

Further specimens of two rare mud snakes (Serpentes: Homalopsidae) of mainland Indian coasts: *Fordonia leucobalia* (Schlegel, 1837) and *Gerarda prevostiana* (Eydoux and Gervais, 1837), from premier Indian museums

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Citation: Mondal, S., Adhikari, O. D., Deuti, K. and Ganesh, S. R. (2025). Further specimens of two rare mud snakes (Serpentes: Homalopsidae) of mainland Indian coasts: *Fordonia leucobalia* (Schlegel, 1837) and *Gerarda prevostiana* (Eydoux and Gervais, 1837), from premier Indian museums. *Journal of Animal Diversity*, 7 (2): 1–9. <http://dx.doi.org/10.22034/JAD.2025.7.2.1>

Abstract

We report on two uncommon species of mud snakes of the mainland Indian coast, *Fordonia leucobalia* (n= 10) and *Gerarda prevostiana* (n= 24), based on historical and recent non-type specimens. We provide morphometric data on preserved voucher specimens stored in two of the major natural history museums of the country – the Bombay Natural History Society, Mumbai (BNHS) and the Zoological Survey of India, Kolkata (ZSI). In addition to providing vital information on intra-specific variation based on previously unreported specimens, this work provides precise collection records and point localities for these two uncommon species from Indian coastlines (n= 19)—which were previously lacking—and a few neighboring countries, viz. Myanmar (n= 10) and Singapore (n= 5).

Editor-in-Chief: Dr. Ali Gholamifard

Assistant Editor: Dr. Fred Kraus

Received: 20 March 2025

Revised: 20 May 2025

Accepted: 11 June 2025

Published online: 30 June 2025

Key words: Brackish-water snakes, distribution, morphology, salt-adapted species

Introduction

The Indian Peninsula's coastline is home to four species of brackish-water homalopsid snakes: *Cerberus rynchops* (Schneider, 1799), *Fordonia leucobalia* (Schlegel, 1837), *Gerarda prevostiana* (Eydoux and Gervais, 1837) and the endemic *Dieurostus dussumierii* (Duméril, Bibron and Duméril, 1854) (Whitaker and Captain, 2004; Ganesh et al., 2019). Apart from the widespread and diverse *Cerberus*, others are monotypic genera (Wallach et al., 2014; Boundy, 2020) and are barely well-studied (Murphy, 2007; Murphy and Voris, 2002). A unique feature is that both *Fordonia* and *Gerarda* are known for crab-ripping where the snakes bite and cut out body parts of freshly molted crabs to feed (Jayne et al., 2002, 2018; Nobbs and Blamires, 2004; Chen, 2010). For half a century following their

descriptions, there were no further reports of *F. leucobalia* and *G. prevostiana* from mainland Indian coasts (Gray, 1849; Duméril et al., 1854; Günther, 1864; Theobald, 1868a, b, 1876; Boulenger, 1890), with the closest reports coming from Bago (Myanmar) and Nicobar (Sundas). Only with Slater (1891) and Boulenger (1896) were there precise reports from Indian mainland coasts: *F. leucobalia* from Bengal and *G. prevostiana* from Bombay. Even some historical reports outside of mainland Indian localities were contentious, e.g., *F. leucobalia* in Nicobar (Das, 1999; Vijayakumar and David, 2006) and *G. prevostiana* in Manila (Cope 1862 vs. Günther, 1864; Slater, 1891; Boulenger, 1896).

Even in later years, very few Indian reports of these taxa came in. Acharji and Mukherjee (1966) reported

