

Notes on the distribution and morphology of *Coelognathus helena* (Daudin, 1803) (Squamata: Colubridae) from Gujarat State, India

Harshil Patel^{1,2*}, Rajdeep Jhala³ and Raju Vyas⁴

¹Department of Biosciences, Veer Narmad South Gujarat University, Surat 395007, Gujarat, India

²Voluntary Nature Conservancy, 101-Radha Darshan, Behind Union Bank, Vallabh Vidyanagar 388120, Gujarat, India

³42, Satyam Park, Nana Mauva Road, Rajkot, Gujarat, India

⁴1 - Shashwat Apartment, 23 Anandnagar Society, BPC Road, Alkapuri, Vadodara 390007, Gujarat, India

*Corresponding author ✉: harshilpatel121@gmail.com

Abstract

We provide an account on the distribution, morphology and biology of the Indian trinket snake, *Coelognathus helena* (Daudin) from Gujarat, India, and report the first record of the subspecies, *Coelognathus helena nigriangularis* Mohapatra, Schulz, Helfenberger, Hofmann, and Dutta from the Gujarat state based on reptile surveys throughout the state. We show that our understanding regarding the morphology of this species is not fully known as our series of specimens shows range of 204–245 ventral scales in *C. h. helena* and 219–279 ventral scales, 78–98 subcaudal scales in *C. h. monticollaris*.

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Introduction

The old world colubrid snakes of the genus *Coelognathus* Fitzinger, 1843 are represented by seven species distributed in South and Southeast Asia, namely *Coelognathus helena* (Daudin, 1803), *C. radiatus* (Boie, 1827), *C. flavolineatus* (Schlegel, 1837), *C. subradiatus* (Schlegel, 1837), *C. erythrurus* (Duméril, Bibron and Duméril, 1854), *C. enganensis* (Vinciguerra, 1892) and *C. philippinus* (Griffin, 1909), of which the first three species are found in India (Mohapatra et al., 2016; Uetz et al., 2021). All these mentioned species have formerly been members of the ratsnake genus *Elaphe* Fitzinger, 1833 (Schulz, 1996; Utiger et al., 2005).

Coelognathus helena, commonly known as the Indian Trinket snake, is a widely distributed species reported from India (Whitaker and Captain, 2004), Bangladesh (IUCN Bangladesh, 2015), Bhutan (Wangyal et al., 2020), Nepal (Schleich and Kästle, 2002; Kästle et al., 2013) and Sri Lanka (De Silva, 2009). This species was originally described as *Coluber helena* by a French Zoologist, François Marie Daudin (1803), based on the description and an illustration by Patrick Russell (1796) (Fig. 1).

Smith (1943) considered *Coluber helena* as a member of the genus *Elaphe*. Later, Helfenberger (2001) revalidated the genus *Coelognathus* and transferred *E. helena* to *Coelognathus*. Now, *C. helena* has three subspecies, namely *C. h. helena* (Daudin, 1803), *C. h. monticollaris* (Schulz, 1992) and *C. h. nigriangularis* Mohapatra, Schulz, Helfenberger, Hofmann, and Dutta, 2016. All three subspecies are well distinguished having significant morphological differences in body markings and patterns (Mohapatra et al., 2016). *Coelognathus helena helena* is widely distributed throughout India, Nepal, Bangladesh and Sri Lanka (Schulz, 2013), *C. h. monticollaris* occurs in Western Ghats from the states of Gujarat to Kerala and forests of Southern India (Mohapatra et al., 2016) and *C. h. nigriangularis* is a recently described subspecies, reported from the states of Odisha, Madhya Pradesh, Chhattisgarh, Jharkhand, Rajasthan, Maharashtra, Andhra Pradesh and West Bengal, India (Mohapatra et al., 2016; Chowdhury, 2018). Gujarat is the western most state of India and two subspecies of *C. helena* have been reported from the state, namely *C. h. helena* (Fig. 2), distributed throughout the state and *C. h. monticollaris* (Fig. 3), found in the forests of southern Gujarat (Vyas, 2009; Patel and Vyas, 2019).

