



# Description of head scalation variation, hemipenis, reproduction, and behavior of the Indian Smooth Snake, *Coronella brachyura* (Günther 1866)

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**Abstract.**—The first confirmed record of the Indian Smooth Snake, *Coronella brachyura*, with nine supralabials on both sides is reported from Indian state Gujarat, with taxonomic and morphological details, and information on etymology, behavior, diet, hemipenis, report of gravid female with eggs, and distribution of species. Information provided is based on examination of three individuals, two live and one dead. Present study includes details of examined individuals' data and observations, along with references to published literature.

**Keywords.** Reptilia, Squamata, Serpentes, Colubridae, rare, endemic, taxonomy, Gujarat, Surat

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## Introduction

The Indian Smooth Snake, *Coronella brachyura* (Günther 1866) is an endemic, rare, and harmless Colubridae with smooth scales, a slender almost tubular body and a short tail. This snake occurs in two colors: glossy black or brown dorsally, and uniform creamy white ventrally (Fig. 1A, B). Small in size, reaching a maximum length of 640 mm, this snake is reclusive and mild-tempered. It is reported from the Tapi district of India, which shares a border with the Dangs district (part of Western Ghats, one of the hotspot regions of biodiversity in the world), from Surat district in South Gujarat, and from three other states in India: Maharashtra, Madhya Pradesh, and Chhattisgarh. From Gujarat, this species was first obtained by the author in 2006 from the Surat district. After identification and scale counts were recorded it was handed over to R. Vyas for further investigation, and he subsequently deposited it as a voucher specimen in the museum of Bombay Natural History Society, Mumbai (BNHS 3407).

The Indian Smooth Snake is often mistaken for the Wallace's Striped Snake (*Wallaceophis gujaratensis*), Banded Racer (*Argyrogena fasciolata*), Glossy Bellied Racer (*Platyceps ventromaculatus*), or hatchlings of the Checkered Keelback (*Xenochrophis piscator*) which have a dark color or faint checkered pattern. Vyas and Patel (2007) presented a photograph of *Wallaceophis guja-*

*ratensis* as *Coronella brachyura*. Later Patel et al. (2015) reported that specimens identified by Vyas and Patel (2007) from two localities (Ahmedabad and Bhavnagar) were incorrect, and the misidentified specimens from Bhavnagar were *Wallaceophis gujaratensis* not *Coronella brachyura* but they stated records from these two localities remains in question. Then Mirza, Vyas, Patel, Maheta, and Sanap (2016) established the misidentified photograph from Bhavnagar locality as *Wallaceophis gujaratensis*. In all, the same record was presented as two different species in three different publications by a total of seven authors claiming to have identified it by examining photographs. Among these seven, one mutual author identified the specimen three times, first as *Coronella brachyura* in 2007, then as *Wallaceophis gujaratensis* in 2015 (but stating that this record remained in question), and finally as *Wallaceophis gujaratensis* in 2016. This sequence of events shows the confusion among authors in identifying specimens and localities of *Coronella brachyura* and *Wallaceophis gujaratensis*. However, Patel et al. (2015) stated that specimens from two localities (Ahmedabad and Bhavnagar) remained in question, but the current author (DSP) identified these specimens from the published photographs. Photograph labeled in Sauria as “Fig. 2 The specimen of *Coronella brachyura* from Sagwadi, Bhavnagar, Gujarat” is here confirmed as *Wallaceophis gujaratensis* based on morphological features: absence of crown-like mark on head at parietal region,

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**Fig. 1.** Two colors of *Coronella brachyura*. (A) Black color. (B) Brown color. Photo credit Dikansh S. Parmar.

presence of two distinct dark lateral stripes, and reddish iris (not visible in the published photograph). Photograph labeled in *Sauria* as “Fig. 3 The specimen of *Coronella brachyura* from Jodhapur [sic], Ahmedabad, Gujarat” is here confirmed as *Coronella brachyura* based on morphological features: upper edges of supralabials marked with black streak from first supralabial on snout to supralabials in contact with eye, indistinct dark stripes on lateral sides, crown like pattern on head seen only on sharp observation, two thin parallel indistinct lines on vertebral region from head (right behind the parietal shields) to neck, morphology of scales on body and eye entirely black.

In the literature, *Coronella brachyura* is considered poorly-known. Herein are reported additional data and observations on etymology, taxonomy, morphology, behavior, diet, reproduction, habitat, distribution, and scale variations in this poorly-known species.

