

## On further specimens of the Pit viper *Trimeresurus erythrurus* (Cantor, 1839) (Squamata: Viperidae), with description of a topotype and range extension to the Godavari Basin, peninsular India

Kaushik Deuti<sup>1</sup>, Ramaswamy Aengals<sup>2</sup>, Sujoy Raha<sup>1</sup>, Sudipta Debnath<sup>1</sup>, Ponnusamy Sathiyaselvam<sup>3</sup> and Sumaithangi Rajagopalan Ganesh<sup>4\*</sup>

<sup>1</sup>Zoological Survey of India, Herpetology Division, 27 JL Nehru Road, Kolkata 700016, West Bengal, India

<sup>2</sup>Zoological Survey of India, Sunderbans Field Research Center, Canning 743329, West Bengal, India

<sup>3</sup>Bombay Natural History Society, Hornbill House, Shaheed Bhagat Singh Marg, Mumbai 400023, India

<sup>4</sup>Chennai Snake Park, Rajbhavan post, Chennai 600022, Tamil Nadu, India

\*Corresponding author ✉: [snakeranglerr@gmail.com](mailto:snakeranglerr@gmail.com)

### Abstract

We report on a topotypical specimen of the spot-tailed pit viper *Trimeresurus erythrurus* recorded from Sunderbans in India and a distant, southerly, range extension from Kakinada mangroves, based on preserved (n= 1, seen in 2019) and live uncollected (n= 2; seen in 2014) specimens, respectively. The specimens (n= 3) share the following characteristics: verdant green dorsum, yellow iris, white ventrolateral stripes in males, 23 midbody scale rows, 161–172 ventrals, 61–76 subcaudals, and reddish tail tip. Drawing on the published records, its apparent rarity within its type locality and lack of records from the Circar Coast of India, our study significantly adds to the knowledge of the distribution and morphology of this species. Being a medically important venomous snake, its presence in the Godavari mangrove basin calls for wider dissemination of this information among medical practitioners, in addition to fundamental researchers like academics and herpetologists.

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### Introduction

Oriental Pit vipers of the genus *Trimeresurus* Lacépède, 1804 are a highly diverse group of over 50 species of little-known venomous snakes (David et al., 2011; Uetz et al., 2021). Of these, the Spot-tailed pit viper, *Trimeresurus erythrurus* (Cantor, 1839) is a species of venomous snake found in Indo-Burma, encompassing Northeast India, Bangladesh, Bhutan, Nepal and Myanmar (Smith, 1943; Leviton et al., 2003; Gumprecht et al., 2004; Whitaker and Captain, 2004; Vogel, 2006; Ahmed et al., 2009; Das et al., 2009; Mahony et al., 2009; David et al., 2011; Wallach et al., 2014; Hakim et al., 2020). This species was originally described as *Trigonocephalus erythrurus* by Theodore Edward Cantor in 1839, from the type locality “Delta Gangeticum” alluding to the Sunderban mangroves of the present time. As Theodore Edward Cantor worked for the British East

India Company at that time and was based at “Calcutta” it can be supposed that the holotype came from the Indian Sunderbans of the West Bengal State. The description was very brief with only a few lines of coloration features and the holotype, BMNH 1946.1.19.99 (ex. 1894.6.25.15), is a subadult female (Snout-vent Length (SVL) 322 mm, Tail Length (TL) 71 mm) having 167 ventral scales and 68 subcaudal scales (Cantor, 1839; Wallach et al., 2014; Patrick David, pers. comm.).

To date, this species has been reported from the mesic forested zones in the Indo-Burma region (Smith, 1943; Gumprecht et al., 2004; Whitaker and Captain, 2004; Vogel, 2006; Ahmed et al., 2009), but has rarely, if ever, been reported from its type locality, subsequently. Unlike the later records (fide Gumprecht et al., 2004; Wallach et al., 2014) of this species (Eastern Himalayas, Puruvanchal Ranges,

Terai Plains, Arakan Yomas of northeast India and Myanmar), the type locality lies in a lowland (< 200 m a.s.l.), seashore delta or mangrove swamp area in the Bay of Bengal (the Sunderbans of India and Bangladesh). The only other country, apart from India, that shares this ecoregion is Bangladesh. In Bangladesh vouchered records of *T. erythrurus* are only from near Chittagong (Mahony et al., 2009; Ahsan et al., 2015) away from the mangroves. In this work, we report on the morphology of a topotypical specimen (also a juvenile female) and present significant range-extension records of *T. erythrurus* south along the Circar Coast on the Indian peninsula.

