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A NEW SPECIES OF *URAEOTYPHLUS* (AMPHIBIA: GYMNOPHIONA: URAEOTYPHLIDAE) OF THE *MALABARICUS* GROUP

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Abstract: A new species of *Uraeotyphlus* (Amphibia: Gymnophiona: Uraeotyphlidae) of the *malabaricus* group is described from a type series of 21 specimens from the Western Ghats of southernmost Tamil Nadu, peninsular India. Three additional specimens are referred to the species. The new species differs from other species of the *malabaricus* group in its combination of total number of annuli, length of the tail (as measured by number of post-anal annuli), and numbers of teeth. By virtue of its sample size and precise locality data, the new species represents the best-known member of the recently described but poorly-known *malabaricus*-group of *Uraeotyphlus*. The *malabaricus* group likely includes additional unrecognized species, but increased sample sizes and better locality data are required to assist the interpretation of available material.

Key words: Caecilians; Herpetology; India; Systematics; Western Ghats

The caecilian amphibian (Gymnophiona) genus *Uraeotyphlus* Peters, 1879 is endemic to the Western Ghats region of peninsular India (e.g., Gower and Wilkinson, 2007; Pillai and Ravichandran, 1999; Wilkinson and Nussbaum, 2006). Its suprageneric classification has varied (Duellman and Trueb, 1986; Frost et al., 2006; Lescure et al., 1986; Nussbaum, 1979; Taylor, 1968). Here we follow Wilkinson and Nussbaum (2006) in recognising a monogeneric Uraeotyphlidae and in using the rankless Diatriata for the clade (= Ichthyophiidae of Frost et al., 2006) comprising the Uraeotyphlidae + Ichthyophiidae sensu stricto. Gower and Wilkinson (2007) recently partitioned the six nominate species into two groups, the *malabaricus*-group species with *U. malabaricus* (Beddome, 1870) and *U. oommeni* Gower and Wilkinson, 2007, and the *oxyurus*-group species with *U. interruptus* Pillai and Ravichandran, 1999, *U. menoni* Annandale, 1913, U. *narayani* Seshachar, 1939, and *U. oxyurus* (Duméril and Bibron, 1841). The principal distinguishing feature of these species groups is their annulation. Whereas *oxyurus*-group species have primary annuli that are congruent with trunk myomeres and secondary annuli that are distinguishable from primary annuli, at least anteriorly, the annuli of *malabaricus*-group species are not congruent with trunk myomeres, and there is no external differentiation between primary and other annuli, at least in metamorphosed individuals. Each of the two *malabaricus*-group species is currently known with certainty from only a single specimen (see Discussion). Here we describe a new *malabaricus*-group *Uraeotyphlus* species on the basis of 21 specimens from the southern end of the Western Ghats region of peninsular India. This new material lends further support to the partition of *Uraeotyphlus*, and substantially improves knowledge of the *malabaricus* group.

Species Description

Uraeotyphlus **gansi** *sp. nov.*
(Figs. 1–4, Tables 1, 2)

Uraeotyphlus malabaricus (Beddome, 1870) in part; Boulenger (1882:92)

Uraeotyphlus malabaricus (Beddome, 1870) in part; Taylor (1968:697–700)

Uraeotyphlus malabaricus (Beddome, 1870) in part; Pillai and Ravichandran (1999:64–66, fig. 31, map VIII)

Uraeotyphlus oxyurus (Duméril and Bibron, 1841) in part; Pillai and Ravichandran (1999:74–77, map IX)

Holotype.—Bombay Natural History Society, Mumbai, India (BNHS) 4615, adult male, collected at the end of Nalumukku tea estate

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TABLE 1.—Some meristic and morphometric data for the holotype (*), paratypes, and three referred specimens (†) of *Uraeotyphlus gansi* nov. sp. Tail annuli = number of annuli between posterior of vent and tip of tail, including terminal cap; vent annuli = number of annuli interrupted by vent; ant. = anterior; C = circumference; DB = distance between…; D = along dorsal surface; f = female; Grvs = grooves; L = laterally; m = male; ST = snout tip; TL = total length; L = length; JA = jaw angle; O = occiput (first collar groove); V = ventrally; W = width; ‡ = 4 teeth on left, 0 on right. Fresh TL measured with a piece of thread and a ruler; preserved TL with a ruler. Other measurements made with a pair of callipers. Values in parentheses from Pillai and Ravichandran (1999), values in square brackets from Taylor (1968).