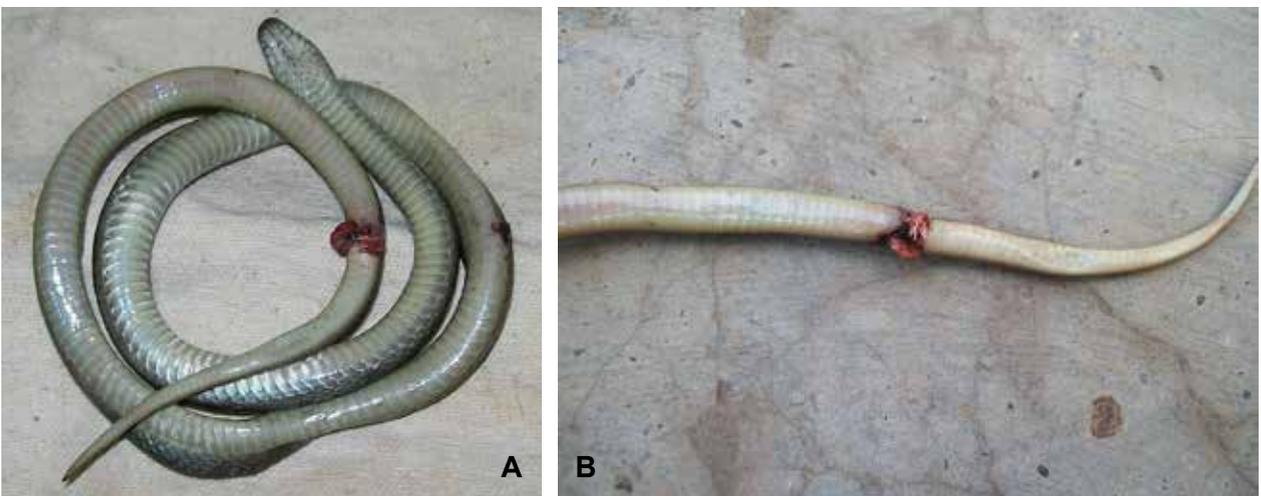
### Methods

Data are based on three individuals: Two were live captured individuals and one was found dead on the road (roadkill). Recovered individuals are mentioned as A, B, and C, according to dates and years of their recovery (Ta-

ble 1). Individual A was found on 1 January 2008 from the Department of M.Sc. (IT), Veer Narmad South Gujarat University at 0730 hours. Individual C was found on 16 November 2010 from Piplod area Saru Nagar Society at 1600 hours. Individuals A and C were live female individuals. Road kill individual B was found on 8 June 2010 from University road at 2200 hours, and was male (Fig. 2A, B). Equipment used in taking data includes: a standard ruler to the nearest mm, magnifying lens, vernier caliper, pen, record book, string, and a camera. Ventral scale counts were taken according to the method proposed by Dowling (1951). Subcaudals were counted on one side by excluding the terminal scute.

Sex determination was completed using the popping method (Gregory 1983). In this method the thumb is placed under the cloaca, applying gentle pressure toward the vent. Gentle pressure is applied with the other thumb moving from the tip of the tail towards the cloaca. Squeezing it gently toward the cloaca the hemipenis of the male pops out by the increased internal pressure in the base of the tail. This technique should be done only by an expert due to the risk of damaging the sexual organs.

Snout to vent length and tail length were measured by marking the length on a piece of string. Snout to vent



**Fig. 2.** (A) Male individual found in road kill. (B) Close up of its hemipenis. Photo credit Dikansh S. Parmar.

length was measured up to the posterior margin of the anal plate. The last infralabial is defined as the infralabial still completely covered by the last supralabial. Numbers of dorsal scale rows were counted at one head length behind the head, at midbody, and at one head length before the tail. Measurements and scale counts taken to describe the scalation and characteristics were: total body length (TBL), snout to vent length (SVL), tail length (TL), dorsal scales (DS), ventrals (V), subcaudals (SC), supralabials (SL), infralabials (INL), right and left side (RL), number of supralabials in contact with eye (SLCE), Supraoculars (SO), preoculars (PRO), postoculars (PO), loreals (L), supralabials in contact with loreal (SLCL), temporals (T), and anal plate (AP).

## Results

**Etymology:** *Coronella brachyura*. *Coronella* is a Latin word meaning “small crown,” in reference to the pattern around the head of snake. *Brachyura* is modern Latin from the Greek words *brachys*, “short,” and *oura*, “tail” (Wiktionary 2017). The full name means a snake with a small crown-like pattern on head and a short tail. Its vernacular name in Gujarati language is Suvaro saap (Desai 2011, 2017). *Suvaro* means “smooth” or “silky” and *saap* means “snake.”

**Taxonomy:** This species belongs to the family Colubridae, subfamily Colubrinae, genus *Coronella*, and species *C. brachyura*. Scientific name is binomial *Coronella brachyura*, and a synonym is *Zamenis brachyurus* Günther, 1866. *Coronella brachyura* was described by Günther in 1866 as *Zamenis brachyurus* (Smith 1943) based on specimens collected from Western Ghats in Poona (Pune) district of Maharashtra (Smith 1943). *Coronella* is closely related to *Lampropeltis*, the American king snakes. Both groups were once classified within the same genus, then separated later and placed in different genera (Mehrtens 1987). Hoser (2012) separated *Wallophis* from the genus *Coronella* on the basis of phylogenetic studies and by the presence of 23 rows of scales on dorsal midbody and triangular frontal scale. Hoser placed *C. brachyura* within a monotypic genus *Wallophis*. Similarly, after Hoser (2012), Mirza and Patel (2017) transferred the genus *Coronella* to *Wallophis* on the basis of phylogenetic study. This phylogenetic analysis was based on partial sequencing of nuclear and mitochondrial genes using a road kill specimen. The scalations of supralabials, number of supralabials touching eye, temporals, ventrals, and subcaudals described by Mirza and Patel (2017) in diagnosis vary from the scalations described in this present study. Patel et al. (2015) mentioned eight to nine supralabials in *Coronella brachyura*, but have not provided any individual with nine supralabials on both sides and fifth and sixth supralabials touching eye on both sides. Patel et al. (2015) provided evidence of: eight supralabials on both sides, eight supralabials on one side and nine supra-