## Material and Methods

This study is based on examination of both live (n= 2; in 2014) and preserved (n= 1; in 2019) specimens. We follow David et al. (2001; 2002) for scoring morphometric data and for the nomenclature and definition of terminologies. The voucher specimen was preserved in the Zoological Survey of India, Canning Station, registered as ZSI/KN-2713. Measurements were taken with a Mitutoyo™ digital caliper to the nearest 0.01 millimeter. Snout to vent length (SVL) and tail length (TL) were measured with a tape. In the live snakes, fewer measurements were made, as it is not possible to score as detailed information as in the case of a preserved specimen. But yet, the species identity of the uncollected snakes was determined unambiguously. Symmetrical morphological character values were given in left / right (L/R) order.

Sex was determined by tail base palpation and by the probing method. Photographs were taken using high resolution digital cameras (Canon EOS 7D; Canon Powershot SX 130 IS). Color notes were taken either when the snakes were alive or shortly after euthanasia (for the topotype) or based on photos. GPS coordinates were sourced from Google Earth software and represented in decimal degrees format, rounded up to three decimal places.

## Results

Our examination of the external morphology (scalation, measurements; see Tables 1 and 2) of the snakes from both Sunderbans, South 24 Parganas, West Bengal, India and Kakinada, East Godavari district, Andhra Pradesh, India (Fig. 1) reveal conspecificity between both these populations and congruence with *Trimeresurus erythrurus* sensu Gumprecht et al. (2004). These snakes differ from the broadly sympatric and similar-looking *Trimeresurus salazar* Mirza, Bhosale, Phansalkar, Sawant, Gowande and Patel, 2020 as follows: scales on top of head beady; body scales keeled; lack of red post-ocular and ventro-lateral stripes in males; lack of distinctly yellowish dorsal colour in females (see Mirza et al., 2020). We use this opportunity and data set to address two issues concomitantly: modern, extended

morphological description of a topotypic specimen (ZSI/KN-2713) and to record its range extension from a distant site (Kakinada) by direct comparison with a topotype for accuracy. Below, we elaborate on the morphology of the preserved specimen from Sunderbans and supplement it with data from the live snakes examined in Kakinada.

### *Trimeresurus erythrurus* (Cantor, 1839)

Tables 1, 2; Figures 2, 3.

#### Preserved specimen examined

ZSI/KN-2713, sub-adult female, Collector Ramaswamy Aengals and party in July 2019 from Netidhopani, the Sunderban Tiger Reserve, South 24 Parganas district, West Bengal.

#### Live specimens examined

Two adult males (probe reached 20–22 subcaudals) sighted by Ponnusamy Sathiyaselvam and his team in the Coringa Wildlife Sanctuary in the East Godavari district, Andhra Pradesh during January 2014.

#### Description (based on the topotype, ZSI/KN-2713)

Body small, with a tail 0.2 times that of snout-vent length. Head 1.6 times longer than wide. Snout length half of head length. Nostril nearer, 0.26 times, to snout tip than to eye. Loreal pit 0.35 times nearer to eye than to snout tip, and slightly higher than wide. Eye diameter 0.5 times the snout length. Internasal distance 0.4 times the inter-orbital distance. Rostral triangular, not visible from above, 1.3 times broader than high. First supralabial completely fused to nasal. One pair of enlarged, slightly curved internasals, fully in contact with each other, 2 times as long as wide. Scales on upper snout irregular and imbricate, smaller (0.77–0.78 times) than width of internasals; 5/7 canthal scales bordering canthus rostralis between internasal and corresponding supraocular, slightly larger than adjacent snout scales. One triangular loreal scale between two upper preoculars and nasal. Two upper preoculars above loreal pit, elongate and in contact with loreal scale. One lower preocular forming lower margin of loreal pit. Postoculars 2/3. One large, entire, long and relatively narrow supraocular on each side, 2.5–2.9 times longer than broad. Supraoculars much wider than adjacent upper head scales, indented on their inner margin by the upper head scales. Supraoculars 1.1–1.2 times wider than internasal but separated from each other by 13 smooth cephalic scales. 6 snout scales in a line between interjunction of internasals and a line connecting the anterior margin of eye. Cephalic scales smaller (0.56–0.62 times width of supraoculars), irregular, juxtaposed, smooth and flat on upper head surface. Snout and cephalic scales without any keels. Dorsal scales with one moderate keel. One thin, elongated, crescent-like subocular extending up to posterior corner of eye. Temporal region having rather small, subequal scales in 4 rows, with one distinct keel on each scale row.