Specimen	* BNHS 4615	BNHS 4616	BNHS 4617	BNHS 4618	BNHS 4619	BNHS 4620	BNHS 4621	BNHS 4622	BNHS 4623	UMMZ 238,312	UMMZ 238,313	BNHS 4624	BNHS 4625	BNHS 4626	BNHS 4627	BNHS 4628	BNHS 4629	BNHS 4630	BNHS 4631	BNHS 4632	BNHS 4633	† ZSIM VAG 13	† ZSIM VAG 16	† BMNH 82.12.12.14
Sex	m	m	m	m	m	m	m	m	m	m	f	f	f	f	f	f	f	f	f	f	f			f
Vertebrae										108	107													103
Annuli	248	267	245	229	263	258	275	274	256	249	260	268	270	240	238	259	244	254	246	252	251	250 (247)	240 (243)	245 [246]
Annuli (D)	253			242		261											251							
Annuli (V)	244			224		256		264									243							
Annuli (L)																	244							
Grvs on collar 2	3	1	1	3	2	1	1	2	3	3	2	2	3	4	2	4	2	1	4	3	1	2	0	1
V complete annular grvs ant. to vent	49	27	21	16	37	45	33	29	41	13	8	37	35	17	49	24	24	41	33	57	22	16	23	41
Tail annuli	2	1	2	2	2.5	2	2	2	2	1	1	1	2	1	1.5	2	3	2	1.5	3	1	1	1	3
Vent annuli	5	5.5	4.5	5	4.5	4.5	5	5	5	5.5	5.5	5	5	4.5	4.5	4.5	4.5	4.5	5	5	4.5			5.5
TL (fresh)		192		216	177	168									238						212			
TL (preserved)	218	179	193	207	165	163	197	283	250	213	201	232	191	191	218	212	186	187	180	174	185	246	178	230 [231]
Tail L	3.4	2.2	2.6	2.5	2	2.3	2.3	2.3	3	2.3	2.2	2.9	2.5	2.6	3.2	2.2	2.2	2.4	2.5	2.5	2	2.4	2.6	2.3 [2.35]
Head L to JA	6.5	5	5.2	6.1	4.8	4.5	6.2	8.1	7.1	6.6	6	6.8	5.2	5.3	6.1	5.5	5.3	5.4	5.2	5.2	5.4	6.6	4.7	
Mandible L to JA	5.6	4.3	4.5	5	3.6	3.7	5.1	6.9	5.8	5.6	5.1	5.7	4.1	3.7	4.9	4.8	4.3	4.4	4.1	4	4.6	5.8	3.3	
Head L to O	8.6	7.4	7.7	8.7	6.6	6.6	7.7	10.6	9.3	8.5	7.8	9.3	7.5	7.2	8.9	8.3	7.2	7.6	7.3	7.2	7.5	9.2	6.7	
Collars L	5	4.5	5.1	5.8	4.5	4	6.5	7.8	6.1	5	4.5	6.2	5.1	5.2	6.2	6.1	4.8	4.7	4.2	5.1	4.1	5.8	3.8	
Head W at JA	6.1	4.4	4.9	5.3	3.9	4.2	5.3	6.6	5.9	5	4.8	5.5	4.7	4.3	5.4	5.4	4.7	4.7	4.3	4.1	4.4	5.7	3.6	
Head W at O	6.9	5.3	5.9	5.9	4.6	4.8	6.2	7.1	7.3	5.4	5.5	6.5	5.7	5.3	6.4	6.7	5.6	5.5	5	4.9	5.3	6.4	4	
Snout projection	1.6	1.2	1.5	1.3	1	1.2	1.5	1.5	1.5	1.5	1.5	1.5	1.3	1.3	1.4	1.6	1.3	1.4	1.3	1.3	1.3	1.4	0.9	
DB ST-midline between eyes	4	3.1	3.7	4.2	3.2	2.8	3.6	4.7	4	3.6	3.8	3.9	3.2	3.1	3.9	3.8	3.1	3.4	3.2	3	3.5			
DB eye-ST	4.9	3.6	4.1	4.3	3.5	3.2	4.2	5.2	4.8			4.4	3.7	3.4	4.4	4.3	3.7	3.9	3.7	3.4	3.9	4.3	3	
DB nares	2	1.5	1.6	2	1.5	1.5	1.9	2.6	1.9	1.8	1.8	2	1.6	1.6	1.9	1.9	1.5	1.7	1.5	1.6	1.6	1.9	1.4	
DB eyes	3.7	3.1	2.9	3.3	2.6	2.5	3.3	4.2	3.6	3.3	3	3.3	3	2.8	3.4	3.3	2.9	3	2.8	2.7	2.8	3.6	2.6	
DB eye-naris	3.2	2.6	2.8	3.1	2.3	2.2	2.8	3.6	3.1	2.9	2.4	2.9	2.5	2.1	3	2.9	2.3	2.6	2.5	2.4	2.8	3.3	2.3	
DB eye-mouth	1	0.8	1	1	0.7	0.7	0.9	1.3	0.9	0.9	1	0.9	0.7	0.7	1	1	0.9	0.8	0.9	0.5	0.9	0.8	0.7	
DB eye-tentacle	3.5	2.7	3.1	3.2	2.3	2.4	3.2	4	3.3	3.2	3	3.2	2.9	2.5	3.2	3.1	2.6	2.8	2.6	2.5	3	3.6	2.5	
DB naris-tentacle	1.1	0.7	0.9	0.9	0.8	0.6	0.9	1	1	1	1.1	0.9	0.9	0.8	0.8	1	0.7	0.8	0.8	0.7	0.7	1	0.8	
DB tentacles	3.1	1.8	1.9	2.3	1.8	1.6	2	3.2	2.9	2.4	2.3	2.9	2.1	1.9	2.4	2.5	1.8	2.1	2.2	1.9	2.2	2.5	1.9	
DB tentacle-mouth	1	0.7	0.8	0.8	0.6	0.6	0.8	1	1.1			0.9	0.8	0.9	0.8	1.1	0.9	0.7	0.9	0.7	0.7			
DB tentacle-ST	1.9	1.3	1.5	1.4	1.2	1.1	1.7	1.9	1.9			2	1.2	1.3	1.8	1.7	1.4	1.5	1.4	1.3	1.3			
DB eye-JA	2.1	1.6	1.2	1.9	1.7	1.3	1.8	2.9	2.7	2	2.2	2.7	1.7	1.7	2	1.8	1.5	1.4	1.7	1.5	1.8	1.9	1.6	

TABLE 1.—Continued.

