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On the taxonomic validity of *Boiga whitakeri* Ganesh et al., 2021 with new insights on *Boiga dightoni* (Boulenger, 1894) (Reptilia: Squamata: Colubridae)

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Abstract

Colour polymorphism has been previously reported in several colubrid snakes including *Boiga* spp. In this paper, we report colour variations within the poorly known southern Indian *Boiga dightoni*, provide the first molecular data for this species, from two localities (including the type locality) and compare them with data from other congeners. Additionally, we provide detailed dentition and hemipenis descriptions for *B. dightoni*. Molecular data for *B. dightoni* show very little difference (0.2–0.4% 16S; 0.9–1.2% cyt *b*) to the recently described *Boiga whitakeri*, also from southern India. We have re-examined and present new information on the pholidosis of the type specimens of *B. whitakeri* and reconsider its taxonomic status. On the basis of molecular data and overlapping morphological characteristics, we argue that *Boiga whitakeri* and *Boiga dightoni* are conspecific, and place *B. whitakeri* under the subjective synonymy of the latter. Furthermore, we show that colour polymorphism in *B. dightoni* is a gender-independent character and that both colour morphs are found in high as well as low elevations and partly in sympatry. A revised key to the *Boiga ceylonensis* complex is provided.

Keywords

Boiga ceylonensis complex, taxonomy, synonymy, Kerala, Tamil Nadu, India

Introduction

The colubrid snake genus *Boiga* Fitzinger, 1826 is represented by 37 currently recognised species distributed from the southern Palaearctic and the Oriental region to the northern and eastern coasts of Australasia (Uetz et al. 2022). Of these, eight species viz., *Boiga beddomei* (Wall, 1909), *B. dightoni* (Boulenger, 1894), *B. thackerayi* Giri et al., 2019, *B. whitakeri* Ganesh et al., 2021, *B. forsteni* (Duméril, Bibron & Duméril, 1854), *B. flaviviridis* Vogel & Ganesh, 2013, *B. nuchalis* (Günther, 1875) and *B. trigonata* (Schneider, 1802) are found in the Western Ghats of peninsular India. *Boiga beddomei*, *B. dightoni*, *B. thackerayi* and *B. whitakeri* are endemic to the Western Ghats (Ganesh et al. 2021). Among these, *Boiga whitakeri* is the most recently described species, based on two specimens from the southern Western Ghats (Ganesh et al. 2021). Prior to this, Ganesh et al. (2020) clarified the status of *B. ceylonensis* and *B. beddomei* based on morphological data and restricted these taxa to Sri Lanka and India, respectively. Ganesh et al. (2020) speculated that Indian records of *B. ceylonensis* might actually represent *B. thackerayi*, which was confirmed subsequently by analysis of molecular data from across the species' range (Ganesh et al. 2021).

Ganesh et al. (2021) also provided molecular data for the holotype of *Boiga whitakeri* and all previously unsampled species of the genus *Boiga* from across peninsular India, except *B. dightoni*. *Boiga dightoni* was originally described based on a single female specimen collected from "Pirmed" (now Peermed, Kerala state, India) (Boulenger 1894) and appears to be a rarely encountered snake. Since its description, only a few studies reported the occurrence of this species from different parts of the southern Western Ghats and none so far from the type locality (Inger et al. 1984; Murthy 1984; Kanagavel and Ganesh 2021).

During our recent fieldwork in the southern Western Ghats, we collected two individuals of *Boiga* sp., one from Peermed and the other from Arippa, Kerala. The specimen from Arippa superficially resembled the holotype of *B. whitakeri*, in colour and inconspicuous dorsal markings, and the specimen from Peermed resembled the paratype of *B. whitakeri* in having prominent dorsal bands. We generated molecular and further morphological data for these two individuals and compared them with the types and with non-types of other *Boiga* spp. from the Western Ghats. In this work, we reassess the taxonomic status of *B. whitakeri* in light of new data on scale variation, and we report colour polymorphism within *Boiga dightoni*.

Materials and Methods

Molecular phylogenetics

We generated DNA sequences for two *Boiga* sp., a specimen (ZSI-CZRC-V-7541) from Peermed, Kerala (9.602710°N, 76.937857°E, 1238 m Above Sea Level (ASL)) approximately 9 km from the type locality of *B. dightoni* and one more specimen (BNHS 3617) from south of Shencottah gap (Arippa, Kerala, 8.831640°N, 77.038542°E, 195 m ASL) (Fig. 1), and one specimen (BNHS 3618) of *Boiga nuchalis* (Yercaud, Tamil Nadu, 11.775140°N, 78.214654°E, 1300 m ASL).

We extracted genomic DNA from liver samples stored in absolute ethanol at –20°C, using the DNeasy (QiagenTM) blood and tissue kit following the manufacturer's protocol. We amplified partial sequences of two mitochondrial genes, 16S rRNA (16S) and cytochrome *b* (cyt *b*). Respective primers for these genes are as follows: 16Sar-L and 16Sbr-H (Palumbi et al. 1991) and CS1L and LTyph2R (Adalsteinsson et al. 2009). PCR conditions were as follows: Fragments of 16S were amplified using an initial denaturation at 95°C for 5 min, followed by 39 cycles of denaturation at 95°C for 45 sec, annealing at 50.4°C for 45 sec and extension at 72°C for 1 min 30 sec. Final extension was at 72°C for 10 min. Fragments of cyt *b* gene were amplified using an initial denaturation at 95°C for 5 min, followed by 35 cycles of denaturation at 95°C for 45 sec, annealing at 48°C for 45 sec and extension at 72°C for 55 sec. Final extension was at 72°C for 10 min. PCR reactions were carried out in 25 µl reactions containing 11µl of Takara emerald RR310B mastermix, 12 µl of PCR grade H_2O, 0.5 µl of each forward and reverse primers and 1µl (60–80 ng) of template DNA. PCR amplifications were carried out in S1000TM Thermal Cycler (Bio-Rad, USA). Amplified PCR products were run on a 2% agarose gel and viewed with an Essential V4 (UVITEC Cambridge, UK) gel documentation system to confirm the PCR amplification. PCR products were purified and Sanger sequenced in both directions at Barcode Biosciences (Bangalore, India) using the same primers that were used for amplification.

Bidirectional sequences were checked manually using CHROMAS (http://technelysium.com.au/wp/chromas) and aligned using ClustalW with default prior settings implemented in MEGA 7 (Tamura et al. 2011; Kumar et al. 2016). We checked for unexpected stop codons in the protein-coding gene cyt *b* by translating nucleotide alignments to amino acids in MEGA7 (Kumar et al. 2016). The new sequences generated in this study were concatenated with data for twenty-three other *Boiga* and three outgroups (*Telescopus tripolitanus*, *T. variegates* and *Toxicodryas pulverulenta*) (Appendix 1).

Maximum Likelihood (ML) analysis was performed using IQ-TREE (Nguyen et al. 2015), implemented in the web server version (http://iqtree.cibiv.univie.ac.at) (Trifinopoulos et al. 2016). The IQ-TREE server used Modelfinder (Kalyaanamoorthy et al. 2017) to find the best-fit evolutionary model for each of the four suggested partitions (16S: TIM2+F+I+G4; Cytb position 1: TIM2+F+G4; Cytb position 2: TN+F+I+G4; cyt *b* position3: TIM3+F+G4). Bayesian (BI) phylogenetic analysis was carried out with MrBayes 3.2 (Ronquist et al. 2012), with default prior settings and implementing the best-fit models and partitioning scheme as determined by