**Table 1:** Measurements of the preserved topotype (ZSI/KN-2713) and live uncollected specimens of *Trimeresurus erythrurus* from Coringa, East Godavari, Andhra Pradesh, India.

Measurements (in mm)	ZSI/KN-2713 (Female)	Coringa Sp. 1 (Male)	Coringa Sp. 2 (Male)
Snout-vent length	261.0	670.0	700.0
Tail length	55.0	180.0	200.0
Total length	316.0	850.0	900.0
Relative tail length	0.2	0.21	0.22
Head length	11.4	30.0	33.5
Head width	7.2	22.0	25.0
Head height	7.5	12.0	12.0
Snout length	5.3	-	-
Tip of snout to nostril	1.4	10.5	11.5
Nostril to Loreal pit	2.0	5.5	6.5
Loreal pit to eye	0.8	3.0	3.5
Eye to nostril	2.8	11.5	12.0
Eye to upper lip	2.5	3.5	4.0
Nostril diameter	0.4	-	-
Loreal pit width	1.0	-	-
Loreal pit height	2.0	-	-
Eye diameter (horizontal)	2.6	4.0	4.5
Eye diameter (vertical)	2.1	2.5	3.0
Inter-nasal distance	2.9	-	-
Inter-orbital distance	7.0	-	-
Rostral width	2.2	-	-
Rostral height	1.7	-	-
Internasal length (L/R)	1.7 / 2.0	-	-
Internasal breadth (L/R)	0.9 / 0.9	-	-
Diameter of snout scale	0.7	-	-
Supra-ocular length (L/R)	3.1 / 3.2	-	-
Supra-ocular breadth (L/R)	1.2 / 1.1	-	-
Diameter of head scale	0.7	-	-
Second supralabial width	1.6	-	-
Second supralabial height	2.4	-	-
Third supralabial width	2.2	-	-
Third supralabial height	1.7	-	-
Fourth supralabial width	1.35	-	-
Fourth supralabial height	1.11	-	-
Fifth supralabial width	0.96	-	-
Fifth supralabial height	0.85	-	-
Mental width	2.20	-	-
Mental height	1.70	-	-

Ventral scales without any keels. Supralabials 10/10. First supralabial rectangular and fused to nasal completely. Second supralabial 1.5 times higher than wide, forming the anterior border of loreal pit. Second supralabial separated from nasal by 2/2 very small scales. Third supralabial distinctly enlarged and much longer, 1.4–2.3 times than other supralabials, pentagonal and touching lower preocular and subocular. Third supralabial approximately 1.3 times as long as high. Fourth supralabial distinctly shorter, 0.64 times as high as the third supralabial and separated from the subocular by one scale row with a single prominent keel. Fifth supralabial onwards are smaller 0.7 times as long as fourth supralabial. Fifth supralabial separated from subocular by two rows of scales which all have a single prominent keel each. Infralabials 13/12, those on the first pair in contact with each other. Mental triangular, 1.3 times broader than high and almost same size as the rostral. Chin shield in contact with the first two infralabials (on left side) and first three infralabials (on right side).

6/6 gular scales present. Ventrals: 161 + 3 pre-ventrals, sub-caudals: 61 paired + 1 terminal unpaired scale, dorsal scale rows: 22:23:16.

#### Coloration (based on preserved and live specimens)

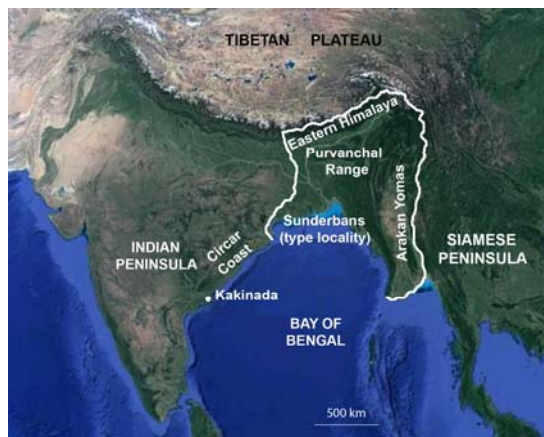
In fixative (70% alcohol), dorsal and lateral sides of body uniformly dark green, slightly paler on bottom of flanks. Rostral and supralabials pale emerald green. Chin, throat and venter creamy white up to mid half of its length, thereafter, turning to emerald-green up to the vent. Tail dark green both dorsally and ventrally in its anterior part but deep red turning into deep maroon both dorsally and ventrally in its posterior part.