labials on other side, fourth and fifth supralabials touching eye on both sides, and fourth and fifth supralabials touching eye on one side and fifth and sixth supralabials touching eye on other side. Later on in diagnosis, Mirza and Patel (2017) mentioned eight to nine supralabials and fifth and sixth supralabials touching eye rarely, without any photographic evidence or data of any individual with nine supralabials on both sides and fifth and sixth supralabials on both sides, neither have they provided phylogenetic analysis of any specimen with these variations. This type of variation in supralabials and number of supralabials touching eyes on left and right side have been noted by author (DSP) in many snakes, including: Common Trinket Snake, *Coelognathus helena helena*, Glossy Marsh Water Snake, *Gerarda prevostiana*, Common Vine Snake, *Ahaetulla nasuta*, Common Wolf Snake, *Lycodon aulicus*, and Barred Wolf Snake, *Lycodon striatus*. This type of variation may occur due to mutations, breaking of scales, injury at birth to hatchling emerging from its egg, or variations in temperature during incubation (Parmar 2017). Variations in scalations for example right side (eight) and left side (nine or more) are common in many species, some of them are mentioned above but specimens having variations with equal numbers of scalations for example right side (nine) and left side (nine) are rarely found. However, Mirza and Patel (2017) have mentioned eight to nine supralabials and fifth and sixth touching eye in diagnosis without presenting a record of any individual with such variations on both sides. Moreover, Patel et al. (2015) did not accept the allocation of the genus *Wallophis* by Hoser (2012) and commented that Hoser (2012) did not provide any valid taxonomic characters to support partitioning the genus *Coronella*. The case is the same with Mirza and Patel (2017) as they have not yet reported phylogenetic analysis or morphology and scale counting studies of individuals with nine supralabials on both sides, fifth and sixth supralabials touching eye on both sides, two + one temporals, and greater numbers of ventrals and subcaudals. The Reptile Database website has posted a comment (viewed on 13 Jul 2018) on this issue that:

“Synonym: *Wallophis* was revived in a non-peer reviewed journal (*Litteratura Serpentina*), without adequate justification (by Ken Welch) and more recently by Mirza and Patel 2017. Although Mirza and Patel provided a diagnosis for *Wallophis*, they did not include any other members of *Coronella* in their molecular analysis despite the availability of DNA sequences, hence we do not recognize the genus for the time being.”

According to us in order to accept this replacement of genus more evidence and detailed studies of additional specimens from India are required. Required also would be molecular analysis of other members of *Coronella* due to the many morphological and scale count variations in

**Table 1.** Details and measurements (mm) of *Coronella brachyura*, individuals A, B, and C.

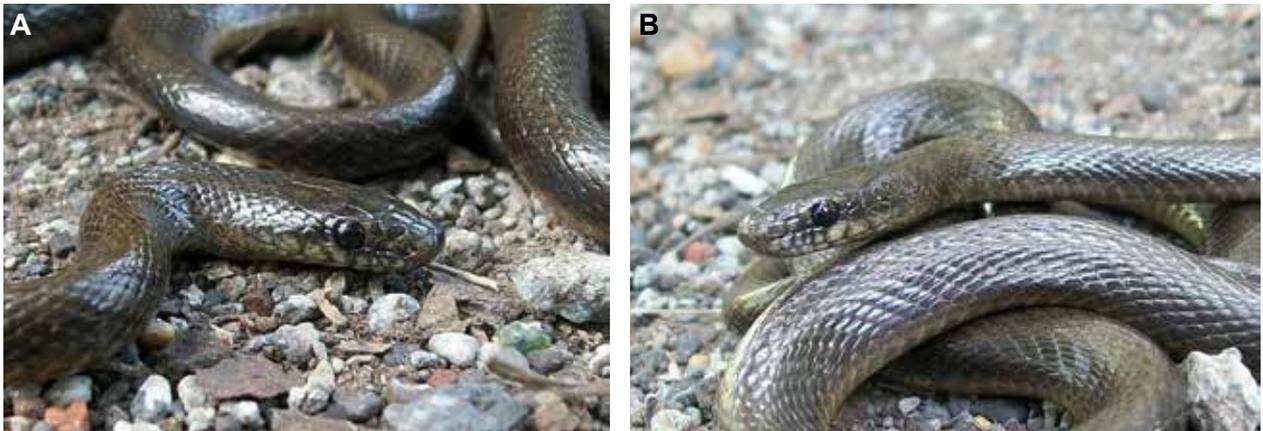
Individuals	A	B	C
<b>Date of collection</b>	1 January 2008	8 June 2010	16 November 2010
<b>Name of locality</b>	M.Sc. (IT) Surat	University Road Surat	Piplod Surat
<b>Gender</b>	F	M	F
<b>TBL</b>	458	469	491
<b>SVL</b>	395	396	427
<b>TL</b>	63	73	64
<b>DS</b>	23:23:19	23:23:19	23:23:19
<b>V</b>	241	219	215
<b>AP</b>	Entire	Entire	Entire
<b>SC</b>	48	50	57
<b>SL</b>	RL- 9	RL- 8	RL- 9
<b>INL</b>	RL- 10	RL- 10	RL- 10
<b>SLCE</b>	RL- 2 (5 <sup>th</sup> and 6 <sup>th</sup> )	RL- 2 (4 <sup>th</sup> and 5 <sup>th</sup> )	RL- 2 (5 <sup>th</sup> and 6 <sup>th</sup> )
<b>SO</b>	1	1	1
<b>PRO</b>	2	1	1
<b>PO</b>	2	2	2
<b>L</b>	1	1	1
<b>SLCL</b>	RL- 3 (2 <sup>nd</sup> , 3 <sup>rd</sup> , and 4 <sup>th</sup> )	RL- 2 (2 <sup>nd</sup> and 3 <sup>rd</sup> )	RL- 3 (2 <sup>nd</sup> , 3 <sup>rd</sup> , and 4 <sup>th</sup> )
<b>T</b>	2+2	2+2	2+2