Recently, we came across a specimen that did not match the description of the two reported subspecies from Gujarat. A detailed examination and morphological comparison confirmed that the specimen belongs to *C. h. nigriangularis* (Fig. 4). This is a first record for the Gujarat state. Also, we provide additional data on the other two subspecies already reported from the state.

The present study is based on 16 live specimens (nine specimens of *Coelognathus helena helena*, HP 11 to HP 15 and RV11 to RV 14; six specimens of *C. h. monticollaris*, HP 16 to HP 20 and RV 15; one specimen of *C. h. nigriangularis*, RJ). The specimens were found during active field search during day or nighttime, nocturnal road cruising or were rescued by snake rescuers and brought to us. The individuals were photographed, examined and released at the same locality. The present study was conducted with appropriate permissions granted by the Forest Department of Gujarat state (permit numbers WZP/5585/22/C/590-92/3-8-1990 and B/WPS/8/9388-92/2013-14) and in accordance with the Indian Wildlife (Protection) Act 1972. The pholidosis, morphometric and locality data of the specimens are given in Table 1. Abbreviations used in the specimen numbers are as follow: HP, Harshil Patel field series; RV, Raju Vyas field series; RJ, Rajdeep Jhala field series. Map was prepared using the QGIS software (available at: <https://qgis.org/en/site/>). Images were taken with either a Canon 700D camera using a Canon 100-mm macro lens and illumination using the inbuilt flash or a Canon SX40 camera.

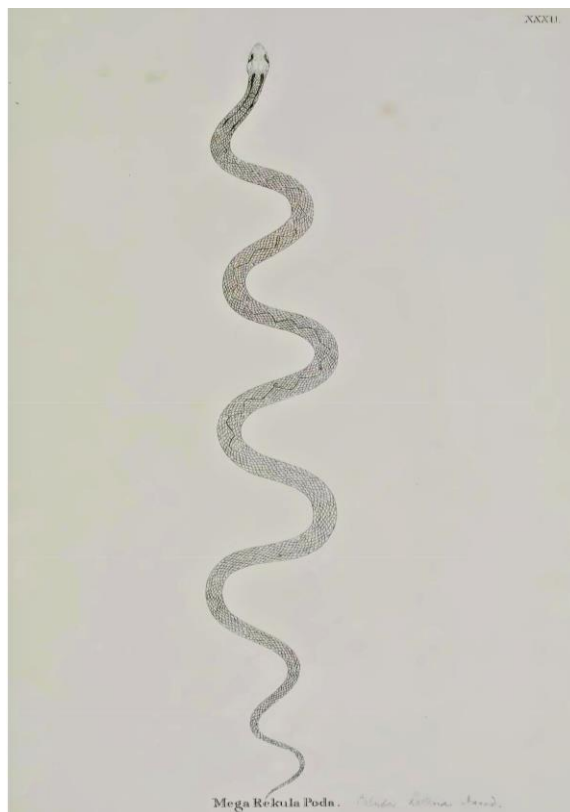


Figure 1: Drawing of the holotype of *Coluber helena* Daudin, 1803, reproduced from Russell (1796: 37, plate 32).



Figure 2: *Coelognathus helena helena* in life from Gujarat, India; Dorsal aspect of the entire individual HP 12 from Valsad (A), and lateral view of head of HP 13 from Waghai (B).



Figure 3: *Coelognathus helena monticollaris* (HP 16) in life from Saputara, Dang, Gujarat, India; Dorsolateral view of the entire specimen (A), and lateral view of head (B).



Figure 4: *Coelognathus helena nigriangularis* (RJ) in life from Kevadiya, Narmada, Gujarat, India; Dorsolateral aspect of the entire specimen (A), and lateral view of head (B).

Table 1: Scale counts, measurements [mm] and collection details for the examined specimens of *Coelognathus helena*.