In live specimens, dorsum and flanks bright green while supralabials and infralabials, rostral and mental uniform yellowish-green. Throat creamy white, venter greenish-yellow, with some small black ventrolateral spots. In the males from Kakinada, the white ventrolateral stripes present either obscured or clearly

visible. Eyes golden-yellow. Tail anteriorly bright green and posteriorly cinnamon red until close to the tip.

**Table 2:** Scalation of the preserved topotype (ZSI/KN-2713) and live uncollected specimens of *Trimeresurus erythrurus* from Coringa, East Godavari, Andhra Pradesh, India.

Characters	ZSI/KN-2713 (Female)	Coringa Sp. 1 (Male)	Coringa Sp. 2 (Male)
Scale rows behind head	22	23	24
Scale rows at midbody	23	23	23
Scale rows before vent	16	17	17
Keels of mid-dorsal scales	keeled	fully keeled	fully keeled
No. of ventral scales	161	165	172
No. of subcaudal scales	61	76	72
Ventral scales	mildly angulate	mildly angulate	mildly angulate
Subcaudal scales	divided	divided	divided
Supralabial scales	10, 10	10, 9	10, 10
Head scales between inter nasals and limit of neck	36	33	36
Snout scales (between inter nasals and before eye)	6	7	7
Internasal scale(s)	2	2	2
Canthal scales (between internasal and supraocular)	5, 7	6, 7	6, 6
Cephalic scales (between middle of supraoculars)	13	11	13
Temporal scales	23, 23	23, 24	24, 24
Infralabials	13, 12	14, 13	13, 13
No. of supralabial scales	20	19	20
Scales between 3rd supralabial and subocular	0	0	0
Scales between 4th supralabial and subocular	3	3	3
Scales between 4th and 5th supralabial and subocular	5	5	5
Keeling of occipital scales	fully keeled	fully keeled	fully keeled
Keeling of temporal scales	mild	mild, beady	mild, beady
No. of scales separating the internasals	0	0	0
No. of scales directly in contact with supraocular	9, 9	8, 9	9, 9



**Figure 1:** Map showing the extended distribution of *Trimeresurus erythrurus*, to Kakinada on the Circar Coast, that is 900 km southwest of Sunderbans (type locality). The previous established global geographic range is outlined (after Vogel, 2006).

