



Morphological variations in *Sinomicrurus macclellandi macclellandi* (Serpentes: Elapidae), the only coral snake species in northeast India

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ABSTRACT

Specimens of *Sinomicrurus macclellandi macclellandi*, a deadly venomous Elapid snake collected from various parts of Mizoram were studied on their morphology and meristic features. The observation revealed that there are three different varieties in this subspecies on the basis of morphology and meristic parameters. Variations in colouration patterns, scalations and body proportion are described in this paper. Our specimens are compared with different varieties mentioned in the existing literatures. It was found that difference in body size and length are observed among this complex subspecies. It is suggested that to reveal this unknown hitherto, a detailed comparative study on molecular basis of these varieties allocated to the same subspecies in this region should be conducted with larger samples.

Key words: Morphology; variations; *Sinomicrurus macclellandi*; Mizoram; hemipenis.

INTRODUCTION

Coral snakes are a large group of elapid snakes that can be subdivided into two distinct groups, Old World coral snakes and New World coral snakes. There are 16 species of Old World coral snake in three genera (*Calliophis*, *Hemibungarus* and *Sinomicrurus*), and over 65 recognized species of New

World coral snakes in three genera (*Leptomicrurus*, *Micruroides*, and *Micrurus*).¹ Both morphological and molecular studies have found that the most basal lineages are Asian, indicating that the group originated in the Old World. *Sinomicrurus*, a new genus contains a series of five (5) subtropical species: *S. hatori*, *S. japonicus*, *S. kelloggi*, *S. macclellandi* and *S. sauteri*.^{2,3}

Sinomicrurus macclellandi, commonly known as MacClelland's coral snake, is a species of venomous elapid snake endemic to Asia. It was described as *Elaps macclellandi* by Reinhardt from

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Assam in 1884.⁴ After its description, it is reported from northern India (Assam, Sikkim, Darjeeling, Mizoram); Arunachal Pradesh (Deban – Changlang district, Chessa, Chimpu – Papum Pare district), Nepal, N. Myanmar (Burma), Thailand, Vietnam, central and southern China (including Hong Kong, Hainan, north to Gansu and Shaanxi), Japan (Ryukyu Islands), Taiwan. Currently, four subspecies are recognized under this genus, *Sinomicrurus macclellandi iwasakii*, *S. m. macclellandi*, *S. m. swinhoi* and *S. m. univirgatus*. *S. m. iwasakii* is found on Ishigaki Island and other Ryukyu Islands in Japan. *S. m. swinhoi* is found in Taiwan. *S. m. univirgatus* is found in Nepal, and Sikkim.¹ Shrestha and Majupuria⁵ described the subspecies *Sinomicrurus (Calliophis) macclellandi nepalensis* from Nepal (Deorali Hill, Kulakhami). David and Ineich⁶ do not acknowledge the validity of this subspecies based on their revision of *Sinomicrurus (Hemibungarus) macclellandi* on only five specimens.

Herpetofaunal survey conducted throughout Mizoram since the year 2007 yields variations on the morphological and colouration among the collected *Sinomicrurus macclellandi macclellandi*. Though Smith reported five different varieties among this coral snake, of these, var. *univirgatus* is assigned to the level of subspecies. However, there is no earlier works on the detailed diagnostic features on the different varieties, except on colouration. In this paper, we are contributing additional descriptions on morphology and meristic variations, a brief description of hemipenes, microhabitats and natural history, this subspecies.