Specimen	* BNHS 4615	BNHS 4616	BNHS 4617	BNHS 4618	BNHS 4619	BNHS 4620	BNHS 4621	BNHS 4622	BNHS 4623	UMMZ 238,312	UMMZ 238,313	BNHS 4624	BNHS 4625	BNHS 4626	BNHS 4627	BNHS 4628	BNHS 4629	BNHS 4630	BNHS 4631	BNHS 4632	BNHS 4633	† ZSIM VAG 13	† ZSIM VAG 16	† BMNH 82.12.12.14
DB naris-JA	5.1	4.5	4.2	5	4.2	3.4	4.7	6.7	6.1	4.8	4.8	5.9	4.4	4.5	4.9	4.6	4.1	4.4	4.3	4.2	4.8	5.1	3.4	
DB tentacle-JA	5	4.3	4.2	5	4.1	3.4	4.7	6.4	5.8	4.8	5.1	5.6	4.4	4	4.8	4.4	4	4.3	4.3	4.1	4.7	4.9	3.6	
Midbody W	7.7	8	8.4	9	6.6	5.4	7.9	9.3	8.4	6	6.9	8	7.4	7.7	8.6	8.8	7.9	6.4	7	5	8.3	8.6	6.7	7.2 [8]
W at ant. of vent	4.9	3.8	4.3	4.7	3.8	3.2	4.2	3.6	4.9	3.7	4.4	4.6	3.7	4	5.3	4.8	4.4	4.1	3.7	3.1	3.7	4.7	3.3	4.1
C at 3rd collar grv	25	22	23	23	17	16	25	24	22			23	19	20	28	24	19	20	19	15	20			
C at midbody	27	29	27	28	22	18	28	29	28			28	25	25	33	30	25	22	22	20	27			24
C at 10 annuli ant. to vent	22	24	19	23	20	16	25	20	23			22	20	20	27	24	22	18	17	16	24			21
L vent disc	2.6	1.9	1.7	1.7	1.8	2.2		2.5	2.4			2.7	2.5	2.5	1.8	2	1.5	1.7	2	1.8	2.1			2.5
W vent disc	2.4	2	1.5	2.5	1.6	1.7		1.7	2			2.5	1.9	1.9	1.8	2.3	1.4	1.5	1.6	1.2	1.8			2
Premax/max teeth	28	29	29	28	29	29	29	32	27	25	26	30	29	28	30	28	27	28	31	26	28	30 (35)	31 (21)	25 [26]
Vomeropalatine teeth						32			30	25	29	37	35	30						28	33	31 (40)	27 (26)	30 [33]
Dentary teeth	27	28	26	23	28	27	26	28	24	24	24	31	28	26	26	26	25	25	27	25	26	29 (37)	25 (20)	23 [36]
Splenial teeth	8					8			9	9	6	9	8	7	10	8				8		10 (16)	9 (8)	4‡ [6]

towards Upper Kodayar (8° 33′ N, 77° 21′ E; 1265 m), in the environs of Kalakad-Mundanthurai Tiger Reserve, part of the Agasthiyamalai Biosphere Reserve, Tirunelveli District, Tamil Nadu State, India on 22 October 2006, by Albert and Naren Rajendran. Specimen collected during search for uropeltid snakes.

Paratypes.—BNHS 4616–4623 (8 males) and BNHS 4624–4633 (10 females), 22 October 2006; Museum of Zoology, University of Michigan, USA (UMMZ) 238312 (male), 238313 (female), 27 June 1989. All paratypes were collected from the immediate vicinity of the type locality, the BNHS specimens by A. and N. Rajendran and the UMMZ specimens (field data state 1420 m) by Carl Gans, C. Rajasundaram and A. Rajendran.

Referred material.—The Natural History Museum, London (BMNH) 82.12.12.14 from 'Malabar', Zoological Survey of India, Chennai, Tamil Nadu, India (ZSIM) 1059 (field number VAG 13) from Kalakad Wildlife Sanctuary (3 March 1985) and 1062 (VAG 16) from Kuliratti Estate, Kalakad Wildlife Sanctuary (26 Nov 1984).

Diagnosis.—A *malabaricus*-group *Uraeotyphlus* (sensu Gower and Wilkinson, 2007) differing from *U. malabaricus* in having fewer annuli (including the terminal cap) posterior to the vent (1–3, $\bar{x}$ = 1.8 for sample of 24 specimens versus 5 for sample of one) and fewer dentary (23–31 versus 35) and splenial (4–10 versus 14) teeth, and from *U. oommeni* in having many more annuli (238–275, $\bar{x}$ c. 254 versus c. 210).

Description of the holotype.—Morphometric and meristic data in Table 1. Mature male, based on presence of phallodeum and copulator loop (see Gower and Wilkinson, 2002). Condition fair, with few exceptions. Body in loose, dorsally flexed coil, with artefactual, midventral, longitudinal groove on second quarter of body. Narrow circumferential constriction about 25 mm posterior to snout. Mouth preserved open. Gingivae swollen, slightly damaged around vomeropalatine teeth. Several annular scale pockets open dorsally and ventrally (see below). Two longitudinal, left of midventral, ca. 15 mm incisions extend anteriorly from approximately 13 mm and 40 mm in front of body terminus.