#### Field observations (Fig. 4)

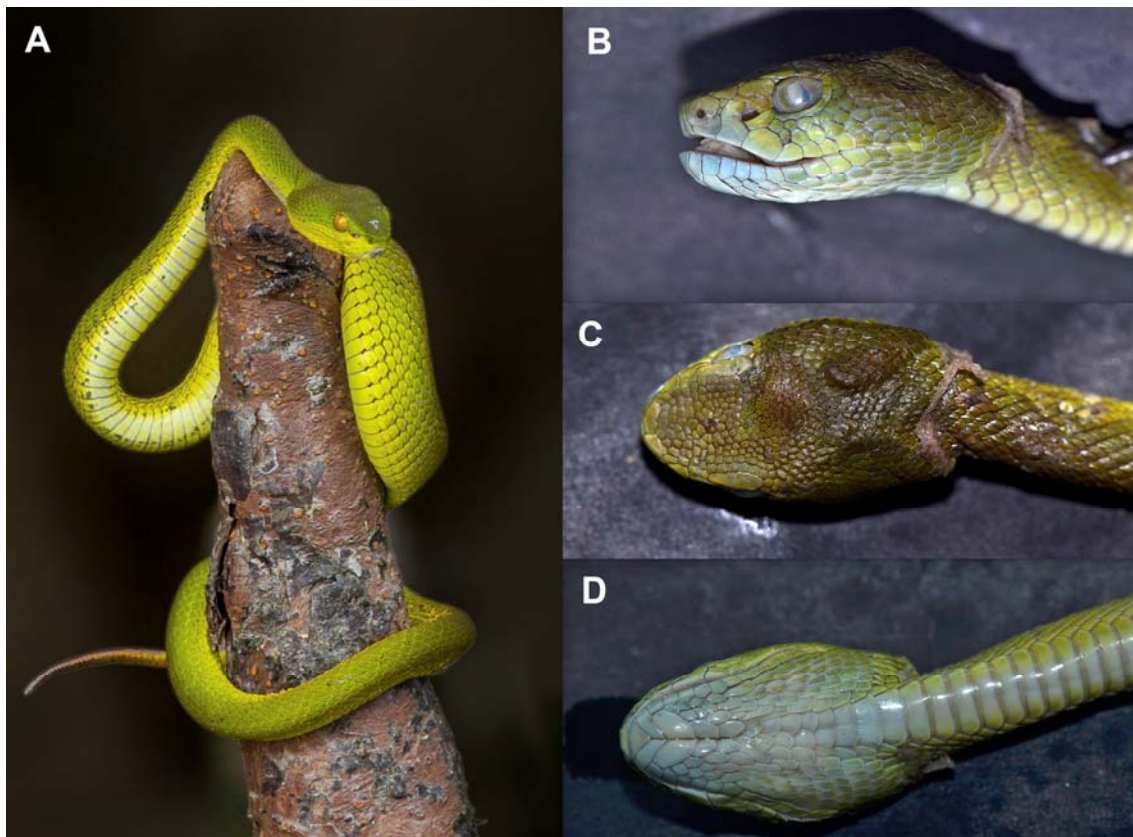
The topotype, a subadult female, was collected in August 2019 from Netidhopani (21.918°N, 88.747°E; 6 m a.s.l.) mangroves inside the core area of the Sunderban Tiger Reserve, India. The snake was

sighted on a barbed wire fence, 1.5 meters above the ground at 16:00 hrs. Another juvenile and an adult were also seen on the same barbed wire fence 2.5 meters above the ground.

There is a watch-tower for the forest department at Netidhopani and the passage from the jetty to the watch tower is protected against tiger attack by a barbed wire fence on which the snakes were seen. Many times, tourists have also seen this pit-viper snake on barbed wire fencing and in the Forest Department Staff quarters at other watch towers too (Sudhyanakhali, Dobanki, pers. comm?) inside the Sunderban Tiger Reserve.

Several wildlife photographers have also photographed *T. erythrurus* here. At other times these pit-vipers have been observed on branches of mangrove plants and basking on their emergent pneumatophores (breathing roots). They seem to feed (pers. obs.) on the Asian house geckos (*Hemidactylus frenatus* Schlegel), the tree frogs (*Polypedates* sp.), insects and perhaps on the small mangrove crabs (*Metapograpsus* spp).

On rare occasions some boatmen in the Sunderbans have observed them swimming for short distances during high tides.



**Figure 2:** Topotypic specimen of *Trimeresurus erythrurus* from Sunderbans, West Bengal, India, showing view in life (A) and in preservation (B-D). Photos by Biju Mukherjee, Arpan Saha, and Soumyojit Nandy.

The Sunderban mangroves in the West Bengal State of India consists of 104 islands and adjoining rivers, canals and creeks. Of these, 54 islands are inhabited by humans and 48 are completely forested and uninhabited. Although the total area of the Sunderbans in India is about 4260 km<sup>2</sup>, the actual mangrove forests are mainly restricted to the 2585 km<sup>2</sup> of the Sunderban Tiger Reserve, the only mangrove tiger reserve on earth. *Trimeresurus erythrurus* appears restricted to the mangrove forests of the uninhabited islands of the Sunderban Tiger Reserve (pers. obs.; Soumyajit Nandy and Arpan Saha pers. comm.).