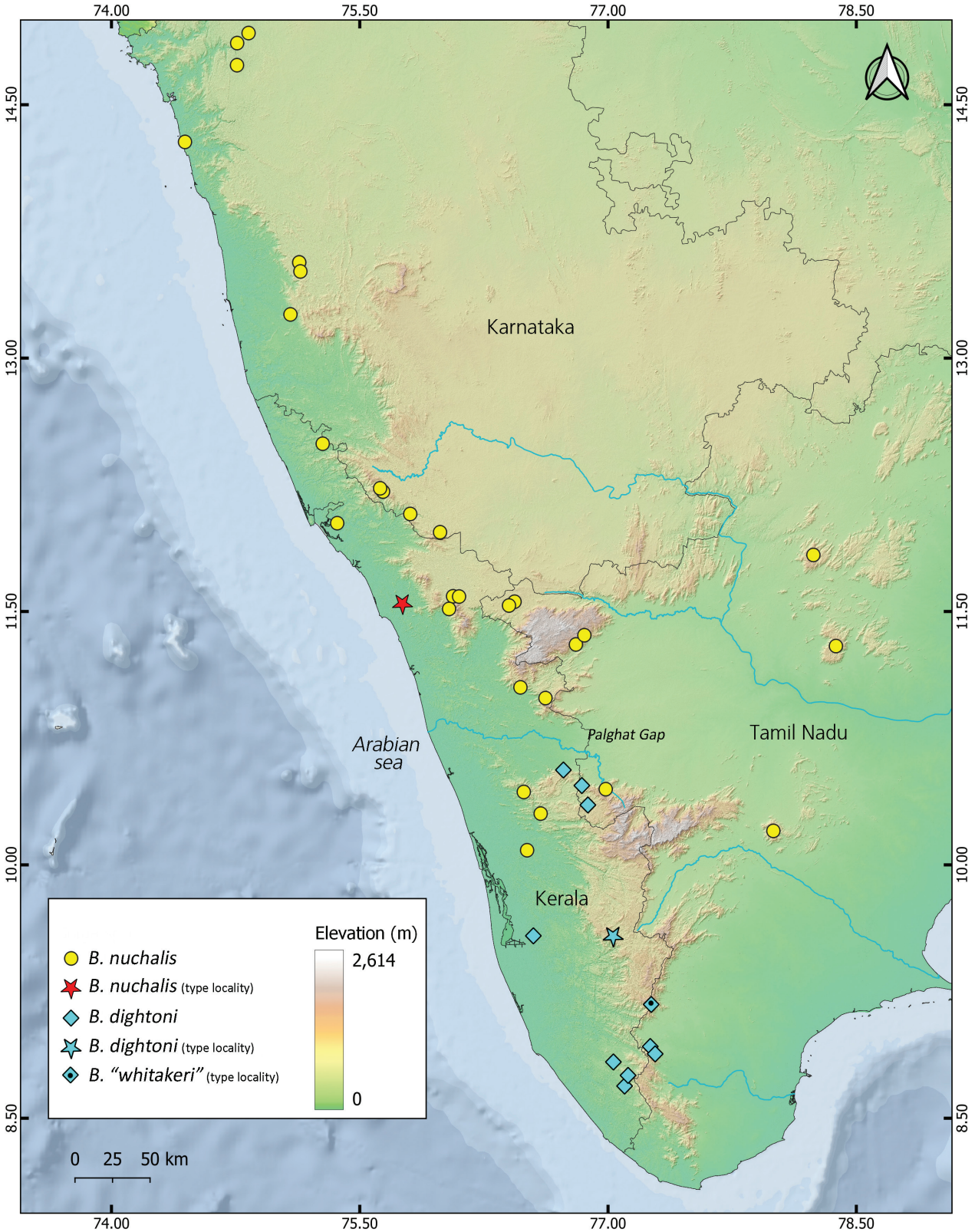

Figure 1. Updated distribution of *Boiga dightoni* and *B. nuchalis* in the Western Ghats and *B. nuchalis* in peninsular India.

Partition Finder V2. (Lanfear et al. 2017) with default settings. The best-fit scheme comprised three partitions, by gene and codon position (16S & cyt *b* position 1: GTR+I+G; cyt *b* position 2: TrN+I+G; cyt *b* position3: TVM+G). Four separate MCMC runs were initiated from random trees and allowed to run for ten million generations, sampling every 1000 generations. Analyses were terminated when the standard deviation of split frequencies was less than 0.005, the first 25% of trees were discarded as "burn-in", and trees were constructed under the 50% majority consensus rule. Support for internal branches in ML and BI trees was quantified using Ultrafast Bootstrap (1000 pseudoreplicates) and posterior probability, respectively.

Morphology

We examined 33 specimens of *Boiga* spp., including *Boiga dightoni* (n = 9), *B. whitakeri* (n = 2), *B. nuchalis* (n = 10), *B. thackerayi* (n = 4), *B. flaviviridis* (n = 1) and *B. ceylonensis* (n = 7) (Appendix 2). Morphological data for *B. ranawanei* were taken from Samarawickrama et al. (2005).

The numbers of dorsal scale rows are reported for one head length behind the head, at midbody (i.e., at the level of the ventral plate corresponding to half of the total ventral number), and at one head length anterior to the vent respectively. Dorsal scale row reduction formulae were based on Dowling (1951a). Ventral scale counts and hemipenial descriptions follow Dowling (1951b) and Dowling and Savage (1960), respectively. The terminal scute is not included in the number of subcaudals. Values for symmetric head characters are given in left/right order.

The following measurements were taken: snout-vent length (SVL); tail length (TL); head length (HL: distance between posterior edge of last supralabial and tip of the snout); head width (HW: at angle of jaws); head depth (HD: height at the occipital region); Frontal length (FL: at the longest point); frontal width (FW: at the widest point on the anterior region); eye diameter (ED: horizontal diameter); eye to nostril distance (E–N: anterior corner of eye to posterior edge of nostril); eye to snout distance (E-S: anterior corner of eye to tip of snout); frontal to snout (FrSN: anterior end of frontal to tip of snout); inter-orbital distance (IO: measured at the anterior edge of eyes); number of dorsal scale rows (DSR). All linear measurements, except SVL and TL were taken using Mitutoyo dial vernier callipers (to 0.1 mm). SVL and TL were measured using a thread and metal scale (to 1 mm).

Among the specimens checked in this study, the holotype (BNHS 3597) of *Boiga whitakeri* is in a poor state of preservation and the paratype (BNHS 1863) of this species is also damaged, especially its anterior ventral scales. Thus, the number of ventral scales provided here for the paratype of *Boiga whitakeri* (BNHS 1863) is not complete Appendix 3C). For the ventrals that are damaged, we counted the adjacent dorsal scale rows assuming that one first-row dorsal corresponds to one ventral here.

Location records for both *Boiga dightoni* and *B. nuchalis* used for the map (Fig. 1) are based on the literature and specimens examined during the study (Appendix 4). Additionally, we downloaded research-grade data for both of these species from the citizen science portals, iNaturalist (https://www.inaturalist.org) and India Biodiversity Portal (https://www.indiabiodiversity.org). All the records for both species were checked individually wherever we could count the dorsal scales on one side, especially for the records from the southern Western Ghats. Doubtful records or records with poor photographs were not considered for plotting on the mapping and distribution (see also Discussion).

To obtain counts of teeth by a non-invasive procedure, the head of the holotype of *Boiga dightoni* was subjected to micro-tomographic analysis at the Museum für Naturkunde Berlin, using a Phoenix nanotomX-ray|s tube. The cone-beam reconstruction was performed using the datos|x-reconstruction software (GE Sensing & Inspection Technologies GMBH phoenix|x-raydatos|x 2.0) and the data were visualised in VGStudio Max 2.2. Teeth (including empty sockets) were counted on all dentigerous bones.

Museum specimen number prefixes

BMNH: The Natural History Museum, London, UK; **FMNH**: Field Museum of Natural History, Chicago, USA; **BNHS**: Bombay Natural History Society; **MCZ**: Museum of Comparative Zoology, Cambridge, USA; **RMNH-BBSR-R**: Regional Museum of Natural History, Bhubaneswar, India; **ZMB**: Museum für Naturkunde (formerly Zoologisches Museum Berlin), Leibniz-Institut für Evolutions- und Biodiversitätsforschung, Berlin, Germany; **ZSI-CZRC**: Zoological Survey of India, Central Zone Regional Centre, Jabalpur, India; **ZSI/SRS/S**: Zoological Survey of India, Southern Regional Centre, Chennai, India. Museum acronyms follow Sabaj (2020).

Results

Molecular phylogenetics

The inferred phylogenies are broadly congruent with those presented by Ganesh et al. (2021). *Boiga ceylonensis*is sister to *B. dightoni* + *B. whitakeri* with strong support (ML 98, BI 1.0) and this clade is sister to *B. nuchalis*. *Boiga nuchalis* from Yercaud (BNHS 3618) is nested with other *B. nuchalis* from the Western Ghats (Fig. 2). *Boiga* cf. *ranawanei* (sensu Ganesh et al. 2021) is sister to *B. flaviviridis* (a dry zone species found in thorn forests and scrub jungle). The holotype sequence of *B. whitakeri* is sister to the sample from Arippa (BNHS 3617) with strong and moderate support in BI and ML, respectively (BI 0.98, ML 83) and these two samples are together sister to the *B. dightoni* from the type locality with strong support (ML 95, BI 1.0) (Fig. 2).