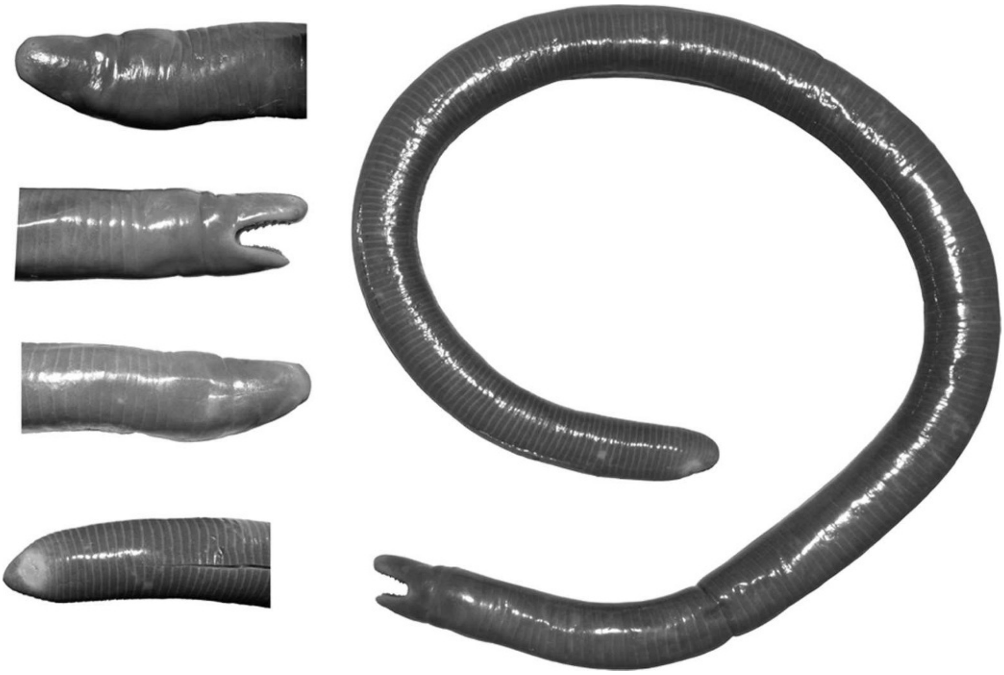

FIG. 1.—Photographs of holotype (BNHS 4615) of *Uraeotyphlus gansi* sp. nov. Images on left show detail of (from top to bottom) dorsal, right lateral, and ventral views of anterior end, and ventral view of posterior end. Image on right shows whole specimen in left lateral view. For dimensions see Table 1.

Vent/anus partly distorted, more tightly closed anteriorly than posteriorly.

Subcylindrical body fairly uniform, apart from gently tapering anterior quarter. Head in dorsal view tapers steadily to just in front of nares, sides very slightly convex, tapers abruptly in front of nostrils to broad, bluntly rounded tip; eyes slightly more than their diameters from sides of head, closer to first collar groove than snout tip; nares close to tip of snout, far from sides, marginally closer to sides than to midline.

In lateral view, upper lip distinctly arched, lower lip straight except for downturned anterior tip; top of head flat; distance from corner of mouth (jaw angle) to bottom of head (2 mm) more than half that from corner of mouth to top of head; eye slightly closer to lip than top of head; snout projects prominently beyond mouth, tip rounded; nares just in front of mouth; tentacles approximately halfway between snout tip and level of anterior margin of mouth. Slit-like tentacular apertures set in raised area, directly visible in lateral, ventral and anterior views, their position indicated by small bulges in dorsal view. In anterior view, tentacular apertures distinctly more lateral than nares. Eyes clearly visible through skin, not raised. Nares subcircular, small, substantially smaller than eyes. In ventral view, lower lips straight posterior to approximately semicircular chin tip; upper lip in slightly narrower arc than lower lip.

Teeth strongly recurved, not all readily visible; bicusped where ascertained; premaxillary-maxillary and dentary tooth crowns much larger and closer to edge of mouth laterally than anteriorly. Tooth size in outer rows increases gradually anteriorly (more abruptly in dentary row, last four teeth notably smaller than those preceding) before decreasing at anterior tip. Splenial teeth small, vomeropalatine teeth smaller. Posterior ends of splenial row subparallel, series tightly U-shaped. Narrow, pointed tip of tongue free. Tongue surface featureless macroscopically. Subtriangular choanae separated by distance about twice greater than transverse width of each choana. Choanae just anterior to eye level.

Collar region marginally thicker than anterior body. First nuchal groove (anteriormost, separating head from collar region) most distinct laterally and ventrolaterally, faintly indicated dorsally (within crease accentuated by preservation), fainter midventrally, perhaps narrowly incomplete. Second nuchal groove (between two collars) visible only ventrally. Measured ventrally, first (anterior) collar (2 mm) shorter than second (3.3 mm). Dorsal surface of posterior part of nuchal region bears three anteromedially flexed, subtransverse grooves; posteriormost groove middorsally complete, slightly more extensive on right, almost reaching lateral apex of collar; medial groove middorsally incomplete, offset, more extensive, approaching first annular groove proper at lateral apex of collar; anteriormost groove short, visible clearly only on left. Additional, very short, possibly artefactual transverse dorsal groove indicated at far anterior of nuchal region. Posteriormost nuchal groove (third = anterior groove of anteriormost annulus) narrowly incomplete midventrally, middorsally complete, anteriorly flexed.

No distinction between primary and other folds/rings/grooves. Some irregular merging of adjacent grooves along body; total annuli 248 (counted laterally), 253 (dorsally) or 244 (ventrally). Grooves are whitish shallow creases, more distinct ventrally. Middorsally, anteriormost annular grooves similarly spaced to grooves on back of nuchal region; anteromedially flexed, decreasingly so up to 20th annulus, otherwise approximately orthoplicate except posteriormost four grooves. Grooves very faint middorsally, occasionally narrowly incomplete on anteriormost quarter; posteriorly deeper, more conspicuous middorsally. Midventrally, grooves orthoplicate, generally narrowly incomplete, only last 50 consistently complete.