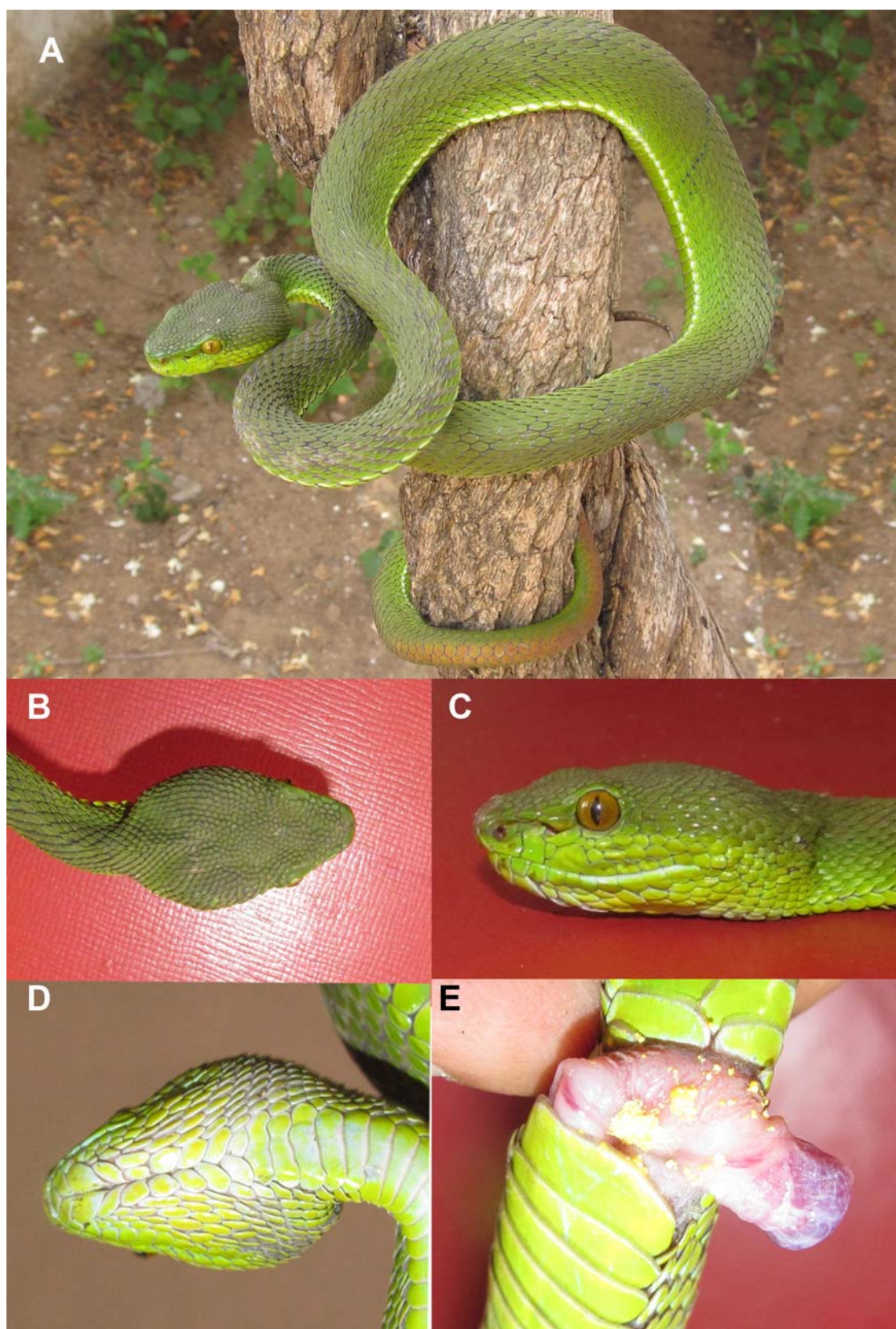
During January 2014, in the mangrove forest of Coringa Wildlife Sanctuary (16.883°N, 82.249°E; 5 m a.s.l.), in East Godavari district, Andhra Pradesh state, two adult males were sighted. The snakes were seen during the daytime, resting coiled up on branches of mangrove vegetation at eye level. The snakes were seen on consecutive days, in more or less the same spot, near the boat-anchoring area where boats are tied to pegs fixed on the banks. When aroused, they targeted the moving adversary and struck repeatedly, often lunging forward with open mouth.

During restraint and morphological examination, the snakes (both males) exuded a yellowish, bitter-smelling anal fluid.