Subspecies	Specimen No	Locality	Coordinates	Collection Date	TL	SVL	TaL	D	V	A	SC	SL	L	IL	PreO	PostO	T	Sex
<i>Coelognathus helena helena</i>	HP 11	Mogarawadi, Valsad	20°36'52.2"N 72°56'32.4"E	04-May-2012	1180	945	235	25:25:19	239	Undivided	78	11(5-7)/11(5-7)	1/1	12/12	1/1	2/2	1+3+3/1+3+3	Female
	HP 12	Nanakwada, Valsad	20°35'28.4"N 72°55'25.3"E	24-May-2013	940	735	205	23:27:19	226	Undivided	93	10(5-7)/10(5-7)	1/1	11/11	1/1	2/2	2+2+3/2+2+3	Male
	HP 13	Waghai, Dang	20°46'56.6"N 73°29'50.4"E	19-Sept-2014	780	610	170	25:25:19	228	Undivided	94	9(5,6)/9(4-6)	1/1	10/10	1/1	2/2	2+2+3/2+2+3	Male
	HP 14	Vesu, Surat	21°09'04.8"N 72°46'55.1"E	18-Oct-2016	965	-	-	23:25:19	235	Undivided	82	10(5-7)/10(5-7)	1/1	11/11	1/1	2/2	2+2+3/2+2+3	ND
	HP 15	Bhavnath, Junagadh	21°31'59.5"N 70°30'21.6"E	15-July-2017	540	420	120	25:25:21	218	Undivided	96	10(5-7)/10(5-7)	1/1	11/11	1/1	2/2	2+2+3/2+2+3	ND
	RV 11	Indroda, Gandhinagar	23°11'49.74"N 72°39'10.08"E	15-Sep-2018	1020	-	-	25:27:21	220	Undivided	87	9(5-7)/9(5-7)	1/1	10/11	1/1	2/2	2+3/2+2	Female
	RV 12	Napad, Anand	22°28'45.47"N 72°58'38.89"E	5-Oct-2019	280	220	60	23:25:21	245	Undivided	88	10(5-7)/10(5-7)	1/1	11/10	1/1	2/2	2+3/2+2	Female
	RV 13	Padra, Vadodara	22°14'10.67"N 73°4'57.47"E	8-Feb-2021	1115*	920	195*	23:25:23	225	Undivided	64*	9(4-6)/9(4-6)	1/1	11/11	1/1	2/2	2+3/2+2	Female
	RV 14	Ghayaj, Padra, Vadodara	22°12'58.76"N 73°5'13.87"E	8-Feb-2021	755	535	220	25:27:19	204	Undivided	93	10(5-7)/10(5-7)	1/1	11/10	1/1	2/2	2+2/2+2	Male
	<i>Coelognathus h. monticollaris</i>	HP 16	Saputara, Dang	20°35'05.0"N 73°45'04.6"E	27-May-2016	1440	1150	290	25:25:19	234	Undivided	84	9(5,6)/10(5-7)	1/1	10/10	1/1	2/2	1+3+3/1+3+3
HP 17		Dhulda, Dang	20°57'14.2"N 73°39'04.2"E	24-Mar-2012	1250	1010	240	25:25:19	248	Undivided	78	9(5,6)/10(6,7)	1/1	9/10	1/1	2/2	1+3+2/2+2+2	Female
HP 18		Waghai, Dang	20°45'05.4"N 73°29'46.2"E	5-Sep-2015	620	-	-	-:25:-	221	Undivided	93	9(5,6)/9(5,6)	1/1	10/10	1/1	2/2	2+2+3/2+2+3	ND
HP 19		Hanmatmad, Valsad	20°32'26.4"N 73°19'20.9"E	01-Sept-2017	1085*	-	-	23:25:19	245	Undivided	63*	9(5,6)/9(5,6)	1/1	10/10	1/1	2/2	2+2+3/2+2+2	ND
HP 20		Vansda National Park, Navsari	20°47'11.9"N 73°28'37.5"E	01-July-2019	700	545	155	23:25:21	219	Undivided	98	9(5,6)/9(5,6)	1/1	9/10	1/1	2/2	2+2+3/2+2+3	Male
RV 15		Saputara, Dang	20°34'24.69"N 73°44'33.25"E	15-Feb-2018	1385	-	-	23:25:19	279	Undivided	88	9(5,6)/9(5,6)	1/1	9/9	1/1	2/2	2+3/2+3	Male
<i>Coelognathus h. nigriangularis</i>	RJ	Kevadiya, Narmada	21°50'12.7"N 73°44'02.2"E	22-Nov-2019	780	-	-	-:25:-	242	Undivided	72	9(5,6)/9(5,6)	1/1	10/10	1/1	2/2	1+2/1+2	ND

ND= Not determined; *indicates missing tail tip.