The uncorrected pairwise genetic distance between the two samples of *B. dightoni* and the holotype of *B. whitakeri*, is 0.9–1.2% and 0.2–0.4% in cyt *b* and 16S, respectively (Table 1). These distances are almost all smaller than intraspecific distances for the other congeners *B. beddomei* 2.5%, *B. flaviviridis* 2.2%, *B. nuchalis* 0.4–2.3% and *B. thackerayi* 0.6–3.6% in cyt *b* and *B. beddomei* 0.8%, *B. nuchalis* 0% and *B. thackerayi* 0.2–0.8% in 16S.

Morphological comparison of *B. dightoni* and *B. whitakeri*

Both specimens of *Boiga* sp. (ZSI-CZRC-V-7541 and BNHS 3617) collected during this study match well with the holotype of *B. dightoni* based on scalation data, main-

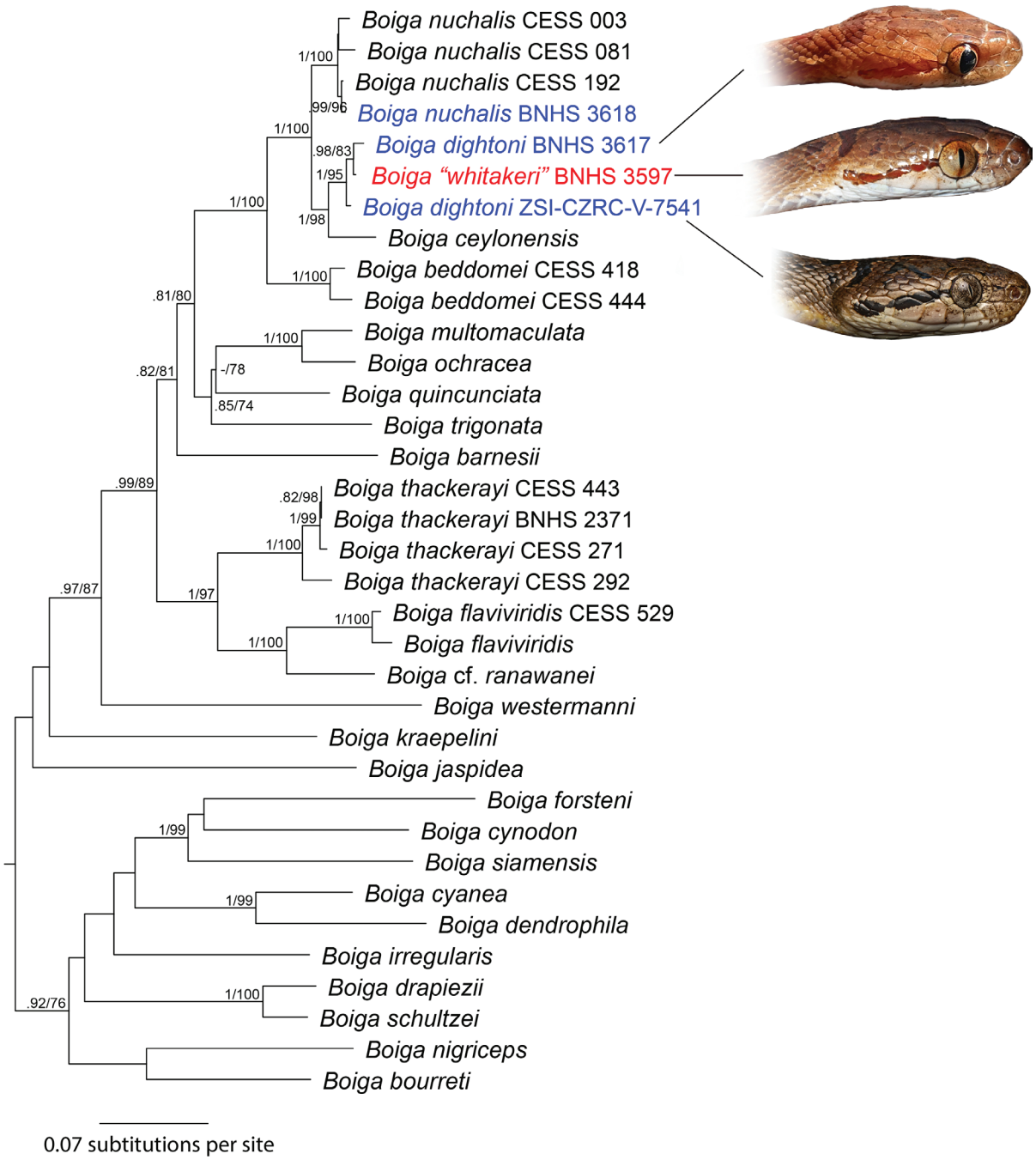

Figure 2. ML phylogeny showing relationships of the newly sampled *Boiga* (in blue) and sequences of other available congeners. ML bootstrap support and BI posterior probability support = />75 or 0.75 is shown at each internal branch. Holotype of *B. whitakeri* (BNHS 3597) labelled in red. Inset image: head closeups of the respective samples in life or freshly roadkill specimen (BNHS 3617). Outgroups are pruned from this tree.

ly in having 23 MDSR (also see scale reduction formula for more characters). However, these two specimens differ significantly in scalation from *B. whitakeri* (based on data provided by Ganesh et al. 2021), despite the strong molecular similarity. MDSRs in *B. dightoni* are predominantly 23 from the 10th ventral throughout most of the midbody (up to ventrals 123–144) in all of the specimens examined during the study, but the point of reduction from 23 to 21 differs slightly among the specimens examined (see scale reduction formula below). *Boiga whitakeri* is diagnosed from congeners mainly based on the presence of 19 MDSR as provided in the original description (Ganesh et al. 2021), but we counted 23 rows in the holotype (scale redcution formula & Table 2). Due to the poor state of preservation, we were unable to acquire the complete scale reduction formula for the paratype of *B. whitakeri* (BNHS 1863) but it has 21 MDSR until the level of the 145th ventral and 19 DSR at the level of the 160th ventral. This matches the dorsal scale reduction range of the sympatric *Boiga nuchalis* (see scale redcution formula). Furthermore, except for the dorsal scale rows, there is a close similarity in the arrangements of head scalation, ventrals and subcaudals between specimens identified as belonging to these "three" species (Table 2).

Dorsal scale row reduction formulae for some of the *Boiga* specimens examined in this study presented below. *between ventral 9 and 14 counts are not possible because of the damaged vertebral region. Additionally, there are several reductions and additions of the paravertebral scale row between the corresponding ventrals of 194 to 209. *** dorsal scales damaged and is not possible to find the area of scale reduction:

Boiga dightoni

BMNH 1946.1.1.32* (holotype), female

	+11(17)	–11(135)	3+4(152)	–9(155)	–8(209)	
(15*)**21**	**23**	**21**	**19**	**17**	**15**(242)	
	+11(27)	–11(135)	4+5(148)	–9(155)	–8(209)	

Summary of five specimens of *B. dightoni*

		(123–144)	(143–153)	(154–167)	
	+11(17)	9+10 or 10+11 or –11	2+3 or 3+4 or 10+11	3+4 or 8+9	–8(209)
21	**23**	**21**	**19**	**17**	**15**
	+11(27)	9+10 or 11+12 or –11	2+3 or 3+4 or 10+11	2+3 or 8+9 or	–8(209)
		(123–144)	(143–155)	9+10(155–166)	

Boiga "*whitakeri*"

BNHS 3597 (holotype), male

	11+12(147)	2+3(153)	9+10(161)	
23	**21**	**19**	**17**(235)	
	11+12(143)	2+3(154)	8+9(159)	

BNHS 1863 (Paratype), unsexed

	***	3+4(160)	
21(5–145)	**19**(150)	**17**(243)	
	***	3+4(160)	

Summary of five specimens of *B. nuchalis*

	10+11(132-151)	3+4(146–156)	8+9(162–175)
21	**19**	**17**	**15**
	10+11(133-150)	3+4(146–156)	8+9(163–175)

Boiga dightoni (Boulenger, 1894)

Figs 3–7; Tables 1, 2

Dipsas dightoni Boulenger 1894, p. 528.