these snakes from lower Bengal, which could mean either today's West Bengal or Bangladesh. Gyi (1970) did not mention any Indian specimen of *F. leucobalia* and mentioned Indian specimens of *G. prevostiana* from Krusadai island in Coromandel Coast, as well as the Malabar and Konkan coasts. Ahmed and Dasgupta (1992) listed both *G. prevostiana* and *F. leucobalia* from Bengal, though they furnished specific accounts only for *G. prevostiana*. Vyas et al. (2013) reported *G. prevostiana* from Saurashtra Coast in the far west. Bag et al. (2018) reported on morphometrics of six voucher specimens of *G. prevostiana*. Vyas and Sethna (2022) reported on mysterious observations of dead *G. prevostiana* sighted in land-locked Mumbai suburbs. Recently, Murphy and Voris (2014) and Bernstein and Murphy (2024) stated the Indian distributions of *F. leucobalia* as Nicobar Islands and *G. prevostiana* as western India / Gujarat coast, thereby implicitly excluding India's eastern coast from their ranges. Uetz et al. (2025) included the Circar Coast population of *F. leucobalia* but listed only the western coast for *G. prevostiana*. Thus, these two rare monotypic genera have remained poorly known in terms of data from Indian populations. In this work, we elaborate on these two homalopsid species based on our examination of voucher materials in two major Indian repositories.

Material and Methods

We examined a total of 10 specimens of *Fordonia leucobalia* and 24 specimens of *Gerarda prevostiana* in the Bombay Natural History Society, Mumbai (BNHS) and the Zoological Survey of India, Kolkata (ZSI), collected between 1907 and 2014. All materials examined here are non-types, with respect to prevailing or synonymized nomina. Taxonomic definitions, synonymy and (Indian) distribution limits of both study species follow Whitaker and Captain (2004), Wallach et al. (2014) and Boundy (2020). Morphological diagnoses are as follows: *Fordonia* has as many as 25–27 (rarely 29) midbody dorsal scale rows; internasal produced posteriorly, partially dividing prefrontals; loreal absent; 3rd supralabial entering the orbit; and ventral color pattern uniform or dirty grey. In contrast, *Gerarda* has only 17 midbody dorsal scale rows; internasal truncate posteriorly, not partially dividing prefrontals; loreal present; 4th supralabial entering the orbit; and ventral color pattern of each scale with a distinct black outline (Whitaker and Captain, 2004; Wallach et al., 2014; Ganesh et al., 2019; Boundy, 2020). Both these genera are easily recognizable from the other syntopic homalopsid, *Cerberus rynchops* (Schneider, 1799), which has rough-keeled scales on the dorsum, nasals not separated by an internasal, partially divided parietal scales, and an alternating black-and-white-blotched ventral color pattern, all of which are absent in *Fordonia* and *Gerarda* (Whitaker and Captain, 2004). We scored over 20 standard morphometric, scalational and color-pattern characters from each specimen. Terminologies and nomenclature for measurement and

scalation characters follow Smith (1943) and Whitaker and Captain (2004). Ventral scales were counted following Dowling (1951). Sex of specimens was determined by probing for hemipenes using a standard snake sex-probe or by examining the tail base of adequately well-preserved specimens, looking for the distinctive bulge in the tail base indicative of males. Dissection of tail base to look for hemipenis or sexual ducts could not be done owing to museum restrictions discouraging such potentially invasive procedures. In some cases, in which the specimen was in suboptimal condition, sex was noted as given in museum ledgers or jar labels or was left as unknown. All measurements were taken to the nearest 0.1 mm using vernier slide calipers and trunk length and tail length, were measured to the nearest 1.0 mm with a standard measuring tape. Color notes were taken by directly examining preserved specimens or from photographs thereof. Specimens were photographed using high-resolution digital cameras.

Taxonomic accounts

Fordonia leucobalia (Schlegel, 1837)

(Figs. 1, 2, 3)

Taxonomic history

This species was originally described as *Homalopsis leucobalia* by Schlegel (1837) based on RMNH 1161 [Rijksmuseum van Natuurlijke Historie, Netherlands], a female, collected by H. C. Macklot and S. Müller, 1825–1832, from Timor, currently Indonesia. Iskander and Colijn (2001) designated this specimen as the lectotype (Wallach et al., 2014). Some literature (Murphy and Voris, 2014; Uetz et al., 2025) claim RMNH 1161 to be the holotype and this remains contentious. The genus *Fordonia* was first described by Gray (1842) to contain this species, and Duméril et al. (1854) described the genus *Hemiodontus* for the same purpose. Currently, as many as five subjective junior synonyms are known for this species (Boulenger, 1890, 1896; Smith, 1943; Wallach et al., 2014): *Fordonia unicolor* Gray, 1849 (type locality Borneo), *Hemiodontus chalybaeus* Jan, 1863 (type locality unknown), *Fordonia bicolor* Theobald, 1868a (type locality Myanmar), *Fordonia papuensis* Macleay, 1877 (type locality Papua New Guinea) and *Fordonia variabilis* Macleay, 1878 (type locality Australia).