Ventral scales were counted following Dowling (1951). Length of the specimens was measured with string and ruler to nearest mm; whenever possible, sex of adult individuals was determined by everting the hemipenis. Descriptions and mensural characters were compared with available literature (Smith, 1943; Mohapatra et al., 2016). The numbers of dorsal scale rows were counted at approximately one head length behind the head, midbody, and one head length before vent, respectively. Subcaudal counts reported here do not include the terminal scute. The supralabials in contact with the eyes are given in brackets next to the number of supralabials. Values for symmetric head characters are given in left to right order. Description style follows Patel et al. (2015; 2019). Scalation and other comparable characters are described as Ventral scales (V); Subcaudal Scales (SC); Dorsal rows of scales (D); Supralabial scales (SL); Loreal scales (L); Preocular scales (PreO); Postocular scales (PostO); Temporal scales (T); Infralabial scales (IL); Snout-Vent length (SVL); Tail length (TaL); Total length (TL).

Results

Taxonomic accounts

Family Colubridae Oppel, 1811

Subfamily Colubrinae Oppel, 1811

Coelognathus helena helena (Daudin, 1803)

Morphology and coloration: Head elongate, longer than wide; distinct from neck; eyes oval with round pupil; nostrils small; body subtriangular. Dorsal ground color of live individuals brown or tan with transverse bands and black and white ocelli markings in the anterior part of the body that disappear into two brown lateral stripes extending from the posterior part of body to the tail; upper side of the head is brownish, with black colored sutures of the shields (Fig. 5A); a black line below each eye; underside white without any marking (Fig. 6A).

Lepidosis: Dorsal scale rows smooth, glossy, highly variable in 23–25:25–27:19–23 rows; with a pair of apical pits on the posterior margin. Ventrals 204–245 (210–252 fide. Mohapatra et al., 2016); anal undivided; subcaudals 78–96, divided; rostral wider than high, visible from above; 2 internasals, wider than long; 2 prefrontals, longer than wide, more than twice the length of the internasals; frontal bell shaped, longer than wide; parietals longer than wide, longer than frontal; 1 loreal, longer than high, touching 2nd and 3rd or 2nd to 4th supralabials; 1 preocular reaching top of head; 2 postoculars; 2 anterior temporal scales (rarely 1); 2–3 posterior temporal scales; 9–11 supralabials, 4th to 6th or 5th to 7th or 5th and 6th touch the eye; 10–12 infralabials.

Distribution in Gujarat: The present study and published literature (Mohapatra et al., 2016; Patel et al., 2018; 2019; Patel and Vyas, 2019) shows that the subspecies is distributed throughout the state (Fig. 7A).

Habit, habitat and natural history: The subspecies is crepuscular in habit, though some individuals were found during daytime, showed aggression on handling by opening of the mouth widely and raising its body as S-shaped coil. A juvenile individual from Surat while cornered by one of us constantly vibrated its tail along with raising its body in an S-shaped coil (Patel, pers. obs.). The subspecies occupies diverse habitats from dry scrublands to deciduous forests and densely populated human habitats. One individual regurgitated a rodent (*Mus* sp.) upon capture.

Coelognathus helena monticollaris (Schulz, 1992)

Morphology and coloration: Head elongate, longer than wide; distinct from neck; eyes oval with round pupil; nostrils small; body subtriangular. Dorsal ground color of live individuals dark brown or olive brown with transverse black bands in the anterior part of the body that disappears into two brown lateral stripes extending from the posterior part of body to the tail, each band has five white ocelli markings; lateral side of the neck has a light and black bordered, transverse band, usually connected dorsally by a black U or V-shaped marking that has its opening in the direction to the head (Fig. 5B); upper side of the head is brownish, with black colored sutures of the shields; a black line below each eye; anterior venter whitish with irregular black markings, posterior venter becomes darker and greyish (Fig. 6B).