Dipsadomorphus dightoni – Boulenger 1896, p. 69.

Boiga dightoni – Smith 1943, p. 567; Murthy 1984, p. 84; Inger et al. 1984, p. 567; Wallach et al. 2014, p. 103; Kanagavel & Ganesh 2021, p. 67, 68, fig. 1,2; Ganesh et al. 2020, p. 314, fig. 7; Ganesh et al. 2021, p. 449–151, 453.

Boiga whitakeri Ganesh, Mallik, Achyuthan, Shanker & Vogel, 2021 p. 453, fig. 3, **syn. nov.**

Taxonomic comments. A detailed description of the external morphology of the holotype of *Boiga dightoni* (BMNH 1946.1.1.32) is presented by Ganesh et al. (2020). In this work, we provide scale reduction formula and detailed dentition based on microCT scans for the holotype of *Boiga dightoni*. In addition, we provide a detailed description of the hemipenis of *B. dightoni* based on a topotypic specimen (ZSI-CZRC-V-7541).

Based on the morphological data from the two specimens collected during this study, including the specimen from the type locality (Peermed, Kerala) of *Boiga dightoni*, we confidently identify these two specimens as *B. dightoni*. Our morphological examination of the types and non-type materials of *Boiga whitakeri*, *B. dightoni* and *B. nuchalis* provide evidence that led us to conclude that the holotype of *B. whitakeri* is conspecific with *B. dightoni.* This is consistent with our molecular analyses, in which the holotype of *B. whitakeri* is nested within the samples (including the topotype) that we identify as *B. dightoni*.

Figure 3. Representative images of *B. dightoni* in life. Morph 1: **A** Uncollected individual from Arippa, Kerala (female), **B** BNHS 3597 (male); Morph 2: **C** ZSI-CZRC-V-7541 (male), **D** uncollected individual from Arippa, Kerala (male).

On the other hand, the type series (BMNH 74.4.29.933–6) and two other specimens of *Boiga nuchalis* examined here have 21 dorsal scale rows at midbody (Scale reduction formula; Appendix 2). This further confirms that the paratype (BNHS 1863; Appendix 3) of *B. whitakeri* is rather *B. nuchalis*. Because the holotype and paratype of *B. whitakeri* clearly represent two already described species, we relegate *Boiga whitakeri* Ganesh, Mallik, Achyuthan, Shanker and Vogel, 2021 to the junior subjective synonymy of *Dipsas dightoni* Boulenger, 1894.

Morphology. A medium-sized *Boiga* (greatest TL 1000 mm (male), 935 mm (female)); 229–249 ventrals, 99–112 divided subcaudals; 13/14 teeth on maxilla and 7 on palatine; dorsal scales smooth, 23:23:19 in rows; dorsal scale reduction from 23 to 21 rows occurs between ventrals 123–144 and the reduction from 21 to 19 occurs between ventrals 148–155. Dorsum reddish dun to olive greenish with dorsal light brown to dark bands. Head with dark marking dorsally (rarely absent) and a dark laterocular stripe present.

Colouration in life and preservative. Based on the (live and museum) specimens examined and information available from the literature, we report two different colour morphs in *B. dightoni*.

Morph 1 (n = 5). Reddish dun-coloured dorsum with faint reddish bands on the body (rarely absent) with or without distinct dark marking on the head, and ventral scales uniformly creamish white (Figs 3A–B, 4, 6 A–C, G–I, M–O). Holotypes of both *B. dightoni* and *B. whitakeri* are of this colour morph with no markings on the body in preservation. However, it might be noted that the recently collected specimen from Arippa (BNHS 3617) had faint markings on the body at the time of collection (3rd February 2022) that disappeared in the preservative (Figs 2, 3C–D, 4, 6 A–C). This also applies to the holotype of *B. whitakeri* (Fig. 3B), which had markings on the body in life that disappeared in the preservative (Ganesh et al. 2021). A specimen from Aanapara, Kerala reported by Kanagavel and Ganesh (2021) also belongs to this morph, with very faint bands.

Morph 2 (n = 5). Olive greenish dorsum with black bands (76–80) on the body, with distinct marks on the head and a postocular stripe that ends shortly behind the fissure of the mouth, and irregular small dark blotches along the paraventral scales (Figs 3C–D, 5, 6D–F, J–L, P–R). The topotypic specimen (ZSI-CZRC-V-7541) of *B. dightoni* collected during this study is of this morph (Fig. 3C) and we observed several specimens from museum collections of this morph including a specimen (ZSI/SRS/S-73) collected from the Anamalais in Southern India.

Based on the specimens examined here, it is also clear that these two colour morphs are not explained by sexual dichromatism because both male and female specimens are known for both morphs. For example, the male specimens BNHS 3597 and ZSI-CZRC-V-7541 and

Table 1. Pairwise genetic distances (%) between the *Boiga* spp. from the Western Ghats, Eastern Ghats and Sri Lanka for both mitochondrial 16S and cyt *b* genes.

	CYT *B*	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
1	*Boiga "whitakeri"* BNHS 3597																	
2	*Boiga dightoni* BNHS 3617	1.2																
3	*Boiga dightoni* ZSI-CZRC-V-7541	0.9	1.2															
4	*Boiga ceylonensis*	5.1	5.2	5.0														
5	*Boiga nuchalis* BNHS 3618	5.3	5.3	4.3	6.4													
6	*Boiga nuchalis* CESS_192	5.2	5.3	4.3	6.3	0.4												
7	*Boiga nuchalis* CESS_081	5.7	5.3	4.6	6.0	1.6	1.9											
8	*Boiga nuchalis* CESS_003	5.4	5.9	5.0	6.5	1.6	1.4	2.3										
9	*Boiga barnesii*	13.3	13.2	12.8	14.2	13.6	13.0	13.5	13.2									
10	*Boiga beddomei* CESS_444	8.9	8.6	7.9	9.4	8.7	8.1	8.5	8.5	14.0								
11	*Boiga beddomei* CESS_418	9.3	9.1	8.3	9.4	8.4	7.7	8.3	8.1	13.7	2.4							
12	*Boiga* cf. *ranawanei*	14.5	15.0	14.8	14.8	15.1	14.3	14.8	14.2	14.8	13.4	13.7						
13	*Boiga flaviviridis*	13.2	13.7	13.3	13.5	14.0	12.9	12.6	13.3	16.1	13.2	13.3	9.3					
14	*Boiga flaviviridis* CESS_529	13.4	13.0	12.6	13.1	13.3	12.9	12.9	13.2	15.7	13.5	13.3	9.1	2.2				
15	*Boiga thackerayi* CESS_271	13.9	14.3	13.7	14.9	13.8	13.2	13.1	13.5	14.5	13.5	13.3	11.1	13.1	12.5			
16	*Boiga thackerayi* CESS_443	13.6	13.8	13.4	14.6	13.7	13.1	13.0	13.4	14.6	13.1	13.1	10.8	12.7	12.2	0.6		
17	*Boiga thackerayi* CESS_292	14.2	14.2	14.1	14.6	14.3	13.6	13.3	14.1	14.6	13.8	14.1	11.1	12.7	12.0	3.6	3.3	
18	*Boiga thackerayi* BNHS_2371	13.6	14.1	13.8	14.6	14.0	13.1	13.0	13.4	14.7	13.1	13.1	10.5	12.5	12.2	0.6	0.0	3.3

	16S	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	*Boiga "whitakeri"* BNHS 3597														
2	*Boiga dightoni* BNHS 3617	0.2													
3	*Boiga dightoni* ZSI-CZRC-V-7541	0.4	0.2												
4	*Boiga ceylonensis*	0.8	0.6	0.4											
5	*Boiga nuchalis* CESS_003	0.7	0.9	0.7	1.1										
6	*Boiga nuchalis* CESS_081	0.6	0.8	0.6	1.0	0.0									
7	*Boiga nuchalis* CESS_192	0.6	0.8	0.6	1.0	0.0	0.0								
8	*Boiga barnesii*	4.0	3.7	4.0	4.0	4.6	4.6	4.6							
9	*Boiga beddomei* CESS_418	1.5	1.7	1.9	2.3	1.8	1.7	1.7	3.3						
10	*Boiga beddomei* CESS_444	1.7	1.9	2.1	2.5	2.4	2.3	2.3	3.8	0.8					
11	*Boiga* cf. *ranawanei*	3.6	3.8	3.6	4.0	3.5	3.4	3.4	4.6	3.1	4.0				
12	*Boiga flaviviridis* CESS_529	2.9	2.7	2.5	2.5	3.1	3.1	3.1	3.8	3.4	3.8	2.7			
13	*Boiga thackerayi* CESS_292	1.9	2.1	2.3	2.3	2.6	2.5	2.5	3.5	2.1	2.5	3.4	2.9		
14	*Boiga thackerayi* CESS_443	2.7	2.5	2.7	2.7	3.5	3.4	3.4	3.1	2.5	2.9	3.6	3.4	0.8	
15	*Boiga thackerayi* CESS_271	2.7	3.1	3.4	3.4	3.5	3.4	3.4	3.8	2.5	2.9	3.4	3.6	0.8	0.2

the female specimens BMNH 1946.1.1.32 and BMNH 1940.10.13.19 belong to Morph 1 and 2, respectively. Both the morphs are found in sympatry in at least one location (Arippa, Kerala), so they additionally cannot be explained as purely geographic variation. Furthermore, these colour morphs cannot be currently explained as simple ontogenetic variation, because all the specimens examined here are adults.