Material examined (n= 10)

INDIA: ZSI 8441 female collected by H. J. Harrison from Sundarbans, Calcutta; ZSI 27212 male collected by S. K. Dutta in 2002 from Digha, West Bengal; SINGAPORE: ZSI 13314 female, Raffles Museum exchange; ZSI 12085 male collected by T. S. Gardiner; ZSI 8185, 8186 males, 8741 subadult, collector, date and locality unknown; MYANMAR: BNHS 2071, 2702 collected by F. Wall, G. H. Evans on 31-xii-1907 both from Moulmein; BNHS 2073 collected by F. Wall and G. H. Evans on 02-vii-1908 from Watin.

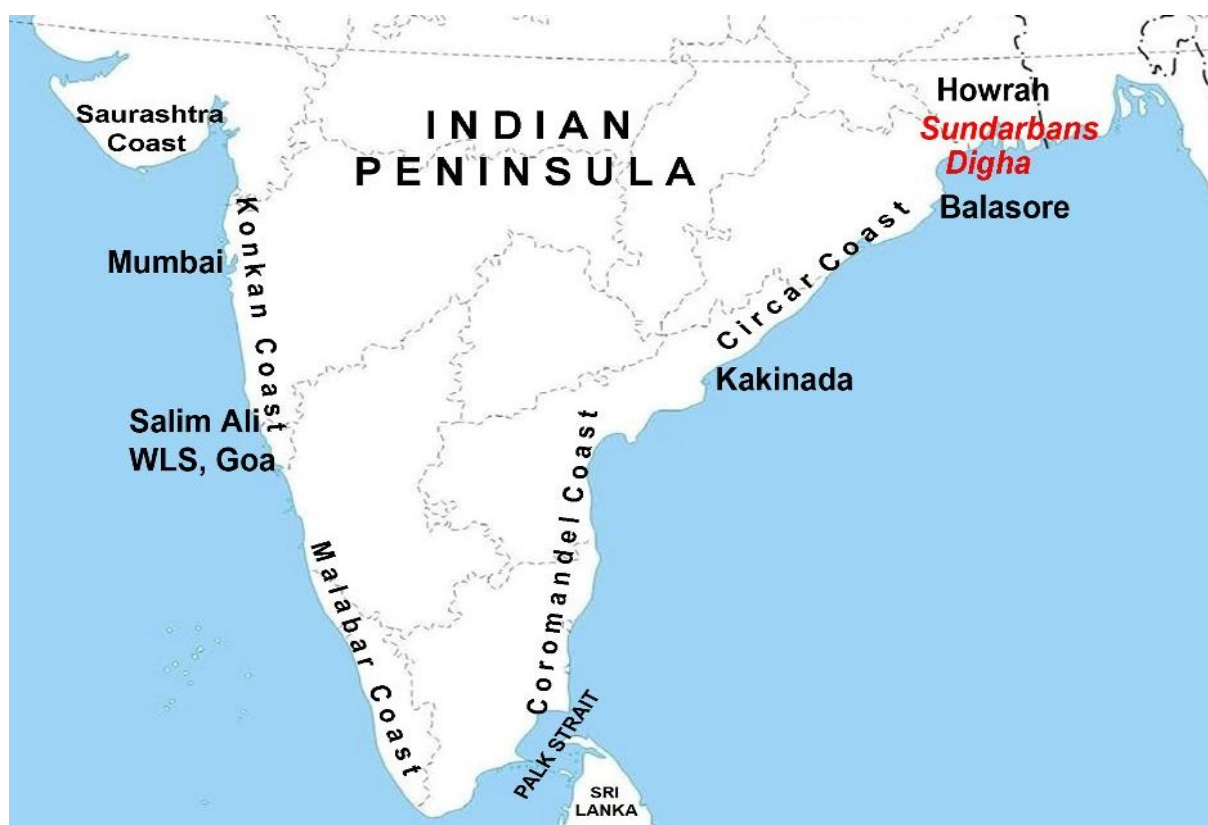


Figure 1: Map of Peninsular Indian coastline showing the specimen-based records of *Fordonia leucobalia* (red text) and *Gerarda prevostiana* (black text) records, discussed in the text.