the species. In order to change a genus a complete study of species is required. A genus should not be changed on the basis of variation in one single individual, particularly in rare, poorly known and a species with highly variable scalations in head (labials, oculars, temporals, loreals, etc.), dorsal body, ventrals and subcaudals. Mirza and Patel (2017) mentioned the variations in supralabials and number of supralabials touching eye (without providing any individual with such variations on both sides). However, in individuals with nine supralabials on both sides and fifth and sixth supralabials touching eye on both sides, the author has found that unreported variations in supralabials, number of supralabials touching loreal, postoculars and temporals. Therefore, it is not possible to accept allocation of genus *Wallophis* without a detailed comparison of morphological and genetic differences in individuals with both normal and varied scalation. Only after all individuals with normal and varied scalations are evaluated should any appropriate changes to the genus be considered.

**Morphology and coloration:** Details of all three individuals are given in Table 1. These snakes are small, glossy black- or brown-colored, tubular or round-bodied with uniform creamy white belly and large ventrals. Head is slightly broader than neck, less wide and more elongated, with round eye pupil. Eye entirely black. Short tail is less than one sixth of the total length, pointed at the end. Snout is not tapered, but slightly round. Nostril occupies whole depth of the sutures between nasals. Supralabials are distinctly white or pale white, or sometimes light

brown in color. Upper edges of supralabials are marked with a black streak, which begins from the first supralabial on snout and ends on the first supralabial in contact with the eye. Scales on dorsal body are often edged with pale white or white dots, displaying a slightly checkered pattern on the forebody. Two indistinct thin parallel lines (appears in the form of dots or short dashes) on nape are usually present. Indistinct or faint ventrolateral stripes on body run from right behind the eye to the end of the tail.

**Scalations:** According to data cited in the literature, mid-body scales are in rows of 23:23:19 and 200–224 ventral scales. Anal plate entire. Paired subcaudals 46–53. Eight supralabials (fourth and fifth touching eye), one loreal, one preocular, two postoculars, and two + two temporals (Whitaker and Captain 2004, 2008). Scalation of individuals examined here differs from the scalation mentioned above. Individual A has 241 ventrals, more than recorded in the literature (Whitaker and Captain 2004; Vyas and Patel 2007; Patel et al. 2015; Mirza and Patel 2017), and individual C has 57 subcaudals more than documented in the literature (Whitaker and Captain 2004, 2008; Vyas and Patel 2007; Patel et al. 2015; Mirza and Patel 2017). Rescued individuals also have one side with nine supralabials, fifth and sixth touching eye, and the other side with eight supralabials, fourth and fifth touching eye. In the present study, individuals A (Fig. 3A, B) and C (Fig. 4A, B) have nine supralabials on both sides, fifth and sixth supralabials touching eye on both sides, while individual B (Fig. 5A, B, C) has eight supralabials on both sides, fourth and fifth touching eye on both sides. The in-



**Fig. 3.** Individual A, both sides nine supralabials, fifth and sixth supralabials in contact with eye, and second, third, and fourth supralabials in contact with loreal scale. (A) Left side. (B) Right side. Photo credit Dikansh S. Parmar.

dividual (B) with eight supralabials on both sides has the fifth supralabial in contact with the temporal and postocular, while the individuals with nine supralabials on both sides have the sixth supralabial in contact with the temporal and postocular. Individuals in this species have one preocular, but individual A has variations in preoculars, with two preoculars instead of one. At first, the left side preocular looked different from the right. However, on close observation with a magnifying lens, the presence of two preoculars was confirmed on both sides in individual A. Loreal is in good contact with postnasal, prefrontal, preocular, and second and third supralabials in individual (B) with eight supralabials on both sides. In individuals (A and C) with nine supralabials, loreal is in good contact with postnasal, prefrontal, and preocular, but differs by touching three supralabials: second, third, and fourth, instead of only second and third supralabials. Loreal is not in contact with internasal in any case and is distinctly separated by contact of postnasal and prefrontals. Frontal is triangular shaped. Rostral is broad and high in contact with first supralabial, prenasal, and internasal. The individual obtained in 2006 (and subsequently handed over to R. Vyas) had variations in temporals, dorsals and ventrals: it had temporals two + one instead of two + two,

dorsal midbody scales 23:23:21 versus 23:23:19 and 237 ventrals instead of 224, more than noted in the published literature (Whitaker and Captain 2004, 2008). Reduction in midbody scales are also marked with 23:23:17 dorsal midbody scales (Patel et al. 2015).