Description of hemipenis of ZSI-CZRC-V-7541 (Fig. 7). The right hemipenis is fully everted and removed in situ for further analysis. The hemipenis is sub-cylindrical and moderately elongate (length: 17.0 mm, maximum width: 5.7 mm), extending to the 7th subcaudal. The sulcus is undivided, bounded by thick walls on both sides, and terminates at the centre of the lobe. It can be differentiated into three zones; the proximal zone is covered with 4–6 rows of spines (~40% of the total length), the middle zone with 5 or 6 rows of spinulate flounces arranged transversely (~35% of the total length), and the distal calyculate area (~25%) with 4 or 5 rows of irregular calyces with papilate edges. The sulcus spermaticus is exposed before entering the calyculate area. There is not much variation in the arrangements of spines and body calyces on sulcate and asulcate sides. The overall structure of the hemipenis of ZSI-CZRC-V-7542 is similar to that described for ZSI-CZRC-V-7541.

Dentition based on the holotype of B. dightoni (BMNH 1946.1.1.32) (left/right order). Maxillary bone with 13/14 prediastemal teeth, followed by a distinct diastema that is as long as the socket of the last prediastemal tooth and followed by two distinctly enlarged, grooved and posteriorly bent postdiastemal teeth. Prediastemal teeth increase in size posteriorly, the anterior three distinctly posteriorly hooked, the following with less pronounced curvature. On the left side, prediastemal teeth 1, 4, 5, 7, 9, 11, and 13 missing, maxilla broken behind the diastema.

Table 2. Meristic and morphometric data (in mm) for *Boiga dightoni* and *Boiga nuchalis* examined in this study.

Species	***B. dightoni***	***B. dightoni***	***B. dightoni***	***B. dightoni***	***B. dightoni***	***B. dightoni***	***B. dightoni***	***B. nuchalis***	***B. nuchalis***	***B. nuchalis***	***B. nuchalis***	***B. nuchalis***	***B. nuchalis***
Voucher	BNHS 3617	BNHS 1842	ZSI-CZRC-V-7541	ZSI-CZRC-V-7542	BMNH 1946.1.1.32	FMNH 217699	1940.10.13.19	74.4.29.935	74.4.29.934	74.4.29.933	74.4.29.936	BNHS 3618	BNHS 3619
Location	Arippa, Kerala	Palagapandy, Kerala	Peermed, Kerala	Topslip, Tamil Nadu	Travancore	Ponmudi, Kerala	Kottayam, Kerala	Malabar, Western Ghats	Malabar, Western Ghats	Malabar, Western Ghats	Malabar, Western Ghats	Yercaud, Tamil Nadu	Wayanad, Kerala
Sex	Female	Unsexed	Male	Male	Female	Male	Female	Male	Female	Male	Juvenile Female	Female	Female
HL	22.46	21.8	27.9	21.56	26.2	NA	24	20.3	21.2	25.5	12.3	16.64	15.5
HW	13.1	15.8	16.3	13.51	15.8	NA	14.2	10.79	13.9	15.85	7.3	12.65	10.6
HH	8.1	9.1	9.58	9.37	10	NA	9.2	6.7	9.4	10.5	4.5	6.31	5.4
FL	5.3	5.7	6.16	6.2	6	NA	5.83	5.2	5	5.94	3.96	4.22	4.5
FW	4.9	5.4	5.19	5.1	5.6	NA	5.9	4.4	4.1	5.4	2.85	3.45	3.8
FrSN	4.7	5	6.4	4.86	6.5	NA	6.05	5.2	5.15	6.73	2.85	4.2	3.5
E-S	5.8	6.3	7.6	5.7	NA	NA	NA	NA	NA	NA	NA	4.8	4.3
E-N	4.1	3.9	4.5	3.3	NA	NA	NA	NA	NA	NA	NA	3.1	2.7
ED	3.9	4.3	4.6	4.2	NA	NA	NA	NA	NA	NA	NA	3.2	3
IO	7.1	NA	9.3	7.4	NA	NA	NA	NA	NA	NA	NA	5.6	5.1
SVL	824	832	1000	780	935	932	760	740	722	1010	335	586	465
TL	206	92	268	203	234	245	191*	200	181	255*	80	157	120
Bands on body	not visible	80	76	80	not visible	NA	65	71	85	80	84	98	52 Visible
Bands on tail	not visible	18+	28	not visible	not visible	NA	10	16	21	25	33	22-26	not visible
Preoculars	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1
Postoculars	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2
Supralabials	8,8	8,8	8,8	8,8	8,8	8,8	8,8	8,8	9,8	8,8	8,8	8,8	8,8
Infralabials	11,11	11,11	11,11	11,11	12,11	13,12	12,12	11,11	12,11	11,11	11,11	11,11	11,11
Temporals	2+4/2+3	2+4/2+3	3+4/2+3	3+4/2+4	2+3/2+3	4+4/3+4	3+3/3+3	3+3/3+3	3+4/3+4	2+2/2+3	2+4/2+4	3+4/3+4	3+3/3+4
Preventrals	2	1	2	2	2	3	2	2	2	2	2		
Ventrals	246	249	239	239	241	248	229	242	233	240	244	239	230
Subcaudals	76+	110	103/104	102	99	112	87*	104	95	99*	102	98	100
Anal	single	single	single	single	single	single	single	single	single	single	single	single	single
DSR	23:23:17	23:23:17	23:23:17	23:23:17	23:23:17	21/23/15	23:23:17	21:21:15	21:21:15	21:21:15	21:21:15	23:21:15	23:21:15
* indicates an incomplete tail.													