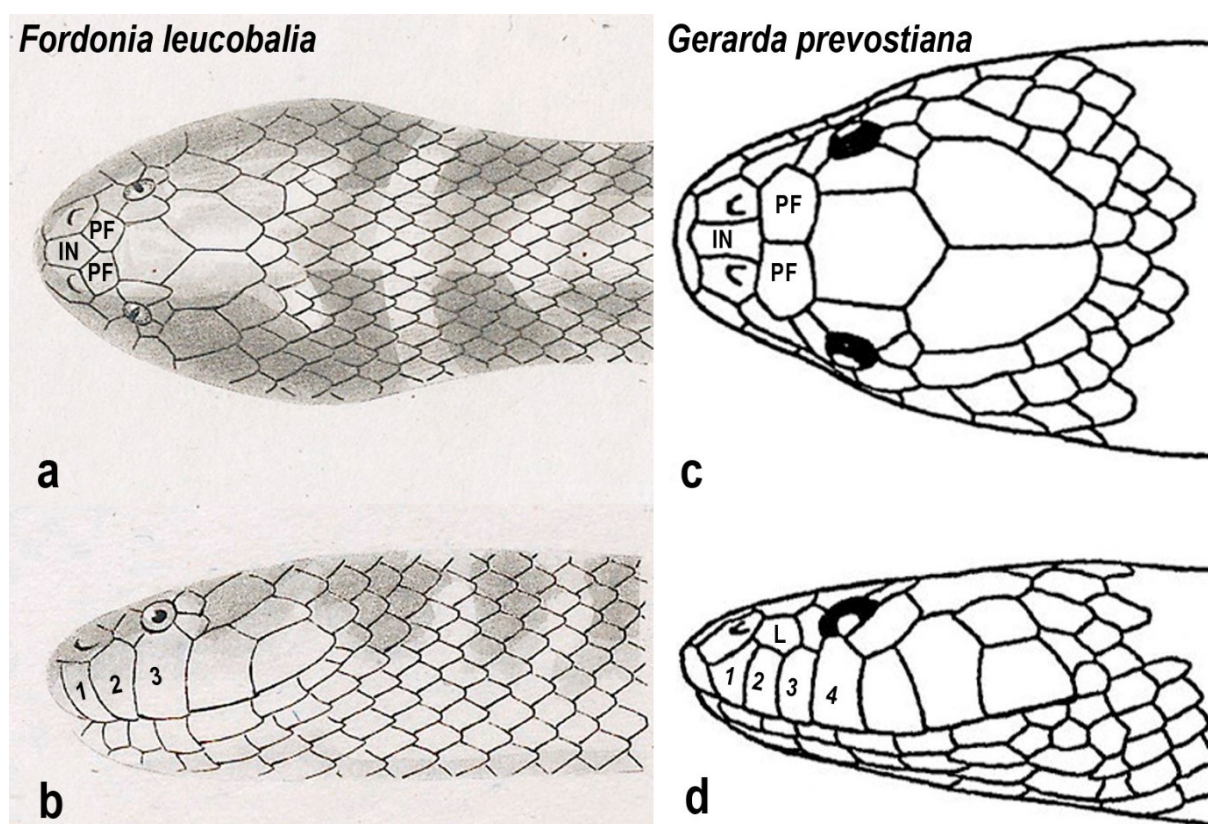


Figure 2: Reproductions of drawings of head dorsal and lateral views of *Fordonia leucobalia* (modified from Schlegel, 1837) showing a: internasal produced posteriorly partially dividing prefrontals; b: 3rd supralabial touching eye, and absence of loreal scale; *Gerarda prevostiana* (modified from Smith, 1943) showing c: internasal truncate posteriorly not partially dividing prefrontals; d: 4th supralabial touching eye, and presence of loreal scale.