Lepidosis: Dorsal scale rows smooth, glossy, variable in 23–25:25:19–21 rows; with a pair of apical pit on the posterior margin. Ventrals 219–248 with one outlier with 279 ventrals (218–250 fide. Mohapatra et al., 2016); anal undivided; subcaudals 78–98 (76–95 fide. Mohapatra et al., 2016), divided; rostral wider than high, visible from above; 2 internasals, wider than long; 2 prefrontals, longer than wide, more than twice the length of the internasals; frontal bell shaped, longer than wide; parietals longer than wide, longer than frontal; 1 loreal, longer than high, touching 2nd and 3rd or 2nd to 4th supralabials; 1 preocular reaching top of head; 2 postoculars; 2 anterior temporal scales (rarely 1); 2–3 posterior temporal scales; 9–10 supralabials, 5th to 7th or 5th and 6th or 6th and 7th touch the eye; 9–10 infralabials.

Distribution in Gujarat: The present study and published literature (Vyas, 2009; Mohapatra et al., 2016; Patel et al., 2018; Patel and Vyas, 2019) shows that the subspecies is narrowly distributed in the hilly forests of three districts of south Gujarat namely: Dang, Navsari and Valsad (Fig. 7A). However, it could also be occurring in hilly forested regions of Tapi District from where the subspecies is not yet reported.

Habit, habitat and natural history: All individuals were found during dusk or night and showed aggression on handling by raising its body as S-shaped coil. The subspecies occupies hilly forests of southern Gujarat, the region is dominated by deciduous Teak forest and Bamboo breaks.

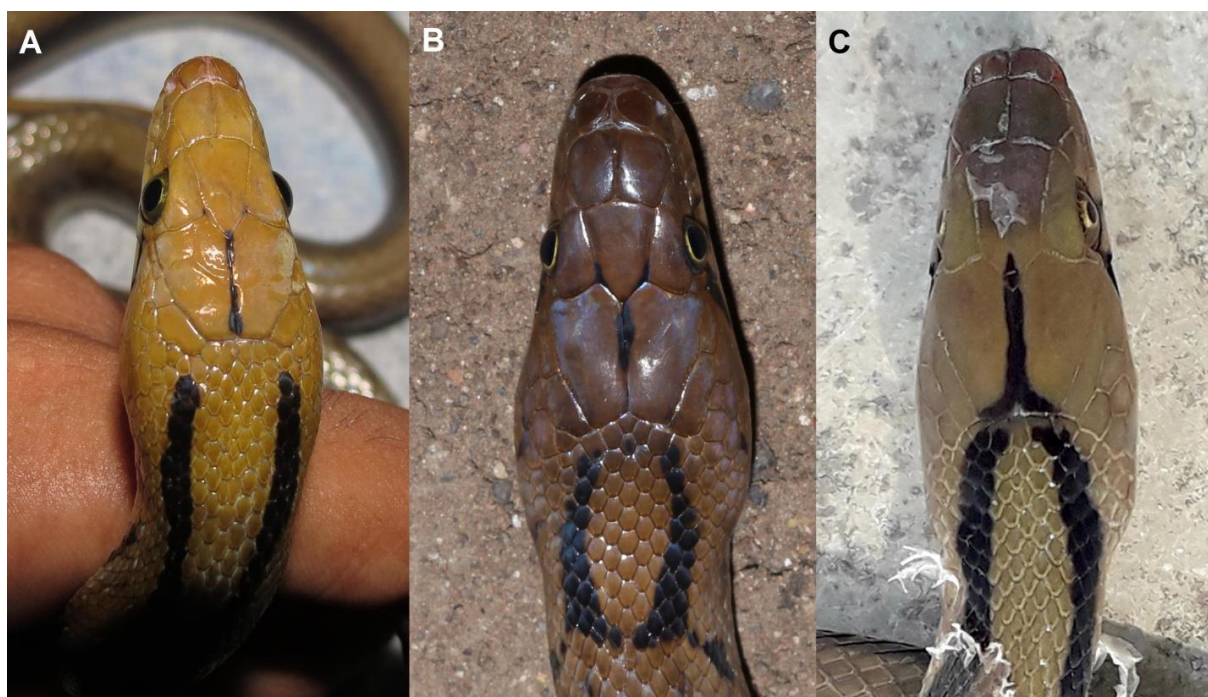


Figure 5: Dorsal marking and color pattern on head and neck of live individuals in three different subspecies of *Coelognathus helena* from Gujarat State, India: *C. h. helena* (A), *C. h. monticollaris* (B), and *C. h. nigriangularis* (C).