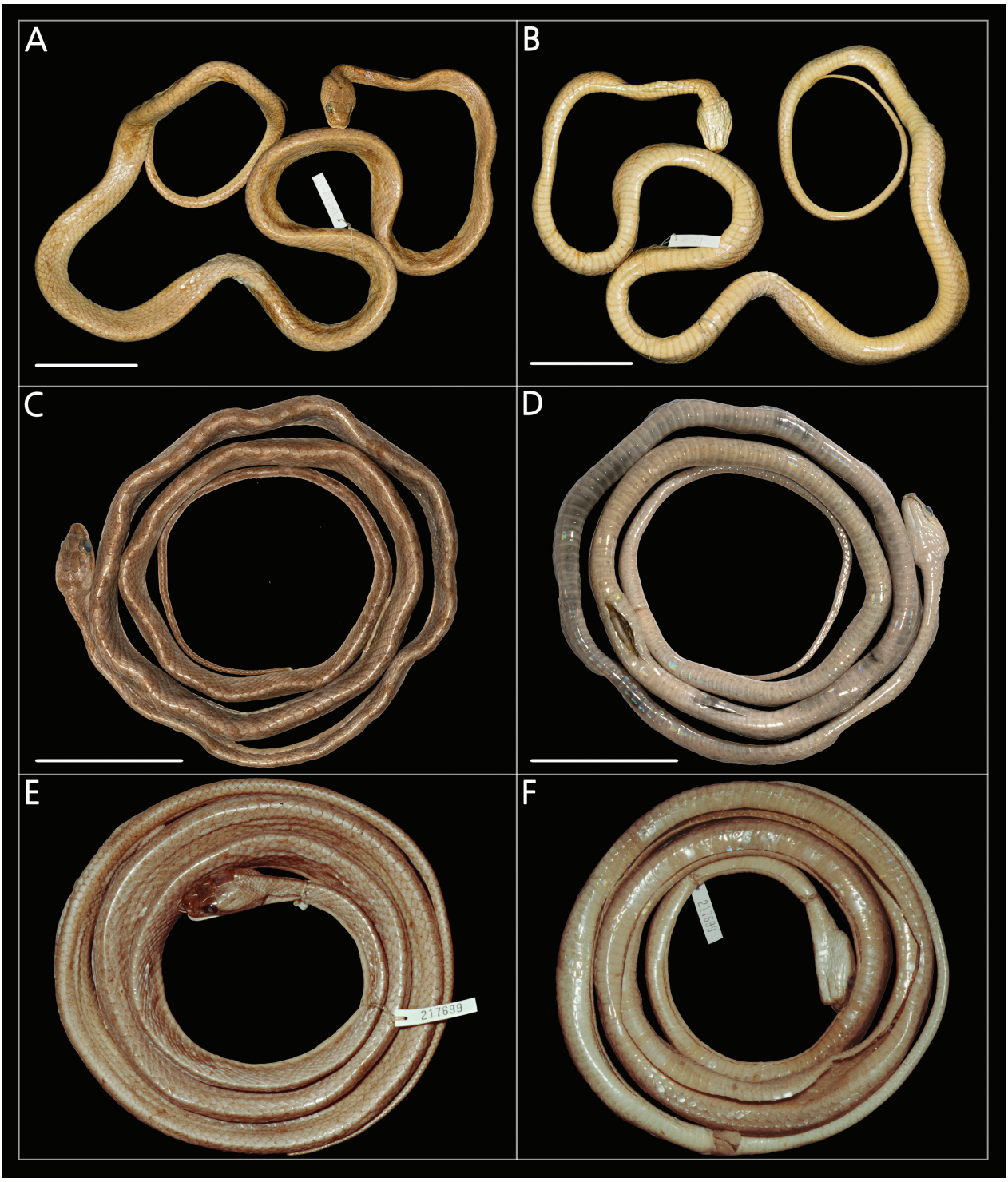

Figure 4. Representative image of *B. dightoni* Morph 1. **A**–**B** BMNH 1946.1.1.32 (female), **C**–**D** BNHS 3617 (female), **E**–**F** FMNH 217699 (male). Scale bar = 5 cm.

On the right side, prediastemal teeth 2–4, 6, 8, 10, 12, 13 and anterior postdiastemal tooth are missing.

Palatine bone with 7/7 posteriorly curved teeth, anterior ones as long as the middle prediastemal teeth, slightly decreasing in size posteriorly. Teeth 1, 5 and 7 are loose, and tooth 3 missing on left side. Teeth 1, 3 and 5 are loose on the right side. Lateral to each palatine tooth is a single replacement tooth at different growth stages. Pterygoid bone with 18/16 posteriorly curved teeth, first one half as long as last palatine tooth, gradually decreasing in size posteriorly, last one minute. Teeth 2, 4, 6, 8, 10, 12, and 14–16 missing on left side, teeth 2, 4, 6, 8, and 10 loose, and 11, 13, and 15 missing on right side. The posterior 45% of the pterygoid bone is without teeth.

Mandibular bone with 20/20 posteriorly curved teeth, shorter than maxillary and palatine teeth, gradually decreasing in size posteriorly. Medial to each mandibular tooth is a single replacement tooth in different growth stages. Teeth 1, 3–7, 9, 11, 13, 15–17, and 19 missing, tooth 2 loose on left side, teeth 1, 3, 5, 7, 9, 11, 13, 15, 17,

Figure 5. Representative image of *B. dightoni* Morph 2. **A**–**B** ZSI-CZRC-V-7541 (male), **C**–**D** BNHS 1842 (unknown), **E**–**F** ZSI-CZRC-V-7542 (male). Scale bar = 5 cm.

and 19 missing, and tooth 2 loose on right side. Mandibular bone broken behind tooth 13 on left side.

Distribution. Based on currently available data, *Boiga dightoni* is widely distributed in the southern Western Ghats (south of the Palghat Gap), at elevations of 9–1258 m (Appendix 4). Murthy (1984) extended the northern range of this species to Topslip in Anamalais. Murthy (1984) reported 23 dorsal scale rows at midbody for the specimen he collected, which is known only for *B. dightoni* among Western Ghats' *Boiga*. The identity of this specimen (ZSI/SRS/S-73) is confirmed by photographs presented by Murthy (1984). With an additional specimen from the same locality (ZSI-CZRC-V-7541), we reconfirm the distribution of *B. dightoni* in Topslip in the Anamalai hills. The northernmost known distribution of *B. dightoni* is based on a specimen (BNHS 1842) from Palagapandy in the Nelliyampathy Hills, Kerala, a specimen that was previously (Ganesh et al. 2020) misidentified as *B. nuchalis.* The southernmost known occurrence of this species is Ponmudi in Kerala (Fig. 1). Thus, *B. dightoni* is found only south of the Palghat Gap in the Western Ghats. *Boiga dightoni* in parts of its range is probably sympatric with *B. nuchalis* and *B. thackerayi*

Figure 6. Head closeup showing colour and pattern in *B. dightoni* Morph 1: **A**–**C** BNHS 3617, **G**–**I** BNHS 3597, **M**–**O** BMNH 1946.1.1.32; Morph 2: **D**–**F** ZSI-CZRC-V-7542, **J**–**L** BNHS 1842 and **P**–**R** ZSI-CZRC-V-7541. Scale bar = 10 mm.

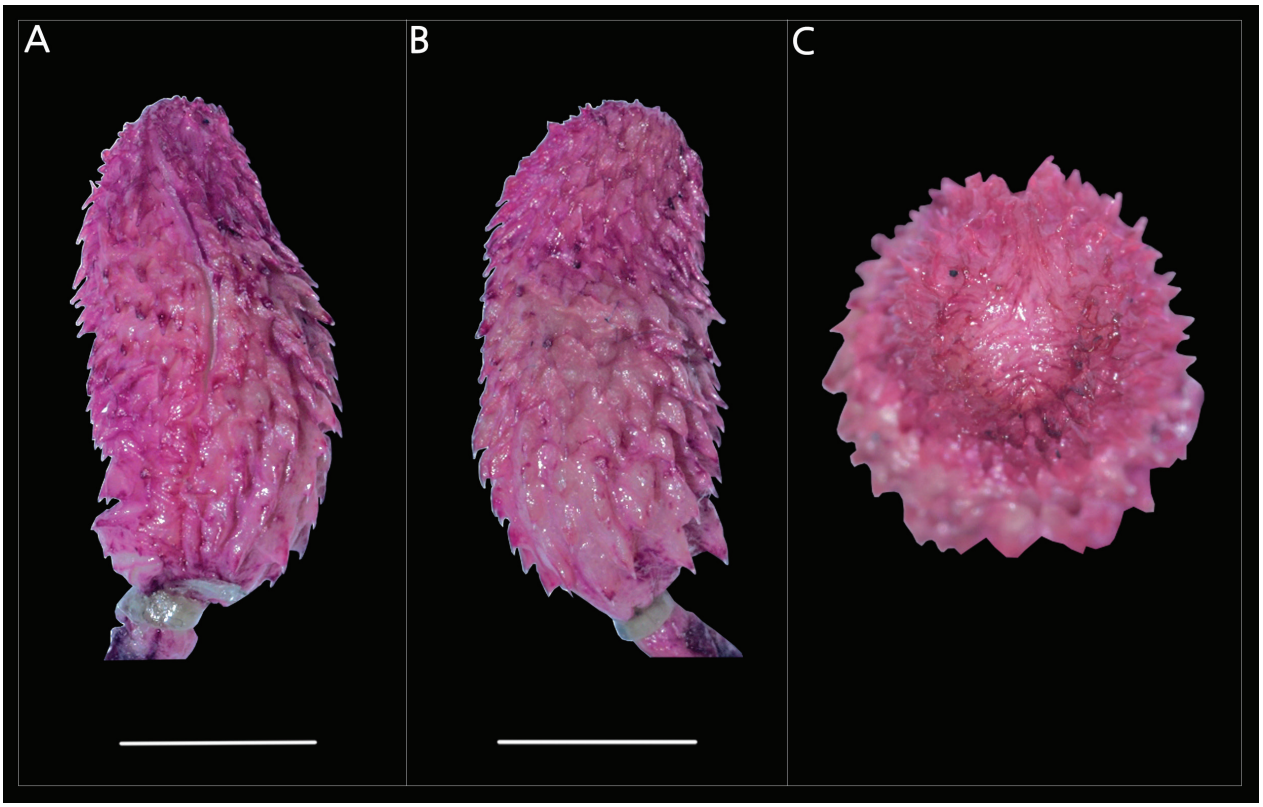

Figure 7. Hemipenis of *Boiga dightoni* (Right organ of ZSI-CZRC-V-7541). **A** sulcate view; **B** asulcate view; **C** apex view. Scale bar = 10 mm.

immediately south of the Palghat Gap, based on distribution data (Fig.1) and the sequences reported by Ganesh et al. (2021).