Figure 3: *Fordonia leucobalia* from India; top row- BNHS 2073; middle row- ZSI 27212; bottom two rows- ZMUC-R62138–9; Zoological Museum University of Copenhagen; photo: D. K. Johansson.

Description and variation

Head short, not distinct from neck, head shields large, regular; rostral broader than high; nasal on top of the head than on lateral side, slightly elongated; nostril opening at the center of the nasal shield; nasals separated by internasal, internasal higher than broad; internasal produced posteriorly partially dividing prefrontals; prefrontal broader than long, in contact with nasal, internasal, supraocular, preocular and frontal; frontal much longer than the distance from the rostral; loreal absent; parietal larger than broad; one anterior temporal; one supraocular; one

preocular; two postoculars; 5 supralabials on each side of the head, 3rd touching the eye, 4th longest, 5th largest; 7 infralabials on each side of the head, no cuneate scale present, 3 infralabials touching anterior chin shield; chin shields well developed, anterior pair slightly larger, in contact with each other, posterior pair smaller, separated by single scale; scale rows at one head length behind head 24–27; scale rows at midbody 25–28; scale rows at one head length before vent 21–24; ventrals well developed, 142–161; precloacal often divided; anal large, divided; subcaudals paired, 29–35; dorsal scales smooth; tail

short; head length 9.4–27.9 mm; head width 5.4–20.9 mm; head depth 3.7–14.5 mm; head width 72.7–75.7% its length; head width 99.1–102.7% of mid-body width; eye to snout distance 2.6–8.4 mm; eye to nostril distance 0.9–4.1 mm; inter-ocular distance 2.7–8.9 mm; inter-nasal distance 0.7–2.2 mm; snout-vent length 175.0–674.0 mm; tail length 23.0–63.0 mm; relative tail length 11.5–13.2%. Dorsum uniform light brown to creamy yellow, top of head grey brown or pale yellow, on the flank the lowermost 3–4 rows of dorsal scales pale whitish brown, labials creamy white; iris black, ventrals and subcaudals uniform pearly white.

***Gerarda prevostiana* (Eydoux and Gervais, 1837)**

(Figs. 1, 2, 4)

Taxonomic history

This species was originally described as *Coluber (Homalopsis) prevostianus* by Eydoux and Gervais

(1837) based on two syntypes MNHN-RA 3758 and 7593 [Muséum National d'Histoire Naturelle, France], longest one 540 mm (J.F.T. Eydoux and F.L.A. Souleyet, Feb. 1836–Nov. 1837), from the type locality – “Manille” now Manila, Luzon, Philippines (fide, Wallach et al., 2014). Later, Gray (1849), whilst describing a new genus *Gerarda*, mistakenly described this species again, as *G. bicolor*. Thus *G. prevostiana* is the type species of the genus *Gerarda*. Dumeril et al. (1854) described a new genus *Campylodon*, for this species. Later Cope (1862) synonymized these taxa and first gave this species its currently accepted combination *Gerarda prevostiana* (also see Cope 1886; Boulenger, 1890, 1896; Smith, 1943; Whitaker and Captain, 2004; Wallach et al., 2014). Other than *Gerarda bicolor* Gray, 1849, no other subjective junior synonyms are known for this species (Boulenger, 1890, 1896; Smith, 1943; Wallach et al., 2014).



Figure 4: *Gerarda prevostiana* from India; top row- BNHS 2070; middle row- ZSI 25351; bottom row- MNHN RA-1946.79; Muséum National d'Histoire Naturelle; photo: J. Courtois.

Material examined (n= 24)