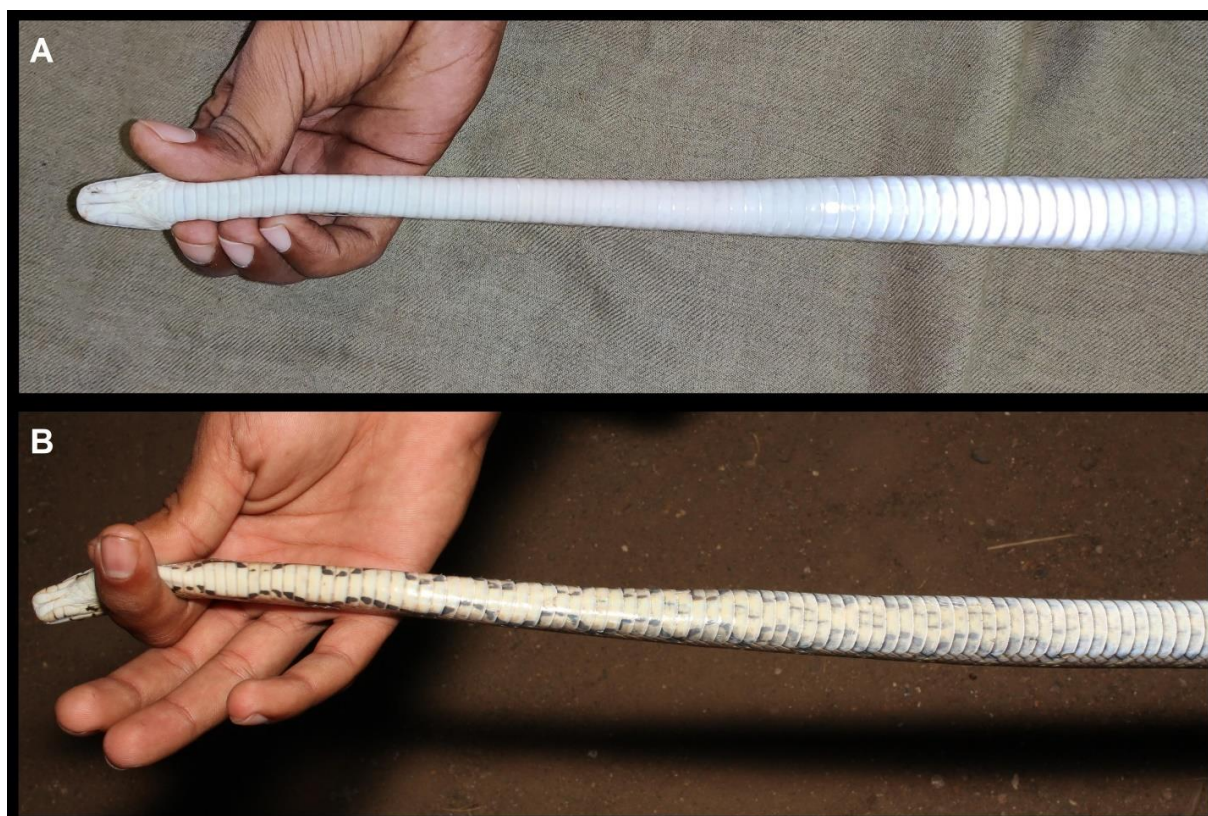


Figure 6: Ventral marking of anterior body in life for *Coelognathus h. helena* (A), and *C. h. monticollaris* (B).