In dorsal view, terminus tapers for final 7 mm (ca. 11 annuli), ending in blunt tip. Tail and vent region slightly upturned. Annular grooves posterior to anal disc incomplete midventrally. Short terminal 'cap' almost twice as long as preceding annuli. One to 1.5 annuli between anus (vent) and terminal cap, anus approximately five annuli long. Vent/anus longitudinal, bilaterally symmetrical, six main denticulations on each side, one minor midline posterior denticulation. Disc subcircular, not raised, without papillae.

In preservation, dorsal surface dark gray with lilac tones, gradually grading to much paler gray-lilac ventrally. Several areas of head paler/off-white, including rings around eyes and nares, lips, tip (to beyond nares) and underside of snout plus broad irregular stripe extending back and enclosing lilac-gray tentacular bulges. Pale midventral line on chin and first collar. Body fairly uniform in color along length; whitish dots (glands) larger, more abundant ventrally than dorsally, especially anteriorly except along darker, narrow midline stripe where annular grooves incomplete. Cream/off-white disc paler than pale gray-lilac of terminus.

Scales sought at five points along body. None found in very shallow pocket of posteriormost transverse groove on second collar. Dorsolaterally at about 40th annulus behind collars, pocket of groove very shallow, less than a third of the interannular distance, no scales found in pockets of three consecutive grooves. At midbody, about three rows of oval (largest = 0.6 mm long) scales dorsally in pockets up to half an annulus deep. At 84th annular groove anterior to body terminus, three rows dorsally in pockets as deep as single annulus, scales here larger (1 mm × 0.6 mm) than those in two to three ventral rows (maximum 0.8 mm long) within pockets half as deep. Twenty annuli anterior to terminus, four rows of larger (1.5 × 1 mm) scales dorsally in pockets about 1.5 as deep as each annulus; three rows of smaller scales (1.2 × 0.5 mm) ventrally in pockets about one annulus deep.

Additional information from the 20 paratypes.—Meristic, morphometric data in Table 1. Mean total length of type series 201.4 mm; 11 females 174–232 mm ($\bar{x}$ = 196.1), 9 males 163–283 ($\bar{x}$ = 206.1; including holotype = 207.3). All specimens presumed metamorphosed, sex determinable from gonads. Two smallest specimens BNHS 4620 (right), BNHS 4632 (left) bear lateral (spiracle?) scars on collar region.

Head shape in dorsal view more pointed in smaller specimens, more broadly rounded anteriorly in larger specimens, more notably in males (Fig. 2). All teeth bicusped where checked. Some variation in extent of completeness of annular grooves along dorsal midline; mostly complete on only posterior third (BNHS 4622) or half of body (e.g., BNHS 4625, 26, 28) or complete along most of body (e.g., BNHS 4620, 30, 32). Squamation investigated in largest and smallest specimens (Table 2). No substantial variation in number of scale rows or distribution along the body, generally, at comparable positions along body, larger specimens have deeper scale pockets, occasionally an additional scale row, larger scales, scales distributed along more of body. As in other caecilians (e.g., Wake, 1970), length of anterior bladder lobe sexually dimorphic – longer in males (n = 5; extending anteriorly to >50–ca.80 annuli anterior to vent) than females (n = 4; 38–42 annuli anterior to vent).

Phallodeum.—Gower and Wilkinson (2002) described lumenal structures in the phallodeum of the *oxyurus*-group *U.* cf. *narayani* and *U.* cf. *oxyurus*, remarked that they were very similar to each other, and suggested that *U.* cf. *malabaricus* has a markedly different morphology. The morphology of the phallodeum of other *malabaricus*-group *Uraeotyphlus* is yet to be described, but that of *U. gansi* (UMMZ 238312, Fig. 3) is consistent with the recognition (Gower and Wilkinson, 2007) of two species groups within *Uraeotyphlus*. Terminology follows Gower and Wilkinson (2002).

The lumen of the phallodeum of UMMZ 238312 bears five (or six) longitudinal ridges in contrast to the seven observed in all those *oxyurus*-group species examined by Gower and Wilkinson (2002). UMMZ 238312 lacks a central, middorsal ridge, instead having only a pair of paramedian ridges. These can be homologized with the dorsolateral ridges in other species because the anterior end of each has a large central sulcus (longitudinal groove) that extends into a well-developed blind sac (partly separate distally from urodeum externally). Unlike the *oxyurus*-group species, the dorsolateral longitudinal ridges in *U. gansi* each bear three instead of two transverse thickenings (tuberosities). Of these, the anteriormost two are closer together, and the posterior one is largest. As in *oxyurus*-group species, a pair of lateral longitudinal ridges

