and morphological patterns (Gower *et al.* 2011, 2016), and we consider it likely that *G. bavali* **sp. nov.** lies outside of the clade (Clade P of Gower *et al.* 2011) comprising those more pigmented species with SAGs and whitish annular grooves that are restricted to the more northerly part of the range of the genus, in northern Karnataka, Goa and Maharashtra.

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