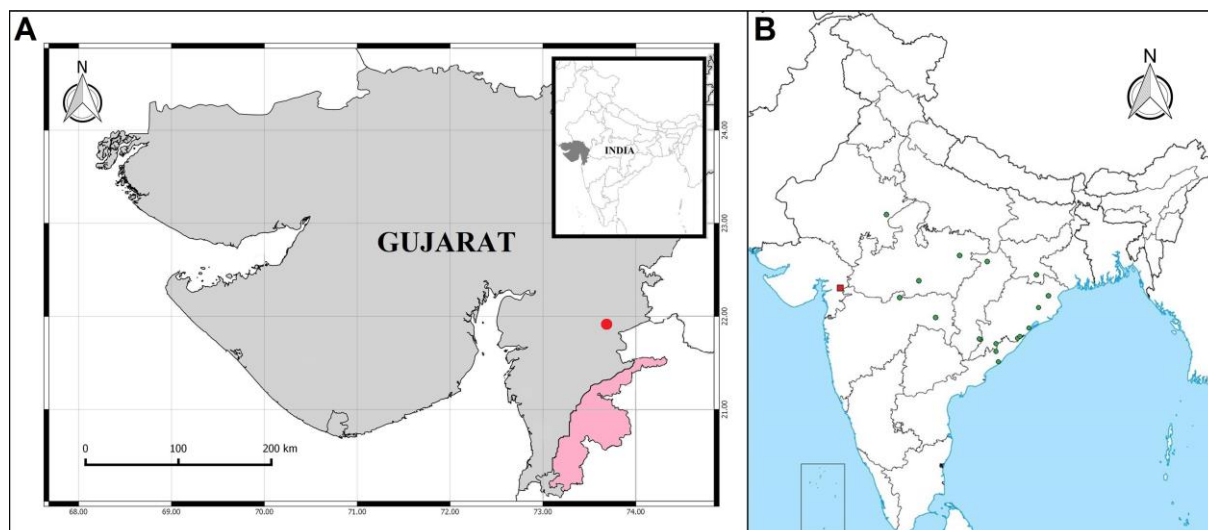


Figure 7: Map of Gujarat state showing distribution of all the subspecies of *Coelognathus helena* from the state: *Coelognathus helena helena* (grey fill), *C. h. monticollaris* (pink fill) and *C. h. nigriangularis* (red circle) (A); map of India depicting previously published locality records (green dots) and first locality record (red square) for *C. h. nigriangularis* in Gujarat (B).

Coelognathus helena nigriangularis Mohapatra, Schulz, Helfenberger, Hofmann, and Dutta, 2016

Morphology and coloration: Head elongate, longer than wide; distinct from neck; eyes oval with round pupil; nostrils small; body subtriangular. Dorsal ground color of live individual yellowish brown with transverse black bands in the anterior part of the body that disappears into two dark brown lateral stripes extending from the posterior part of body to the tail, each band has four white ocelli markings; a black marking extends from the ventro-lateral side of the neck and joins at the head near the base of parietal shield, forming an inverted Y (Fig. 5C); upper side of the head is brownish, with black colored sutures of the shields; a black line below each eye; underside white without any marking.

Lepidosis: Dorsal scale rows smooth, glossy, 25 rows at mid body; with a pair of apical pits on the posterior margin. Ventrals 242; anal undivided; subcaudals 72 (75–96 fide. Mohapatra et al., 2016), divided; rostral wider than high, visible from above; 2 internasals, wider than long; 2 prefrontals, longer than wide, more than twice the length of the internasals; frontal bell shaped, longer than wide; parietals longer than wide, slightly longer than frontal; 1 loreal, longer than high, touching 2nd to 4th supralabials; 1 preocular reaching top of head; 2 postoculars; 1 anterior temporal scale; 2 posterior temporal scales; 9 supralabials, 5th and 6th touch the eye; 10 infralabials.

Distribution in Gujarat: The new record show that the subspecies occurs in the riverine forests of Narmada District of the Central Gujarat region (Fig. 7A). However, it could also be occurring in hilly forested regions of the Central to North Gujarat and future surveys are needed to map the exact distribution in the state.

Habit, habitat and natural history: The habitat of the new record is a recent fast growing tourist complex known as Statue of Unity (SoU), Kevadia, Narmada District; spanning on both sides of the Narmada River. It was originally a dry mixed deciduous reserved forest adjoining the Shoolpaneshwar Wildlife Sanctuary. This sub-adult individual was in moulting stage and was found in the evening in small bushes of a garden. The snake was calm when handled and did not show any aggression as opposed to other subspecies of *C. helena*.