**Behavior and diet:** The Indian Smooth Snake is a crepuscular burrowing snake (Whitaker and Captain 2004, 2008), but is often seen active during the day time. It is terrestrial, but it can climb well. It lives under stones, brick piles, and trees, but is also found in open-ground arid areas and grasses. It does not bite on handling, as it is a mild-tempered snake, but it hunts fiercely. As an active hunter with constricting abilities, it coils around its prey (Fig. 6). Adults and juveniles of *Hemidactylus brookii* were offered to captive individual A, which readily preyed upon them. This snake is active throughout the year, but it is more active from late winter to early monsoon season, in hotter days between February and June. Diet consists of geckos and new-born garden lizards and skinks (Whitaker and Captain 2008). Apart from these, frogs were offered to a captive individual, but it did not show any interest in hunting frogs (Fig. 7), thus frogs are excluded from diet.



**Fig. 4.** Individual C, both sides nine supralabials, fifth and sixth supralabials in contact with eye, and second, third, and fourth supralabials in contact with loreal scale. (A) Left side. (B) Right side. Photo credit Dikansh S. Parmar.

**Table 2.** New distributional records of *Coronella brachyura* in India. Localities in map are shown state-wise in numerals from 1 to 16.

Serial Number	State	Localities in Map	District	Locality	Coordinates
1	Maharashtra	1	Pune	Pune	18.31°N, 73.51°E
2	Maharashtra	2	Pune	Talegaon	18.72°N, 73.68°E
3	Maharashtra	3	Yavatmal	Wani	20.03°N, 78.57°E
4	Maharashtra	4	Solapur	Kurduwadi	18.08°N, 75.43°E
5	Maharashtra	5	Ahmednagar	Visapur	18.48°N, 74.35°E
6	Maharashtra	6	Nashik	Nashik	20.00°N, 73.78°E
7	Maharashtra	7	Amravati	Melghat	21.26°N, 77.11°E
8	Maharashtra	8	Latur	Latur	18.23°N, 76.36°E
9	Maharashtra	9	Pune	Khed	18.56°N, 73.43°E
10	Maharashtra	10	Jalna	Jalna	19.83°N, 75.88°E
11	Gujarat	11	Surat	Surat	21.17°N, 73.83°E
12	Gujarat	12	Tapi	Tapi	21.27°N, 73.60°E
13	Gujarat	13	Ahmedabad	Ahmedabad	23.02°N, 72.57°E
14	Madhya Pradesh	14	Bhopal	Bhopal	23.15°N, 77.25°E
15	Madhya Pradesh	15	Ujjain	Ujjain	23.10°N, 75.47°E
16	Chhattisgarh	16	Rajnandgaon	Rajnandgaon	21.09°N, 81.03°E

**Reproduction:** Snakes and lizards are classified in the order Squamata (scaled reptiles). For the first time a gravid female was obtained from Indian state Gujarat, district Surat, Taluka Oldpad. It laid four eggs on 15 April 2017 (Fig. 8). Length of female was 640 mm. Measured size of eggs in mm were length × width  $\alpha$ - 31.3-12.5,  $\beta$  - 32.3-13.4,  $\gamma$  - 31.6-12.7,  $\delta$  - 33.4-13.9. Eggs were marked with red pen by rescuers in order to make note of proper side and were kept for artificial incubation at room temperature. Laid eggs started shrinking and appeared to be affected by hypoosmosis in early days of incubation (Parmar 2018). On 8 June 2010, the first authentic record of a male was made in Gujarat, district Surat. Male squamates have intromittent organs which function to deliver sperm during copulation. According to an earlier description of a damaged specimen, hemipenes in this species extends up to 13th caudal plate, the distal half of hemipenes is calyculate, the cups large with scalloped edges, and the proximal half spinose (Boulenger 1890). Roadkill individual obtained by us was sexed using the popping method. It has a 10 mm long red, spiky, and unforked hemipenis with visible *sulcus spermaticus*. The spikes are in two colors: white dorsally and red from mid to shaft. Two or three spikes at the base are much larger than others (Fig 2A, B). The spikes on hemipenes help males to fix the hemipenis in place during mating and the *sulcus spermaticus* is a groove that helps to conduct sperm into the female during copulation. Size and shape of hemipenis varies from species to species, and male hemipenis and female cloacas are compatible with each other according to species. If males have spiky hemipenis, females of the same species have thicker cloacal walls compared to those of species with males with less spikes or no spikes on hemipenis. For species of males with branched

hemipenis, females have branched cloacas. These similar structures of hemipenis and cloacas result in a lock and key mechanism during mating which ensures that mating occurs only between a male and female of the same species (see Günther 1866 and Dufour 1844).