INDIA: ZSI 13659, collected by M. A. Smith (through J. A. Murray) from Howrah district, West Bengal; ZSI 22653, collected by A. K. Dutta on 4.ix.1964 from Digha beach on way to Paddapur, West Bengal; ZSI 24212, collected by N. C. Banerjee on 7.xi.1980 from Kakdwip, South 24 Parganas, West Bengal; ZSI 26145, collected by K. Deuti and party on 29.iv.2014 from Bichitrapur mangroves, Talsari, Balasore, Odisha; ZSI 23179, collected by N. V. Subba Rao on 22.i.1964 from Upputera salt canal creek, Kakinada, Andhra Pradesh; ZSI 25351, 25352, collected by S. Ghodke on 29.vi.2001 from Cheepoo, North Andaman; BNHS 2065 collected by W. J. Sinclair on 31-xii-1907 from Alibag, Bombay; BNHS 685 collected by J. Mason from Alibag, Bombay, Maharashtra; BNHS 2061 collected by H. Abdulali on 19-x-1942 from Kihim Kolaba, Maharashtra; BNHS 2067 collected by A. Geddies on 22-x-1941 from Juhu Sand, Bombay, Maharashtra; BNHS 2068 collected by H. Abdulali on 18-x-1950 from Thane, Bombay, Maharashtra; BNHS 2069 collected by H. Abdulali on 09-ii-1953 from Chembur, Bombay, Maharashtra; BNHS 2070 collected by H. Abdulali on 19-xii-1956, from Bandra, Bombay, Maharashtra; BNHS 2994 collected by H. Abdulali on 29-v-1973, from Kihim, Kolaba Maharashtra; BNHS 3416 collected by A. S. Lobo from Dr. Salim Ali Bird Sanctuary, Goa. MYANMAR: ZSI 8374, 8376 females, ZSI 8375, 8377 males, collected by F. Stoliczka from Pegu; ZSI 8421 subadult collected by J. Armstrong from Tenasserim (Amherst); ZSI 8188 female, 8189 male, collector, date and locality unknown; BNHS 2022 collected by unknown, from Rangoon, 1811–12.

Description and variation

Head not distinct from neck, head shields large, regular; rostral broader than high; nasal superior, oval shaped; nostril opening at the center of nasal shield; nasals separated by internasal, internasal higher than broad; internasal truncate posteriorly, nor partially dividing prefrontals; prefrontal broader than long, in contact with internasal, nasal, loreal, frontal, supraocular and preocular; frontal longer than the distance from the rostral, longer than broad; parietal longer than broad; loreal present; temporal 1+2; one supraocular; one preocular; two postoculars; 7 supralabials on each sides of head, 4th touching the eye, 2nd and 3rd touching the loreal, 6th longest, 7th largest; 9 infralabials on each side of head, 4 infralabials touching anterior chin shield; chin shields well developed, anterior pair larger, in contact with each other, posterior pair smaller, separated by two scales; scale rows at one head length behind head 17–19; scale rows at midbody 17; scale rows at one head length before vent 13–15; ventrals well developed, 146–155; preanal undivided; anal divided; subcaudal paired, 29–35; dorsal scales smooth; tail short; head length 11.9–20.3 mm; head width 5.8–10.9 mm; head

depth 3.5–6.0 mm; head width 49.7–54.2% its length; head width 57.3–63.0% of mid-body width; eye to snout distance 2.8–5.2 mm; eye to nostril distance 1.3–2.8 mm; inter-ocular distance 2.8–5.6 mm; inter-nasal distance 1.0–2.5 mm; snout-vent length 240.0–519.0 mm; tail length 40.0–72.0 mm; relative tail length 11.2–14.1%. Dorsum uniform dark grey to light greyish brown, top of head uniform dark brown to light brown, flank region comprising lowermost 1–2 rows of scales whitish to light brown, labials whitish cream; iris dark grey; venter light greyish with outer edge of ventrals edged with darker grey, or ashy brown, giving a mottled or reticulated appearance.

Discussion

Recent treatises of Indian snakes have barely furnished adequate data on any aspect of natural history or morphology of these two genera based on Indian populations. Daniel (2002) did not feature these species in his book, while Das (2002) featured them with rather general accounts. Das (2002) reported *F. leucobalia* only in the Andaman coast within Indian limits, whereas it has been reported from the coasts of Bengal (Smith, 1943) and Nicobar Islands (Gyi, 1970). This study's vouchers from Circar and Bengal Coasts reiterates its occurrence in India's east coast (Ahmed and Dasgupta, 1992; Rahman and Reza, 2013; Rahman et al., 2014; Freed et al., 2015), and those of *G. prevostiana* from Gujarat and Maharashtra coasts supplements reports from India's western coast (Vyas et al., 2013; Bag et al., 2018) and eastern coast (Gyi, 1970; Rahman et al., 2014). Morphology of Indian populations of these genera are furnished in finer resolution here. The morphometric and color pattern features of the Indian population reported here are in line with what has been reported for these two species from the Indian and Sri Lankan coastline (Somaweera et al., 2006; Vyas et al., 2013; Ukuwela et al., 2017; Bag et al., 2018; Karunaratna et al., 2018).