MATERIALS AND METHODS

All the specimens were caught in the field by hand, catalogued and preserved in 10% buffered formalin in the Reptile Section, Departmental Museum of Zoology, Mizoram University (MZMU), Aizawl. Specimens were compared with descriptions provided from the existing literatures.⁷⁻¹² Morphometric measurements were

taken largely with the help of a digital Fischer digital calliper (to the nearest 0.01 mm) and a meter tape following Vogel and Rooijen.¹³ Dorsal scale rows were counted at one head-length behind the head, at midbody, and at one head-length anterior to the anal scute. The midbody scale count was taken at half of the total number of ventral scales. The number of ventrals was counted following Dowling.¹⁴ Subcaudals were counted on one side, the terminal scute was excluded. The first sublabial was defined as the scale that starts between the posterior chin shield and the infralabials and that borders the infralabials (see Peters,¹⁵ Fig. 7; Lillywhite¹⁶). Values of symmetrical pholidotic traits are given in left and right (L/R) order. The last infralabial was defined as the infralabial still covered completely by the last supralabial and the posterior most temporal scales were defined as the scales of which more than half of the area lies in front of an imaginary line that runs from the apex of the last supralabial to the posterolateral corner of the parietal. The sex of the snake was determined by probing with a thin smooth metal probe and by examining the hemipenes.

Statistical analysis

Independent sample *t*-test was used to determine the differences in ten meristic parameters of three morphologically variance coral snakes. The statistical significant level was set at 0.05 and analyses were done using SPSS ver 17.0.

RESULTS AND DISCUSSION

Material examined

MZMU-171 (male): Sawleng (23°58'39.93"N; 92°55'34.10"E; 1150 m asl), Mizoram, India, coll. T.B.C. Lalbiakhlunmawia, 4 May 2010; (2) MZMU-242 (female): Chawlhmun (23°44'41.97"N; 92°41'42.46"E; 938 m asl), Aizawl, Mizoram, India, coll. Lalrotluanga, 4 Oct. 2010; (3) MZMU-243 (male): near Pachhunga University College gate

(23°43'25.07"N; 92°43'35.76"E; 885 m asl), College Veng, Aizawl, Mizoram, India, coll. Freddy Lalrinawma, 23 May 2010; (4) MZMU-247 (male): Sairang (23°48'43.82"N; 92°39'12.53"E; 94 m asl), Mizoram, India, coll. H.T. Lalremsanga, 1 June 2010; (5) MZMU-269 (female): Mizoram University Campus (23°44'00.79"N; 92°39'57.20"E; 873 m asl), Aizawl, Mizoram, India, coll. H.T. Lalremsanga, 18 Aug. 2010; (6) MZMU-270 (male): Darlawn (24°00'56.31"N; 92°55'37.39"E; 1078 m asl), Mizoram, India, coll. Lalduhawma, 25 Nov. 2012. (7) MZMU-271 (male): New Latawh (22°22'05.16"N; 92°56'16.71"E; 409 m asl), Saiha district, Mizoram, India, coll. Zodinliana, 13 Oct. 2011; (8) MZMU-272 (female): Mualpui (23°42'57.94"N; 92°43'34.32"E; 858 m asl), Aizawl, Mizoram, India, coll. Hmangaihzuwala, 30 Oct. 2009; (9) MZMU-273 (male): College Veng (23°43'22.03"N; 92°43'30.31"E; 880 m asl), Aizawl, Mizoram, India, coll. H.T. Lalremsanga, 6 April 2009.

Description and diagnostic characters

All the examined specimens show the same diagnostic features like, body slender and cylindrical; head same width as or very slightly broader than neck; small eye almost entirely black, round pupil; snout round and blunt; short tail with sharply pointed tip; vertebral series of scales not enlarged; body scales smooth in 13:13:13 parallel longitudinal rows; 1 preocular; 2 postoculars; 7 upper labials; temporal 1 + 1, the anterior shield in contact with 2 upper labials, anal shield divided, paired subcaudal; color pattern red or brownish above with or without a series of narrow black transverse bars (or black transverse bars reduced to transverse vertebral spots, head black anteriorly reaching back to the level of the eyes, followed by a broad white band, which is bordered posteriorly by a black nuchal band.

Depending on the similarity and dissimilarity in their morphological and meristic characteristic features, they are divided into three varieties, i.e. Type I, Type II and Type III (Table 1).