Discussion

With the new record of *Coelognathus helena nigriangularis*, all three subspecies of *C. helena*, are now reported from Gujarat State. The occurrence of *C. h. nigriangularis* in Gujarat State is not unexpected, given that the subspecies is known from the neighboring states of Rajasthan, Madhya Pradesh and Maharashtra (Mohapatra et al., 2016; Chowdhury et al., 2018). The present locality of *C. h. nigriangularis* from Gujarat, Statue of Unity Complex, is a tourist site of the national and international repute. This site has been recently developed in last eight years on a 20 sq. km area at the banks of Narmada River, near the Sardar Sarovar Dam (second largest dam in the world by holding capacity). Formerly, the region has a very good forest cover adjoining the Shoolpaneshwar Wildlife Sanctuary (Fig. 8). This protected area contains rich reptilian diversity with 40 species of reptiles reported belonging to 13 families, including *C. h. helena* (Vyas, 2011). This forest habitat has dry mixed deciduous forest and is the western most ends of the Satpura hill range. This region is classified as bio-geographic zone 4 - the semi-arid zone and 4B Gujarat-Rajwada Biotic Province (Champion and Seth, 1968).



Figure 8: Typical habitat type near the collection locality of *Coelognathus helena nigriangularis* at Shoolpaneshwar Wildlife Sanctuary, Gujarat.

The hilly forest habitat continues throughout the north eastern border of Gujarat State and in the north joins the forests of Abu wildlife Sanctuary, Rajasthan. The valley of the Narmada River is composed of continuous habitats of undulating hills with rocky scrubland and pockets of dry deciduous forest that stretches to Dhar and Khargon in Madhya Pradesh and Dhule in Maharashtra. The Narmada River valley falls in central high lands being a distribution range of the subspecies (Mohapatra et al., 2016).

This subspecies *C. h. nigriangularis* is widely distributed in the central highlands and in Eastern Ghats (Mohapatra et al., 2016). The published literature indicates that the subspecies was known to occur in eight Indian states, including Andhra Pradesh (Kantimahanti et al., 2015), Madhya Pradesh (Kumbhar et al., 2011), Jharkhand (Lampe and Lindholm, 1902; Srivastava et al., 2013), Odisha, Chhattisgarh (Mohapatra et al., 2016), West Bengal (Chowdhury et al., 2018), Maharashtra (Khan and Bibekar, 2019; Khate and Deshmukh, 2020) and Rajasthan (Singh et al., 2020). The present record of *C. h. nigriangularis* from SoU tourist complex, Kevadia, Narmada, Gujarat, India is western-most record for the species and Gujarat being the ninth state in the range of the subspecies (Fig. 7B).

Coelognathus helena is a widely distributed species of the Indian subcontinent whose evolutionary history is worth investigating (Mohapatra et al., 2016). It appears that *C. helena* complex has parapatric evolutionary history with *C. h. helena*

being a widely distributed subspecies that can survive in wide variety of habitats of Indian subcontinent; *C. h. monticollaris* is distributed in the hilly forests of western and southern India with majority of their range is in the Western Ghats; *C. h. nigriangularis* is known from hilly forests of central India and reported from northern region of Eastern Ghats, Satpura and Aravalli hill ranges. The presence of all three subspecies in one region (here Gujarat state) is an uncommon situation as subspecies are generally allopatric and sometimes parapatric (Kindler and Fritz, 2018). In the present case of *C. helena*, higher habitat diversity of Gujarat could be a reason as, Gujarat is the westernmost state of India, with most of the major mountain ranges of Peninsular India, like the Aravalli, Vindhya, and Satpura ranges, as well as the Western Ghats have a terminus in Gujarat, and this, along with other different habitats, creates conditions that support a unique and diverse fauna (Vyas, 2007). All these hill ranges have their terminus in a narrow geographical region in the eastern part of Gujarat, which appears to be a contact zone for all three subspecies of *C. helena*. Further studies are needed using morphological characters combined with molecular data and sampling across the potential geographic ranges of all the subspecies, which would help us to gain a better understanding about the distribution and phylogeography of the species.

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Conflict of interest

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

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