**Distribution:** Current type locality, Poona (Pune), was first discovered by Günther (1866). The second specimen was reported by Blanford (1870) near Wun in southeastern Berar. Later records were provided from Anderson (1871), Theobald (1876), Boulenger (1890), Scarlet (1891), Wall (1923), Lindberg (1932), Gharpurey (1935), Smith (1943), Whitaker and Captain (2004), Mistry (2005), Vyas and Patel (2007), Nande and Deshmukh (2007), Shyam Kamble and Rahul Deshmane (2009), Ingle and Sarsavan (2011), Ghadage et al. (2013), and Patel et al. (2015). This species was previously found in three states: Gujarat, Maharashtra, and Madhya Pradesh. Now it is also reported in 2015 from the Churiya block of Rajnandgaon district in Chhattisgarh state by Nova Nature Welfare Society (Fig. 9) [Table 2]. Records of this species are from three districts and twelve localities in Gujarat, eight districts and ten localities in Maharashtra, two districts and two localities in Madhya Pradesh, and one district and one locality in Chhattisgarh, as shown in the distributional graph of this species (Fig. 10). One of the reasons behind the distribution of this species in only four states could be the location of this area around the Tropic of Cancer, which crosses the country at 23.43701°N, as well as the type of forests in the area. The Tropic of Cancer passes through eight states in India. Among these eight states, the species is reported from three states crossed by the Tropic of Cancer: Gujarat, Madhya Pradesh, and Chhattisgarh. As this snake is found

Indian Smooth Snake (*Coronella brachyura*)



**Fig. 5.** Individual B, both sides eight supralabials, fourth and fifth in contact with eye, and second and third supralabials in contact with loreal scale. (A) Left side. (B) Right side. (C) Live individual with same scalation. Photo credit Dikansh S. Parmar.

active mostly in summer or hotter days from February to June, its population is also found in regions where sun rays fall straight, in the states of the central western part of India. Even though the Tropic of Cancer does not pass through Maharashtra, this species and its type locality are reported from Maharashtra, possibly because Maharashtra shares interstate borders with Gujarat in the north-west, Madhya Pradesh in the north and Chhattisgarh in the east. All four states have hilly forest regions. Another possibility is that the species might have migrated from Maharashtra to warmer regions of the other three states that have forests where the climate is moderate and more suitable for the species to survive. Another geographic factor responsible for the distribution range of this species is the presence of rivers. The Tapi and Narmada rivers flow in three states: Gujarat, Maharashtra, and Madhya Pradesh. The origin of the river Narmada is at Amarkantak in Madhya Pradesh, less than 30 km from the fourth state, Chhattisgarh. The river Tapi originates from the hills of Mahadev in Madhya Pradesh and flows through Maharashtra and Gujarat. In 2006 Gujarat was affected by floods due to heavy rainfall. Surat district was especially severely affected because the Tapi river

flows through the central part of the city and meets the Arabian Sea in the west of the city. Tapi is the only major river that flows in Surat. Indian Smooth Snake is reported from parts of Gujarat from 2006 onwards. Along with the Indian Smooth Snake, another rare species endemic to India, the Stout Sand Snake, *Psammophis longifrons*, distributed in Gujarat and Maharashtra (Whitaker and Captain 2008), was also obtained for the first time from Surat district after the floods. The origins of the Tapi and Narmada rivers are in Madhya Pradesh, and they flow



**Fig. 7.** Captive individual did not eat frogs when offered. Photo credit Dikansh S. Parmar.



**Fig. 6.** *Coronella brachyura* preying upon gecko, coiling around it. Photo credit Dikansh S. Parmar.



**Fig. 8.** Eggs of *Coronella brachyura* in hypoosmotic condition. Photo credit Vedant Lala.

**Table 3.** Distribution of *Coronella brachyura* in Gujarat state, Surat, Tapi, and Ahmedabad districts, showing number of individuals and their detailed localities along with abbreviation of localities in map. G1 to G12 indicates localities of species in map of Gujarat.

Serial Number	District	Localities	Localities Shown in Map	Coordinates	Number of Individuals	Total Number of Individuals
1	Surat	Adajan	G1	21.19°N, 72.79°E	1	1
2	Surat	Ambheta	G2	21.26°N, 72.74°E	1	1
3	Surat	Bhatpor	G3	21.30°N, 72.95°E	1	1
4	Surat	Bhestan	G4	21.13°N, 72.85°E	1	1
5	Surat	Oldpad	G5	21.34°N, 72.75°E	1	1
6	Surat	Piplod	G6	21.15°N, 72.77°E	6	6
7	Surat	Sachin	G7	21.08°N, 72.88°E	1	1
8	Surat	University Road, Safal Square	G8	21.14°N, 72.76°E	1	1
9	Surat	VNSGU M.Sc. (IT)	G9	21.15°N, 72.78°E	1	1
10	Tapi	Ambapani	G10	20.97°N, 73.50°E	1	1
11	Ahmedabad	Bopal	G11	23.02°N, 72.57°E	1	1
12	Ahmedabad	Jodhpur	G12	23.03°N, 72.40°E	1	1

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from Madhya Pradesh through Maharashtra and enter into Gujarat. In Gujarat, distributional records of the Indian Smooth Snake species are from Surat, Tapi, and Ahmedabad districts. Records from Gir Somnath district need confirmation. One individual was obtained from a forest near Ambapani village of Tapi district, which is only a few kilometers from The Dangs district. The Dangs district shares a border with the Tapi district and Maharashtra state, thus the species may possibly exist in The Dangs district. The number of individuals obtained from Surat district includes: six individuals from Piplod, one from Veer Narmad South Gujarat University M.Sc. (IT) Surat, one from Adajan, one from Oldpad, one from Ambheta, one from University road (Safal square), one from Bhatpor, one from Bhestan, and one from Sachin (Table 3). A total of 14 individuals were obtained in 11 years from 2006 to 2017 in and around Surat city.