Most data on morphology of these genera often stem from the Indomalayan or Indochinese populations inhabiting S.E. Asia, as can be deduced by localities given in the respective studies. From early taxonomic treatises such as Boulenger (1896), through more later ones like Gyi (1970), till the recent ones such as Murphy and Voris (2014) all deal with such populations of the genera *Fordonia* and *Gerarda*, with very meager representation from Indian coastline. This has been the main motive of all recent studies on *G. prevostiana* from Sri Lanka, that has in the past only been implicitly associated in its distribution with no precise data on Sri Lankan population. As far as Indian population is concerned, *Fordonia* has been even more poorly known, as it occurs only in northern parts of the east coast in the Circar Coast (this work) and Sunderbans (also see Sclater, 1891). Eastern Coast of India is the westernmost area where both their geographical ranges overlap (Murphy and Voris, 2014; Bernstein and

Murphy, 2024) in a global framework (Bag et al., 2013; Rahman et al., 2014; Freed et al., 2015). As encouraging as these new data are, there is still lack of details such as juvenile specimens, those with everted hemipenis or gravid females in the collections of *Fordonia* and *Gerarda* investigated here.

Though these taxa have not been reported in publications from India's east coast, citizen-science posts of geo-referenced photographic posts exist: *F. leucobalia* in the Circar Coast (https://www.inaturalist.org/observations?taxon_id=30089) and *G. prevostiana* in the Circar Coast, Coromandel Coast as well as the Indian side of the Palk Strait abutting Sri Lanka (https://www.inaturalist.org/observations?taxon_id=30014). As for *F. leucobalia* in S.E. Asia, the morphological features of the Myanmar and Singapore specimens are in line with what has been reported on this species (Whitaker and Captain, 2004; Murphy and Voris, 2014; Wallach et al., 2014; Boundy, 2020; Bernstein and Murphy, 2024). Bernstein and Murphy (2024) stated that while the Indochinese population of *F. leucobalia* have uniform drab brown dorsum, the Indomalayan and Australasian populations have multi-colored, ornately-patterned dorsum. Our Singapore specimens were understandably too old and faded to note dorsal coloration, though matching its reported description well. In the past two decades *G. prevostiana* was studied in Sri Lanka (Somaweera et al., 2006; Ukuwela et al., 2017; Karunarathna et al., 2018). Thus, the present study fills a void by furnishing new data on intra-specific morphological variations of Indian and nearby country's populations of these two estuarine snake genera.

Acknowledgments

We thank our respective organizations for encouraging joint research activities; the Director, Officer in Charge, Reptilia Section of Zoological Survey of India (ZSI); Director, Dy. Director and Curator of Bombay Natural History Society (BNHS), Founder Director and Trustees, Kalinga Foundation. We thank Drs. Shuvam Das and Souryadipa Kundu of ZSI, Dr. Jérôme Courtois of Natural History Museum of Paris, France and Dr. Daniel Klingberg Johansson of Natural History Museum of Denmark, University of Copenhagen, for providing the photographs reproduced here. Thanks to Prof. Sushil Kumar Dutta for kindly sharing information on some ZSI specimens. SRG thanks Mrs. Adithi Muralidhar for warmly hosting his visit to Mumbai. We thank the editors and reviewers (Drs. Ali Gholamifard, Fred Kraus, Justin Bernstein) for their time and suggestions in refining many versions of the manuscript. Moreover, thanks to Dr. Justin Bernstein also for sharing some pertinent literature for our reference.

Author contributions

SM gathered data from two museums, ODA and KD gathered data from one museum each, SM, ODA and

KD compiled the gathered data, SRG led the writing, in consultation with SM, ODA and KD. All the authors equally participated in refining and finalizing the draft.

Conflicts of interest

The authors declare that there are no conflicting issues related to this research article.

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