Discussion

Intraspecific colour polymorphism has been reported in several colubrid genera (Pavón-Vázquez et al. 2011; van Rooijen et al. 2011; Cox and Davis Rabosky 2013; Palacios-Aguilar et al. 2022). Within *Boiga*, colour polymorphism is known in *B. forsteni*, *B. multifasciata* (Blyth, 1861), *B. multomaculata* (Boie, 1827), *B. ochracea* (Theobald, 1868), *B. irregularis* (Bechstein, 1802), and *B. drapiezii* (Boie, 1827) (Mohapatra et al. 2009; Tillack et al. 2021; Weinell et al. 2021). Our results demonstrate that *B. dightoni* is polymorphic in colouration with no marked sexual dimorphism or obvious ontogenetic or geographic component to this variation.

The holotype of *Boiga dightoni* (in preservative) is uniform in colour without dorsal markings and this probably led to several misidentifications in the past. Beyond the specimens examined here, it is probable that several individuals of *B. dightoni* are misidentified as *B. nuchalis* based on colour pattern. For example, at least two records (https://www.inaturalist.org/observations/37460080, 86841689) identified as *B. nuchalis* may actually represent *B. dightoni*. As mentioned above, only a few records of *B. dightoni* are available in the literature and this might be mainly because of its overall similarity with *B. nuchalis*, a much more commonly encountered species that partly overlaps in geographic range with the former. It is likely that, at least in some places, these two species are sympatric. Hence, we hereby caution against identifying these species solely based on the colour pattern, especially from the southern Western Ghats where both *B. dightoni* and *B. nuchalis* are present. Our results highlight the importance of careful examination of type specimens when describing new, similar and closely related species, especially in the absence of molecular data. Wherever possible, it is also preferable to select well-preserved and undamaged specimens when designating name-bearing types.

During this study, we also examined the type series of *Boiga thackerayi*. In the original description (Giri et al. 2019), the midbody scales were reported as being disposed in 17 rows for the holotype (BNHS 3569) and paratype (BNHS 3571), and 19 for the other paratype (BNHS 3570). Based on this, Ganesh et al. (2021) used 17–19 midbody scale rows as a character for *B. thackerayi* in their key. However, our examination reveals that these two individuals (BNHS 3569 and BNHS 3571) also have 19 midbody scale rows (Appendix 5), the same as the other specimen (BNHS 2372). Here, we provide the correct scale reduction formulae for these two specimens (Appendix 5) and update an identification key to the *B. ceylonensis* complex.

Revised key to the species in the *Boiga ceylonensis* complex of Western Ghats, India and Sri Lanka, modified from Ganesh et al. (2021)

1a Midbody scale rows 19 ..... **2**
1b Midbody scale rows 21, temporal scales larger than body scales ..... ***B. nuchalis***
1c Midbody scale rows 23, temporal scales subequal to body scales ..... ***B. dightoni***
2a Dorsum greenish ..... ***B. flaviviridis***
2b Dorsum brownish **3**
3a Subcaudals > 110 pairs, preocular 1 ..... ***B. beddomei***
3b Subcaudals > 110 pairs, preocular 2 ..... ***B. ranawanei***
3c Subcaudals < 110 pairs **4**
4a Ventrolateral white blotches absent **5**
4b Ventrolateral white blotches present **6**
5 Crown markings on parietals conspicuous and dark; bands dark, prominent ..... ***B. ceylonensis***
6a Preocular 1; dorsum barred ..... ***B. thackerayi***
6b Preoculars 3; dorsum blotched ..... ***B. barnesii***

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Appendix 1

Genbank voucher numbers for the samples used in this study. New sequences generated for this study are marked in bold.

Species	Voucher no.	Location	CYT B	16S
Boiga barnesii	RAP0452	Sri Lanka	KC347469	KC347345
Boiga beddomei	CESS 418	Mhadei WLS, Goa	MT733292	MT734906
Boiga beddomei	CESS 444	Mahabaleswar, Maharashtra, India	MT733294	MT734908
Boiga bourreti	ZISP 32786	Mang Canh, Kon Plong, Kon Tum, Vietnam	MN962356	–
Boiga ceylonensis	RS-Y	Sri Lanka	KC347467	KC347347
Boiga cf. *ranawanei*	RAP0450	Sri Lanka	KC347466	KC347346
Boiga cyanea	CHS553	—	MK201410	MK194064
Boiga cynodon	—	Palawan Islands, Philippines	KC010340	AF139566
Boiga dendrophila	—	—	AF471089	–
Boiga dightoni	BNHS 3597	DevarMalai, Tamil Nadu, India	MT733284	MT734897
Boiga dightoni	ZSI-CZRC-V-7541	Peermed, Kerala, India	**OP948298**	**OP955936**
Boiga dightoni	BNHS 3617	Arippa, Kerala, India	**OP948299**	**OP955937**
Boiga drapiezii	LSUHC7295	—	KX660482	KX660210
Boiga flaviviridis	—	Meghamalai, Tamil Nadu, India	MN508360	–
Boiga flaviviridis	CESS 529	Horsley hills, Andhra Pradesh, India	MT733297	MT734911
Boiga forsteni	RAP0540	Sri Lanka	KC347468	KC347348
Boiga irregularis	—	—	FJ710794	AF139551
Boiga jaspidea	LSUHC7656	Endau-Rompin, Johor, West Malaysia	KX660484	KX660212
Boiga kraepelini	CHS115	—	MK201272	MK193920
Boiga multomaculata	CHS760	—	MK201511	MK194200
Boiga nigriceps	LSUHC7020	—	KX660485	KX660213
Boiga nuchalis	BNHS 3618	Yercaud, Tamil Nadu, India	**OP948300**	–
Boiga nuchalis	CESS 003	Coorg, Karnataka, India	MT733270	MT734883
Boiga nuchalis	CESS 081	Meppadi,Wynad, Kerala, India	MT733274	MT734887
Boiga nuchalis	CESS 192	Kolli Hills, Tamil Nadu, India	MT733282	MT734895
Boiga ochracea	CAS215390	Yinpaungtaing Village, Yin Ma Bin Township, Sagaing, Myanmar	MN962367	–
Boiga quincunciata	CAS221434	Putao Dist. Myanmar	KX660451	KX660177
Boiga schultzei	KU 327776	Estrella Falls Park, Estrella, Narra, Palawan,Philippines	MN962368	–
Boiga siamensis	LSUHC8502	O'lakmeas, Pursat Province, Cambodia	KX660487	KX660215
Boiga thackerayi	CESS_ 271	Thadiyandamol, Karnataka, India	MT733286	MT734899
Boiga thackerayi	BNHS 2371	Koyna, Maharashtra, India	MN508359	–
Boiga thackerayi	CESS 292	KalakadMundanthurai Tiger Reserve, Tamil Nadu, India	MT733287	MT734900
Boiga thackerayi	CESS 443	Mahabaleswar, Maharashtra, India	MT733293	MT734907
Boiga trigonata	RS-143	Sri Lanka	KC347475	KC347349
Boiga westermanni	—	India	MG428713	MG428711
Telescopus tripolitanus	BEV9377	Mauritania	JX315531	MK372141
Telescopus variegatus	—	—	MK373093	MK372142
Toxicodryas pulverulenta	CAS220642	—	KX660460	KX660187

Appendix 2

List of *Boiga* specimens examined in this study. Specimens examined for scale reductions are marked in bold.