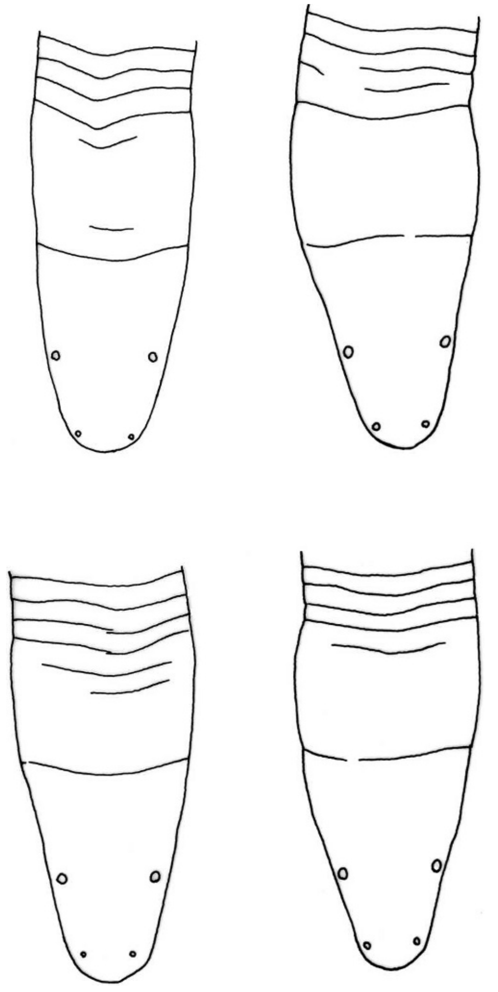

FIG. 2.—Outline figures of head and collar region of largest (left) and smallest (right) female (bottom) and male (top) paratypes of *Uraeotyphlus gansi* sp. nov. drawn to same size. Top left, female BNHS 4624 (TL = 232 mm); bottom left, female BNHS 4632 (TL = 174 mm); top right, male BNHS 4622 (TL = 283 mm); bottom right, male BNHS 4620 (TL = 163 mm).

flanking the dorsolateral ridges are weakly developed, each bearing a single transverse thickening (as opposed to two in the *oxyurus*-group species), this lying just anterior to the posteriormost thickenings on the dorsolateral longitudinal ridges. The *oxyurus*-group species have a pair of well-developed ventrolateral longitudinal ridges, each bearing a pair of transverse thickenings. In *U. gansi* there appears to be only a single, midventral ridge, but the incision into the phallodeal lumen of

TABLE 2.—Squamation in the holotype (*) and two paratypes of *Uraeotyphlus gansi*. For each entry, the values listed correspond to: depth of scale pocket in proportion to length of annulus; number of scale rows; dimensions of largest scales in mm. "—" indicates data not recorded.

	BNHS 4615*	BNHS 4622	BNHS 4620
Total length	218 mm	283 mm	163 mm
Dorsal collar grooves	Very shallow grooves, no scales	Very shallow grooves, no scales	Very shallow grooves, no scales
40th annulus, dorsally	Very shallow grooves, no scales	Very shallow grooves, no scales	Very shallow grooves, no scales
Midbody, dorsally	0.5; c.2; 0.6	0.25–0.33; c. 2; 0.7 × 0.3	Very shallow grooves, no scales
c. 84th annulus, dorsally	1; 3; 1 × 0.6	0.75; — ; 1.5 × 0.8	0.66; 3; 0.8 × 0.4
c. 84th annulus, ventrally	0.5; 2–3; 0.8	— ; 1–2; 0.5 × 0.3	— ; 1; 0.4 × 0.2
20th annulus anterior to vent, dorsally	1.5; 4; 1.5 × 1	1+; 3; 1.4 × 0.9	1+; 3; 0.8 × 0.7
20th annulus anterior to vent, ventrally	1; 3; 1.2 × 0.5	1; 3; 1.1 × 0.9	c.1; 3; 0.6 × 0.4

UMMZ 238312 passes along the length of this ridge making it difficult to completely rule out the possibility that this is actually a pair of closely opposed, poorly differentiated ventrolateral ridges, although we consider this less likely. The ventral ridge bears two transverse thickenings, positioned just anterior to the posteriormost and the central thickenings on the dorsolateral ridges. One other distinctive feature present in *U. gansi* but absent in the *oxyurus*-group species is a pair of fleshy lobes that project posteriorly into the lumen from close to the entrance to the blind sacs, adjacent to the base of the colliculus.

Trunk musculature.—Aspects of the trunk musculature were examined in BNHS 4621 via dissection. Nussbaum and Naylor (1982) found ichthyophiids to differ substantially from the *oxyurus*-group *U. narayani* only in the latter having congruent primary annuli and myomeres. *Uraeotyphlus gansi* differs from *U. narayani* in two of the nine characters scored by Nussbaum and Naylor (1982: table II)—in having incongruent myomeres and primary annuli (in which *U. gansi* resembles ichthyophiids and rhinatrematids) and in having a scalloped, paramedian rather than midventral origin of the ventral part of *M. subvertebralis* (resembling typhlonectids and the caeciliids *Caecilia* and *Oscaecilia* rather than any other uraeotyphlids or ichthyophiids). Thus, Gower and Wilkinson's (2007) prediction that *malabaricus*-group *Uraeotyphlus* have incongruent myomeres and primary annuli is confirmed here for *U. gansi*. BNHS 4621 has varying numbers of annuli per each 10 myomeres–26 anteriorly (from the 41st annulus back), 30 at midbody (107th annulus) and 26 annuli posteriorly (35 annuli anterior to body terminus). UMMZ 238312 has one more vertebra than UMMZ 238313 but about 10 fewer annuli (Table 1).

Color.—In life dark, lilac/slate gray, paler and more lilac ventrally. Chin, throat and parts of snout generally paler gray. Annular grooves paler lilac, but not as conspicuous as seems to be typical for *oxyurus*-group species. Disc surrounding vent off-white (pale lilac-gray).