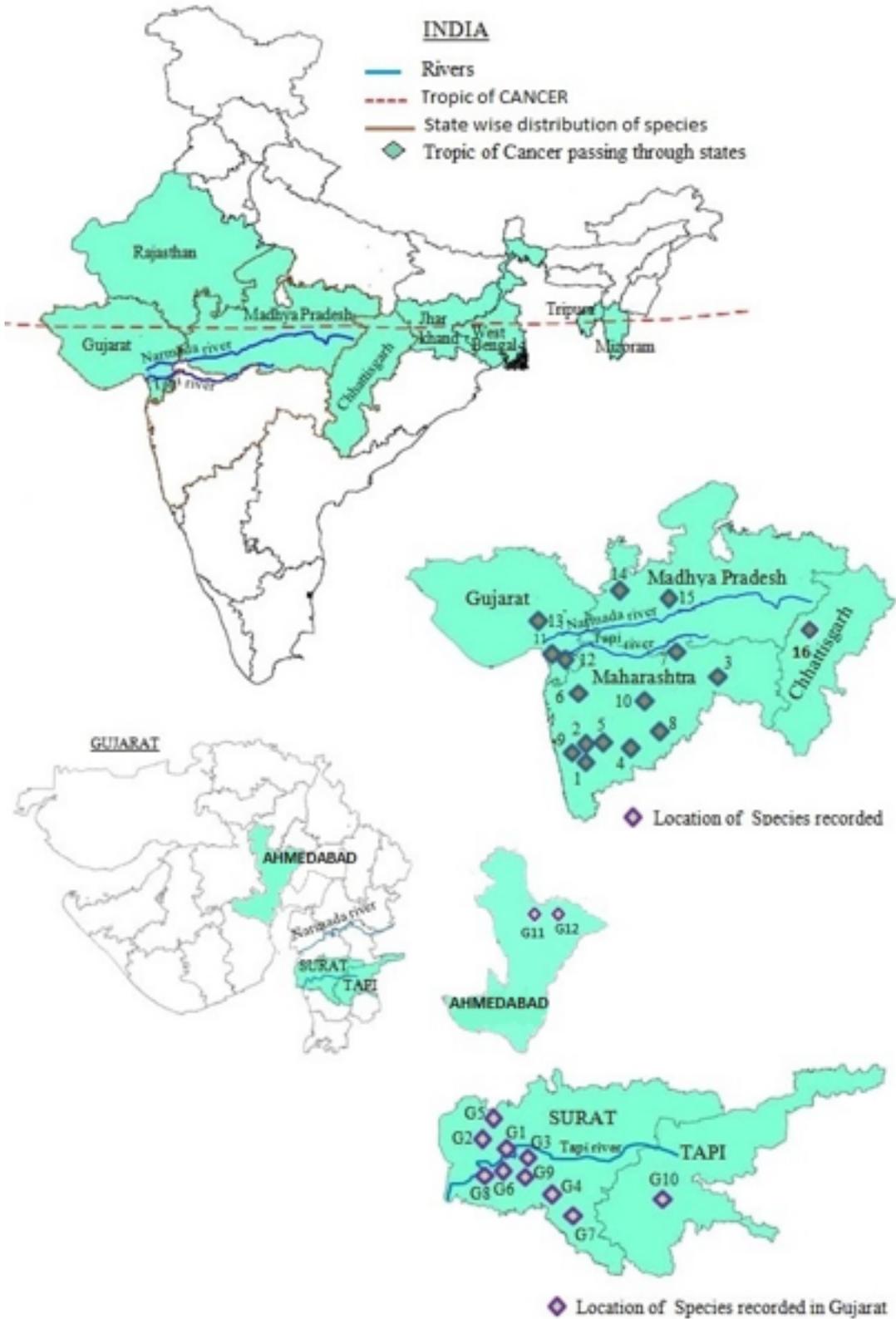
## Discussion

In Gujarat, an Indian Smooth Snake was rescued by the author (Dikansh S. Parmar) in 2006. It was with normal scalation (except 237 ventrals, 23:23:21 dorsals, and two + one temporals). From 2006 to 2018, the author has collected more complete and accurate information from every individual of this species when obtained. In 2008, the author obtained the first Indian Smooth Snake with nine supralabials on both sides and two preoculars. In 2010, a second individual with nine supralabials was obtained. In total, the author recovered six specimens of this species. All of them were released to their natural habitat after recording data. The purpose behind studying this species is to collect more information regarding the taxonomy, morphology, activity, diet, behavior, reproduction, and distribution. These records will be helpful in revealing

the reasons behind the low population of this snake, its sex ratio, its endemism to India, threats to the species, its biological importance, and the role of the species in the environment.