***Boiga dightoni* (n = 9)**

Morph 1. BMNH 1946.1.1.32 (Holotype), female, SVL: 935 mm, Peermed, Kerala, India; **BNHS 3597** (Holotype of *B. whitakeri*), male, SVL: 500 mm, Devarmalai, Tamil Nadu, India; FMNH 217699, male, SVL: 932 mm, Ponmudi hills, Kerala, India; **BNHS 3617**, female, SVL: 824 mm, Arippa, Kerala, India

Morph 2. BMNH 1940.10.13.19, female, SVL: 760 mm, Kottayam, Kerala, India; BNHS 1842, SVL: 832 mm; Palakappandi, Nelliyampathy, Kerala, India; **ZSI-CZRC-V-7541**, male, SVL: 780 mm, Peermed, Kerala, India; **ZSI-CZRC-V-7542**, male, SVL: 780 mm, Topslip, Anamalais, Tamil Nadu, India; **BMNH 1940.10.13.19**, female, SVL: 760 mm, Kottayam, Kerala, India; ZSI/SRS/S-73, sex unknown, SVL: 545 mm, Topslip, Anamalai Tiger Reserve, Tamil Nadu, India.

***Boiga beddomei* (n = 1).** BMNH 69.8.28.123 (Lectotype) Female, SVL: 660 mm, Matheran, India.

***Boiga ceylonensis* (n = 7).** BMNH 1946.1.1.29 (Lectotype), sex unknown, SVL: 770 mm, Ceylon; Paralectotypes: BMNH 1946.1.4.78, female, SVL: 250 mm, Ceylon; BMNH 1946.1.4.79, male, SVL: 481 mm, Ceylon; BMNH 1946.1.4.80, female, SVL: 528 mm; BMNH 1945.1.4.71, male, SVL: 507 mm; BMNH 1945.1.4.75, male, SVL: 735 mm, Ceylon; BMNH 1945.1.4.81, female, SVL: 632 mm, Ceylon.

***Boiga flaviviridis* (n = 1).** BMNH 1911.9.8.4 (holotype), sex unknown, SVL: 790 mm, Berhampur, Odisha, India.

***Boiga nuchalis* (n = 10). BMNH 74.4.29.933**, male, SVL: 1010 mm; **BMNH 74.4.29.934**, female, SVL: 722 mm; **BMNH 74.4.29.935**, male, SVL: 740 mm; BMNH 74.4.29.936, juvenile female, SVL: 335 mm, Malabar, Western Ghats, India; **BNHS 3618**, female, SVL: 586 mm, Yercaud, Tamil Nadu, India; **BNHS 3619**, female, SVL: 465 mm, Wayanad, Kerala, India; **BNHS 1863** (paratype of *B. whitakeri*), sex unknown, SVL: 677 mm, Pullompara, Kerala; CAS 17247, male, SVl: 257 mm, Anamallai, India; ZMB 6039, female, SVL: 555 mm, Nilgherries (Nilgiris, Tamil Nadu, India); MCZ 3876, male, SVL: male, Madras, India.

***Boiga thackerayi* (n = 4). BNHS 3569** (holotype), male, SVL: 870 mm, BNHS 3570 (paratype), female, SVL: 493 mm; **BNHS 3571** (paratype), female, SVL: 552 mm, Koyna, Satara, Maharashtra, India; BMNH 74.4.29.66, male, SVL: 531 mm, Anamalais, India.

Appendix 3

Boiga nuchalis (paratype of "*B. whitakeri*", BNHS 1863) showing the dorsal (A), ventral (B) and damaged ventral scales (C).

Appendix 4

Gazetteer of confirmed locality records for *Boiga dightoni* and *B. nuchalis* in India. Localities where we verified only images for confirmation are marked with an asterisk.

Species	Current locality	Latitude	Longitude
*Boiga nuchalis**	Bekkinjaddi, Audala, Karnataka, India	14.73401	74.75821
*Boiga nuchalis**	Guddekeri, Karnataka, India	13.56631	75.1342
*Boiga nuchalis**	Honnavar, Karnataka, India	14.27975	74.44393
*Boiga nuchalis**	Magod Falls, Karnataka, India	14.86487	74.75922
Boiga nuchalis	Mavinagudi, Karnataka, India	14.92432	74.82812
*Boiga nuchalis**	Guddekeri, Karnataka, India	13.56631	75.1342
*Boiga nuchalis**	Mayfield, Tamil Nadu, India	11.55756	76.43534
*Boiga nuchalis**	Rockwood Estate, Tamil Nadu, India	11.53503	76.40159
*Boiga nuchalis**	Hope Estate, Tamil Nadu, India	11.58956	76.06355
*Boiga nuchalis**	Pilloor, Tamil Nadu, India	11.30443	76.80602
*Boiga nuchalis**	Adderly Estate, Nilgiris, Tamil Nadu, India	11.35901	76.85699
Boiga nuchalis	Kolli hills, Tamil Nadu, India	11.295	78.377
Boiga nuchalis	Yercaud, Shervaroys, Tamil Nadu, India	11.83435	78.24079
Boiga nuchalis	Sirumalai hills, Tamil Nadu, India	10.20065	77.99901
*Boiga nuchalis**	Shimoga, Karnataka, India	13.51287	75.14139
*Boiga nuchalis**	Yevakapadi, Karnataka, India	12.20958	75.64052
Boiga nuchalis	Kasargod, Kerala, India	12.49293	75.27597
Boiga nuchalis	Coorg, Karnataka, India	12.20958	75.64052
Boiga nuchalis	Attakatti, Anamalai Tiger Reserve, Tamil Nadu, India	10.44754	76.9861
Boiga nuchalis	Mannarkad, Kerala, India	11.05046	76.47072
Boiga nuchalis	Vythiri, Wayanad, Kerala, India	11.51478	76.03951
Boiga nuchalis	Siruvani, Tamil Nadu, India	10.987	76.622
Boiga nuchalis	Vazhachal, Kerala, India	10.303	76.593
*Boiga nuchalis**	Chimmini dam road, Kerala, India	10.43104	76.49101
Boiga nuchalis	Taliparamba, Kerala, India	12.022472	75.363804
*Boiga nuchalis**	Kervashe Village, Karnataka, India	13.258421	75.081153
Boiga nuchalis	Kalpetta, Wyanad, Kerala, India	11.588	76.1
Boiga nuchalis	Pullompara, Kerala, India	10.086	76.511
Boiga nuchalis	Iruppu falls, Kerala, India	11.969	75.985
Boiga nuchalis	Thadiyendamol, Karnataka, India	12.229	75.623
*Boiga nuchalis**	Potachipara, Bramagiri, Karnataka, India	12.077	75.805
Boiga nuchalis	Forests of west coast of Malabar, Kerala, India	11.545426	75.757901
Boiga dightoni	Peermade, Kerala	9.576675	77.03061
Boiga dightoni	Aanapara, Ponmudi hills	8.69	77.1
Boiga dightoni	Ponmudi, Kerala, India	8.752984	77.12104
Boiga dightoni	Devermala, Kerala, India	9.173	77.261
Boiga dightoni	Arippa, Kerala, India, Kerala, India	8.832483	77.03245
*Boiga dightoni**	Coutrallam, Tamil Nadu, India	8.923837	77.25514
Boiga dightoni	Kottayam, Kerala, India	9.579248	76.54887
Boiga dightoni	Topslip, Tamil Nadu, India	10.46901	76.84185
Boiga dightoni	Manampalli, Anamalai Tiger Reserve, Tamil Nadu, India	10.35406	76.87829
*Boiga dightoni**	Kalakad Mundanthurai Tiger Reserve, Tamil Nadu, India	8.880428	77.28482
Boiga dightoni	Palagapandy, Nelliampathy, Kerala, India	10.56112	76.7304

Appendix 5

Scale reduction formula for the two *Boiga thackerayi* type specimens at BNHS, Mumbai, India.

BNHS 3569 (male, holotype)

8+9(121), +9(123), 8+9(130) 3+4(144)
19----------**17**----------**15**(221)
8+9(121), +9(123), 8+9(125), +9(126), 9+10(127), 3+4(144)
+9(131), 8+9(132)

BNHS 3571 (female, paratype)

9+10(139), +9(140), 9+10(141) 3+4(145)
19----------**17**----------**15**(212)
9+10(138) 3+4(142)

Appendix 6

Representative images of live *B. nuchalis*: **A** Wayanad, Kerala (uncollected), **B** Attakatti, ATR, Tamil Nadu (uncollected), **C** Yercaud, Tamil Nadu (BNHS 3618).