Referred material.—BMNH 82.12.12.14 lacks precise locality data but agrees in morphometric and meristic characters with the type series (Table 1). It is not well preserved (see also Taylor, 1968:700), and the removal of some of the skin from the head suggests that it might have been the specimen examined by Parker (1927) for his observations of the skull of *U. malabaricus*. The two ZSIM specimens are referred rather than paratypic because they have been examined only briefly by two of us (DJG, MW) in August 2000 before the majority of the type material had been studied. These are from the same area as the type series—ZSIM 1059 is from an imprecise locality in "Kalakad Wildlife Sanctuary", and ZSIM 1062 from Kuliratti Estate, Kalakad-Mundanthurai Tiger Reserve, within 15 km of the type locality. The habitat

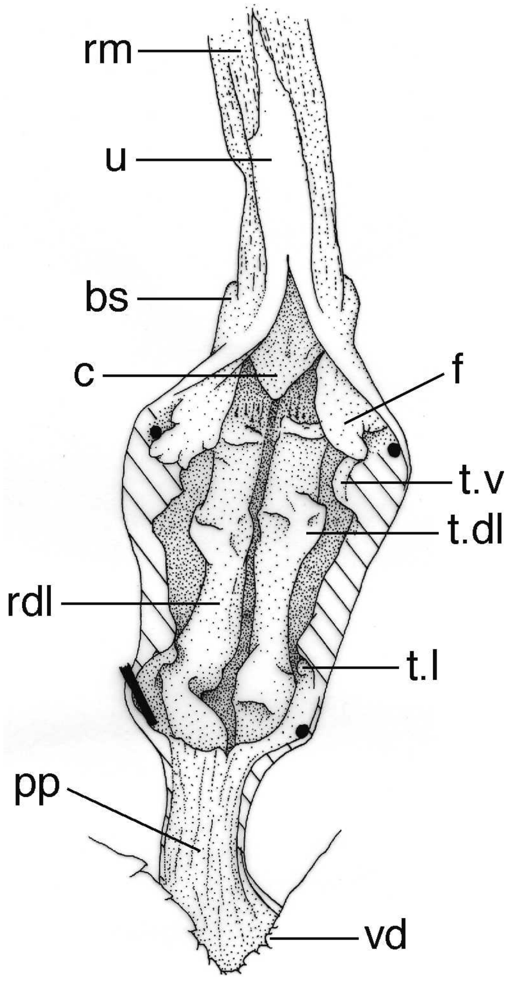

FIG. 3.—Phallodeum of paratype UMMZ 238312 of *Uraeotyphlus gansi* sp. nov. in ventral view (anterior to the top), based on camera lucida sketch. The cloaca has been cut open midventrally and pinned out to reveal the lumenal surface of the phallodeum and posteriormost part of the urodeum. Terminology follows Gower and Wilkinson (2002). Abbreviations: bs — blind sac; c — colliculus; f — fleshy lobe; pp — posterior part of phallodeum; rdl — right dorsolateral longitudinal ridge; rm — retractor muscle; t.dl — thickening/tuberosity on dorsolateral longitudinal ridge; t.l — thickening/tuberosity on lateral longitudinal ridge; t.v — thickening/tuberosity on ventral/ventrolateral longitudinal ridge; u — urodeum; vd — vent denticulations.

at the latter locality has more continuous, native evergreen vegetation than the type locality, but also has some abandoned clove and cardamom plantations. Pillai and Ravichandran (1999) misidentified ZSIM 1059 as *U. malabaricus* and ZSIM 1062 as *U. oxyurus*, and used the two specimens as the basis for their summary descriptions of these two species. Some of our data for these specimens (see Table 1) differ from those presented by these authors.

Etymology.—Named in honor of Carl Gans in recognition of his contributions to the biology of burrowing vertebrates, especially South Asian caecilians and burrowing snakes. Carl conducted fieldwork on uropeltid snakes in southern India in the 1970's and 1980's with Albert Rajendran and his father M. V. Rajendran, and he also accompanied Albert when two of the paratype specimens of *U. gansi* were collected in 1989. As a suggested 'common' name, we prefer "Gans's *Uraeotyphlus*".

Habitat and conservation biology.—The new species is known only from a small area. AR found this species often over the last 20 yr, especially frequently in the last two years while digging to find uropeltid snakes. Population densities of *U. gansi* have not been monitored, but there is no indication of decline. Land use in the region has not changed notably over the last few decades. The type series was collected only from disturbed habitats, but no dedicated searches in nearby forest were made to the best of our knowledge (although ZSIM 1059 may have been found in forest). Adult *U. gansi* can be found syntopically with the uropeltid snakes *Teretrurus sanguineus* and *Uropeltis liura*. Most of the type specimens of *U. gansi* were found within 20 cm of the surface (although deeper digging was not undertaken) in moist, loose, dark soil, and sometimes beneath rotting wood. Most searching was close to water, but some specimens (e.g., BNHS 4620, one of the small specimens bearing a possible spiracle scar) were found at least 60 m from any water source. Some specimens were collected from the immediate margins of cultivated tea, but no digging among tea bushes was undertaken. Other specimens were found in a former cardamom plantation now cleared so that there is no understory vegetation (other than very low herbaceous plants) beneath the original tree canopy. Based on what little is known of the life histories of other uraeotyphlids (Wilkinson, 1992), it might be predicted that *U. gansi* is oviparous and has a free-living larval stage. Nothing is known with certainty of the life

FIG. 4.—*Uraeotyphlus gansi* sp. nov. in life; paratype BNHS 4620 (male, total length 16 cm).

history of any *malabaricus*-group *Uraeotyphlus*, but possible spiracle scars on two paratypes suggest that *U. gansi* has a larval stage.

The type locality for *U. gansi* lies within tea estate land comprising 8000 acres leased for 99 yr to the Bombay Burma Trading Corporation Ltd. (BBTC) by the British Raj in 1929, when the primary forest was cleared. After 1929 some cardamom was planted to replace forest understory, and much of this has now been cleared and represents unexploited, 'recovering' forest that also supports *U. gansi*. The lease to BBTC is up in 2028, when the land will probably be returned to the local Tamil Nadu forest department and absorbed into the Kalakad-Mundanthurai Tiger Reserve. An evergreen forest corridor already exists near Kakachi and Nalumukku, joining the sanctuaries of Kalakad and Mundanthurai. Although very little is known of the biology of *U. gansi*, it clearly tolerates some human disturbance and agriculture, occurs in an area that is unlikely to undergo immediate habitat destruction, and occurs adjacent to and probably within protected areas, Furthermore, there is no evidence of current decline in populations or habitat, and thus the conservation status of *U. gansi* according to IUCN criteria could probably be "Least Concern", though this would be more confidently applied if additional localities could be discovered. All other described species of *Uraeotyphlus* are currently "Data Deficient" (Gower and Wilkinson, 2005; IUCN et al., 2006).