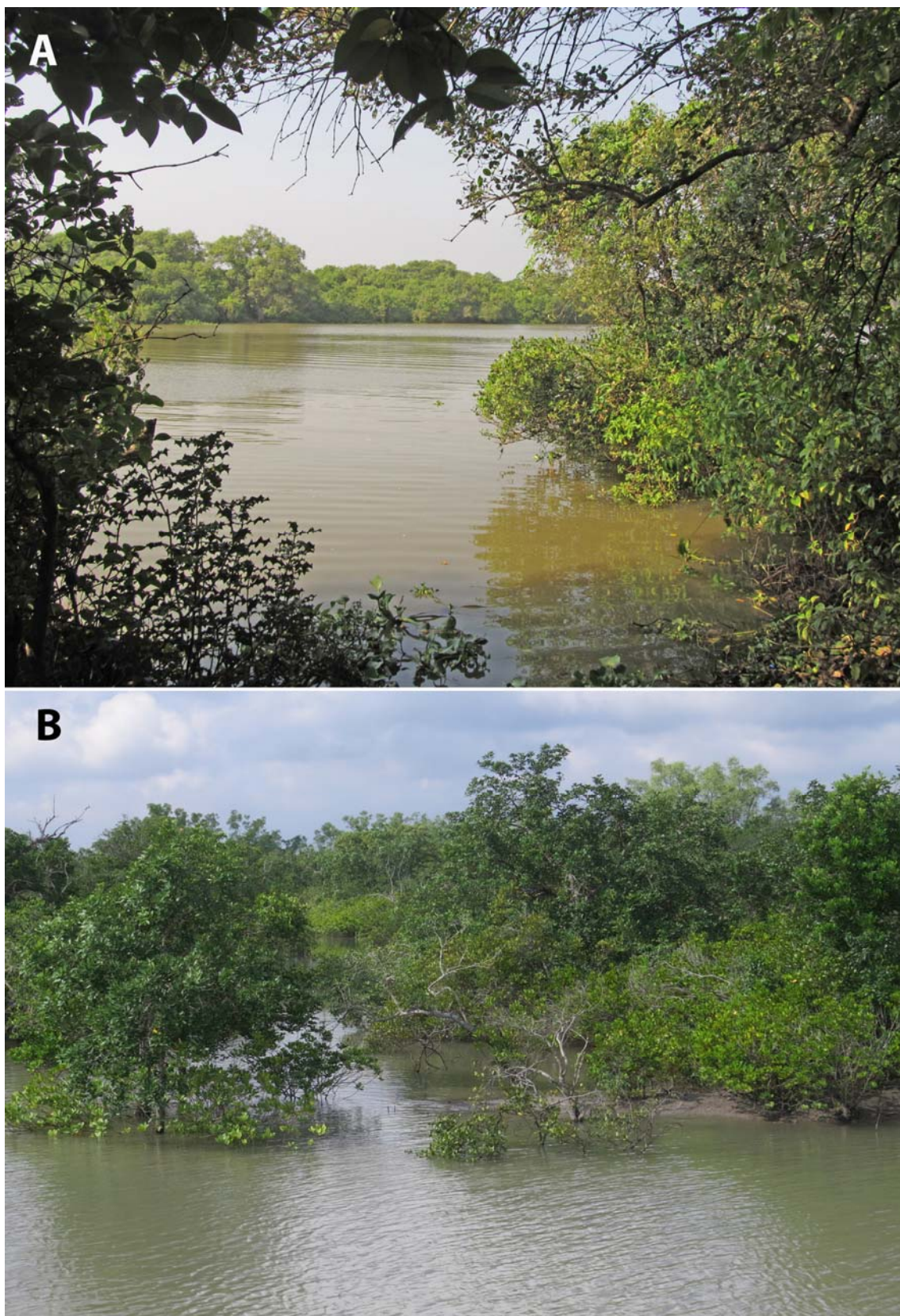
The peripheries of the sanctuary area, around where the snakes were seen, are somewhat polluted and affected by man-made threats such as habitat loss and over exploitation of resources. No other non-marine snakes were sighted at this locality.

Potential prey species sighted were the garden lizards, *Calotes versicolor* (Daudin), the bark gecko, *Hemidactylus leschenaultii* Duméril and Bibron, mudskipper fish (Family Oxudercidae) and birds like the small blue kingfishers, *Alcedo atthis* (Linnaeus).

During our interactions with elderly locals, we understood that many seem to know this snake and that its bite causes severe pain, bleeding, swelling but not death.



**Figure 3:** Live uncollected specimen of *Trimeresurus erythrurus* from Kakinada, Andhra Pradesh, India – Specimen 1: entire (A), Specimen 2: dorsal head (B), lateral head (C), ventral head (D), and the male anal profile (E). Photos by S.R. Ganesh.