Whitaker and Captain (2004, 2008) and Ingle and Sarsavan (2011) reported that *Coronella brachyura* feeds on juvenile geckos in captivity but Patel et al. (2015) reported keeping live individuals for few days but when offered juveniles of *Hemidactylus* sp. they were not accepted. In the present study, *Coronella brachyura* readily fed on either adult or juvenile *Hemidactylus brookii*. Reported variations in scalation also raise questions about its evolution, subspecies, ancestors, and distribution in certain types of localities. A phylogenetic study and DNA sequencing are required to know the relationship between the Indian smooth snake with nine supralabials and Indian smooth snake with eight supralabials. Our present study found variations in supralabials, preoculars, number of scales touching eye, number of supralabials in contact with loreal, number of supralabials in contact with postoculars, number of supralabials in contact with temporals, ventrals, and subcaudals. These variations in scalation are signs of a new sister species or subspecies of Indian smooth snake, which we are looking forward to discovering by phylogenetic study and DNA sequencing in individuals that we will obtain in the future. To get answers to many questions regarding this species, more observations, examinations, and study of different specimens of this species are required. The questionable records in previous reports (Vyas and Patel 2007; Patel et al. 2015; Mirza et al. 2016) on the identification and localities are clarified here with enough justification, so the records from Bhavnagar were *Wallaceophis gujaratensis* but the records from Ahmedabad were *Coronella brachyura*. Recently an individual of *Wallaceophis gujaratensis*

Indian Smooth Snake (*Coronella brachyura*)



**Fig. 9.** Distribution shown in map in all four states of India along with Tropic of Cancer, Narmada and Tapi rivers. Distribution and localities shown separately in Gujarat state, Surat and Tapi districts. *Map prepared by Nitin Patel and Smita Ramkumar.*

## Graph Showing Distribution Of *Coronella brachyura*

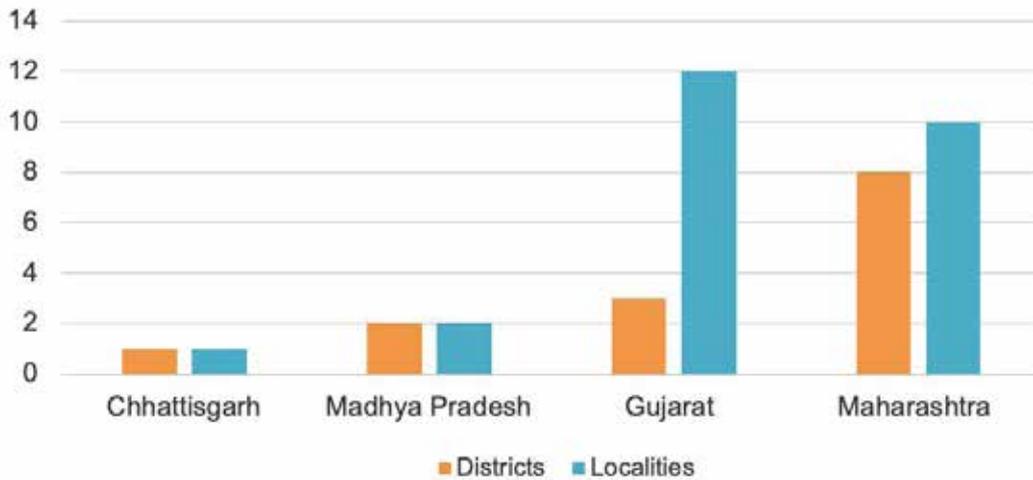


Fig. 10. Graph showing distribution of *Coronella brachyura*. Prepared by Dikansh S. Parmar.

obtained from Saldi village, Amerli district (neighboring district of Bhavnagar district) was mistaken as *Coronella brachyura*. Later when the rescuer sent photographs (Fig. 11), the author (DSP) identified it as *Wallaceophis gujaratensis*. This is further evidence that specimens reported from Bhavnagar were *Wallaceophis gujaratensis* not *Coronella brachyura*. Four individuals of *Wallaceophis gujaratensis* were also reported from Saldi village, Amerli district by Mirza et al. (2016).

In India, *Coronella brachyura* is on schedule IV of the Wildlife Protection Act of 1972 (Srinivasulu et al. 2013). This species is rare but is listed under Least Concern status according to the IUCN (International Union for Conservation of Nature and Natural resources) Red List, which justifies that this species is listed as Least Concern in view of its wide distribution in the western and central states of India, and the absence of recognized major threats (Srinivasulu et al. 2013). However, the author has observed certain threats to this species by humans, including urbanization, expansion of roads, roadkill, habitat loss, and intentional killing of snakes due to fear and lack of awareness. There are also some natural threats such as floods and predators. Although this species is reported from four states of India, the populations are very small. According to our findings this species should be listed under Vulnerable status in order to provide benefits for its protection. Due to rapid urbanization, forest, agriculture lands, grasslands, etc. are being replaced by concrete jungles. The natural habitats of animals including reptiles are lost in most of the region. National government or international organizations can restrict unnecessary construction by passing laws and limiting the number of buildings in key habitat areas.

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Fig. 11. *Wallaceophis gujaratensis* with two distinct lateral stripes, from Saldi village, Amerli district, Gujarat. Photo credit Bhavesh Trivedi.

gestions. Mr. Vasudev Limbachia (animal activist, snake rescuer, and dog handler) for providing one additional locality record of species in Surat. Mr. Vedant Lala (rescuer) for providing photographs of eggs.

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