DISCUSSION

Our description of *Uraeotyphlus gansi* supports the recognition of at least two distinct species groups within *Uraeotyphlus* (Gower and Wilkinson, 2007) and increases the recognized diversity of the *malabaricus* group. Unlike the other two species of the *malabaricus* group (*U. malabaricus*, *U. oommeni*), *U. gansi* is known from multiple specimens and precise localities, and thus offers the best current opportunity for further understanding of the biology of this group. Gower and Wilkinson (2007) considered the possibility that *malabaricus*-group *Uraeotyphlus* are relatively rare and/or occur more at higher altitudes and/or in less disturbed habitats. The discovery of *U. gansi* is consistent with the hypothesis that *malabaricus*-group *Uraeotyphlus* are restricted to higher altitudes, and it can be relatively easy to find locally and does not appear to be rare. The type locality is at about the same altitude as the highest records for *oxyurus*-group *Uraeotyphlus* that we are aware of, those for *U.* cf. *oxyurus* from Valparai, Tamil Nadu (c. 1200 m; DJG, AR and MW, personal observations; O. V. Oommen, personal communication). That two specimens of *U. gansi* were previously (Pillai and Ravichandran, 1999) identified as two different species of *Uraeotyphlus*, one each from the two species groups recognized by Gower and Wilkinson (2007), demonstrates that uraeotyphlid taxonomy has been confused, and that the *oxyurus*-group species probably also require revision. One of the major changes in understanding of caecilian phylogeny in the last 20 yr has been the recognition that Ichthyophiidae and Uraeotyphlidae comprise a clade, Diatriata (Wilkinson and Nussbaum, 2006). This relationship was previously obscured by convergent similarities between teresomates and *oxyurus*-group *Uraeotyphlus*, and by the paucity of specimens of, publications on, and lack of recognition of the distinctness of the more ichthyophiid-like *malabaricus*-group *Uraeotyphlus*.

Distinguishing the posterior end of the nuchal collar region is problematic and potentially arbitrary in at least some species of *Uraeotyphlus*. Thus, we emphasize the importance of making descriptions of the collar region of uraeotyphlids that are sufficiently detailed as to allow precise comparisons with other published descriptions. Here we identified a groove as the third nuchal groove because it corresponds approximately to the back of the expanded collar region, and is also the anteriormost groove that clearly extends onto the ventral surface on both sides.

The literature contains references to further specimens of *malabaricus*-group *Uraeotyphlus*. In particular, Taylor (1968) discussed an additional five specimens that he referred to *U. malabaricus*. Of these, four held in the Natural History Museum, London (BMNH 82.12.12.14–17) are probably among those listed as *U. malabaricus* specimens "a–f" in Boulenger's (1882:92) catalogue. These are R. H. Beddome specimens, all from the imprecise locality of "Malabar" in the Western Ghats region of peninsular India (see Biju, 2001). The other specimen referred to *U. malabaricus* by Taylor (1961, 1968) is BNHS 15 (formerly 222; incorrectly reported as BNHS 19 by Pillai and Ravichandran, 1999) from Ootacamund in the Nilgiri Hills (>2000 m) of Tamil Nadu. We have not carried out detailed analyses of meristic and morphometric data. However, based on annular counts, tail length, tooth counts and head shape, and pending rediscovery and better understanding of *U. malabaricus*, only BMNH 82.12.12.17, of the Beddome specimens, can be tentatively assigned to *U. malabaricus*. This is fortunate because Taylor (1968) used this specimen, instead of the type, as the basis of his description of that species. BMNH 82.12.12.14 can be tentatively referred to *U. gansi*. BMNH 82.12.12.15 is probably an undescribed species, and BMNH 82.12.12.16 is most similar to *U. gansi* among described species, but has a substantially greater number of teeth. Taylor (1968: 699) concluded that, of the BMNH specimens, 82.12.12.14 was an outlier, differing "significantly from the others", but aside from numbers of teeth it is similar to 82.12.12.16. For us, 82.12.12.15 is the obvious outlier, having by far the fewest annuli (204 vs. 236–256). Pending further study, BNHS 15 is best considered to be *U.* cf. *malabaricus*. We now consider the specimen referred to *U.* cf. *malabaricus* by Gower et al. (2002) and Wilkinson et al. (2002) and figured by Gower and Wilkinson (2007: fig. 2B) to be *U.* cf. *oommeni*.

Although the taxonomy of available *malabaricus*-group specimens is not completely resolved, it is clear that BMNH 82.12.12.14–17 is a heterogeneous group representing at least three and possibly four different species, and that the *malabaricus* group is likely to be more speciose than currently recognized. We refrain from describing additional species from single specimens lacking good locality data at this time, Good samples with precise locality data, that enable additional morphological and molecular studies, are needed to clarify geographic variation and species limits within *malabaricus*-group *Uraeotyphlus*. Fruitful areas for new collections of *malabaricus*-group *Uraeotyphlus* are predicted to be the higher elevations of the Western Ghats South of 12° S, including the Nilgiri and Anamallai Hills.

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