**Figure 4:** Mangrove habitats of *Trimeresurus erythrurus* in Kakinada, Andhra Pradesh, India (A) and Sunderbans, West Bengal, India (B). Photos by S.R. Ganesh and Kaushik Deuti.

## Discussion

From our data, it is clear that the studied specimens from Kakinada and Sunderbans are conspecific and represent *T. erythrurus* sensu Gumprecht et al. (2004). The only difference between the Sunderbans and Kakinada snakes being sexually dimorphic traits: white ventrolateral stripes (present only in Kakinada snakes), subcaudal count (61 in Sunderbans vs. 72–76 in Kakinada snakes) and relative tail length (0.17 in Sunderbans vs. 0.21–0.22 in Kakinada snakes). Our data fully agree with *T. erythrurus*, except for slightly higher (172) ventral count for one of our males (< 165 in males; Whitaker and Captain, 2004).

We also note here that the map for this species did not contain its type locality (Whitaker and Captain, 2004). This species was previously briefly described based on a juvenile female collected from the Sunderbans about 180 years ago (Cantor, 1839). Since then, except for some sporadic photographic records, no published topotypic reports with morphological description are known (Leviton et al., 2003; Gumprecht et al., 2004; Whitaker and Captain, 2004; Ahmed et al., 2009; Das et al., 2009; Mahony et al., 2009; Wallach et al., 2014; Hakim et al., 2020). Thus, this description gives detailed information on the morphology of a topotypic specimen. Our field observations also add more information on the natural history of the species from its type locality—the Sunderbans mangroves (also see Basu and Cetzal-Ix, 2018).

Our finding of *T. erythrurus* – an essentially northeast Indian and the Indo-Burmese species (Gumprecht et al., 2004; Whitaker and Captain, 2004; Vogel, 2006; Ahmed et al., 2009; Wallach et al., 2014; Chen et al., 2020; Mirza et al., 2020) in the southern reaches of eastern India from the Godavari Basin may come as a surprise. The Coringa Wildlife Sanctuary, though small, is situated near Kakinada close to the famous Vishakapatnam city. This is a place that was an historical hub of herpetological explorations, most notably by Patrick Russell. Snakes such as *Cerberus rhynchops* (Schneider), *Enhydryis enhydryis* (Schneider) were in fact described from mangroves close to Vishakapatnam and Srikakulam (Bauer, 2015; Bauer et al., 2015). Two publications (Russell, 1796; Underwood, 1946) reporting reptiles from this region did not feature *T. erythrurus*, making ours the first documented record.

The Coringa Wildlife Sanctuary, Kakinada is about 100 km southwest of Vishakapatnam. The Krishna Delta Basin is a further 100 km southwards, along the Coromandel Coast near Machilipatinam; one of the earliest colonies of the European forces in the Coromandel and type locality of snakes discovered by Russell (Bauer, 2015). We stress that, in fact, compared to the northeast Indian and the Indo-Burmese hills, Kakinada is even more homogenous and contiguous with the type locality—the Sunderbans.

Described originally from the Sunderbans mangroves, *T. erythrurus* is also found in Bhitarkanika mangroves of Odisha (Gowrishankar pers. comm. April 2020), where a subset of typical Sunderbans herpetofauna: such as the estuarine crocodile (*Crocodylus porosus*), the water monitor (*Varanus salvator*) and the king cobra (*Ophiophagus hannah*) occur (Daniel, 2002; Das, 2002). The present observation extends the range further south across the Mahanadi River Basin, and into the Godavari Basin. It remains to be seen if the species occurs further south in the Krishna River Basin, at least its northern delta edge. Coringa is nearly 700 km southwest of Bhitarkanika and 900 km from the West Bengal (Haldia), a reference locale that is within the imprecise type locality and the present observation of a topotypic specimen. Being a venomous snake, reported to cause morbidity in humans (Pe et al., 2000 in Bangladesh), our findings of *T. erythrurus* in Kakinada mangroves also have direct bearing on medical issues and warrants the attention of medical practitioners and policy makers in coastal Andhra Pradesh, India.

Also, we advocate DNA studies (Malhotra and Thorpe, 2004) on this and other populations of *T. erythrurus* from across its distribution range (Wallach et al., 2014; this work) to understand its relationships and possible cryptic diversity.

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## Conflict of interest

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



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