Type I: Glossy reddish-brown with regular, narrow black transverse bars, which may or may not reach the belly; the black nuchal mark is pointed anteriorly and touches posterior of frontal; no series of small black spots on each side of the back between the bars; venter with cross-bars and quadrangular spots. It is represented by MZMU 272 (Fig. 1).

Type II: Similar to Type I, but with the black cross-bars reduced to transverse vertebral spots and a series of larger spots along the middle of the belly; dark ring(s) and spots or both may be present or absent at the tail. In the head pattern, all the specimens show the black band, with 3 prominent points, two markings the outer edge of parietal reaching posterior supraocular and one at the middle. It is represented by MZMU-171, MZMU-242 (Fig. 242), MZMU-243, MZMU-247, MZMU-271 and MZMU-273.

Type III: Uniformly reddish-brown above without transverse bars or vertebral spots except 2 minute spots in front and after the level of vent and indistinct vertebral spots in case of female specimen (MZMU-269); venter with a series of blotches along the body; the head pattern similar with that of type II. It is represented by MZMU-269 (Fig. 3) and MZMU-270.

It is confirmed that a specimen, we herein designated under Type I variety agrees well with the descriptions and drawings of "*the common form*" in Wall,¹⁷ Smith⁷ [*fide* Fig. 135: 424] and those of Scleich and Kästle¹⁸ [*fide* Fig. 2&3: 973] in the pattern of head and body colouration. The specimen depicted in Wall,¹⁷ Smith,⁷ Scleich and Kästle¹⁸ where the black nuchal mark is pointed anteriorly and touches posterior of frontal differs with the specimens of Type II variety in the head pattern. In our specimens, the black nuchal band is with three prominent points, two marking the outer edge of parietal and one at the middle. Such a specimen is also described from Doi Suthep, Cheng Mai by Taylor.¹⁹ In this variety, the transverse black cross-bars are absent and instead, small black dots present mid-dorsally and a series of larger spots present along the middle of the belly that could be referred to the variety "*gorei*" earlier described from Assam and

Table 1. Morphometrics and meristematics of male (M) and female (F) *S. m. maccllelandi*.

Collection number	MZMU 171		MZMU 242		MZMU 243		MZMU 247		MZMU 269		MZMU 270		MZMU 271		MZMU 272		MZMU 273	
	Type II	Type III	Type III	Type III	Type III	Type II	Type II	Type I	Type I	Type II	Type II							
Variety	M	F	M	F	M	F	M	F	M	F	M	F	M	F	F	F	M	M
Morphometrics (in mm)																		
Eye diameter	1.20	1.11	1.16	1.44	1.12	1.44	1.15	1.18	1.15	1.18	1.15	1.18	1.51	1.51	1.10	1.10	1.10	1.10
Eye-nostril distance	1.48	1.81	1.52	2.43	1.32	2.43	1.52	1.54	1.52	1.54	1.52	1.54	2.14	2.14	1.50	1.50	1.50	1.50
Tail-length	41	37	47	49	44	49	38	38	38	38	38	38	89	89	39	39	39	39
Snout-width	3.42	3.62	4.58	7.06	4.27	7.06	4.91	3.69	4.91	3.69	4.91	3.69	5.14	5.14	3.25	3.25	3.25	3.25
Snout-length	2.71	3.0	3.97	5.23	3.45	5.23	3.17	3.45	3.17	3.45	3.17	3.45	4.53	4.53	3.72	3.72	3.72	3.72
Head-length	6.77	6.16	7.16	10.19	5.96	10.19	5.58	6.14	5.58	6.14	5.58	6.14	8.62	8.62	6.22	6.22	6.22	6.22
Head-width	5.60	5.84	7.01	9.52	5.71	9.52	4.54	5.40	4.54	5.40	4.54	5.40	7.79	7.79	5.98	5.98	5.98	5.98
Snout-vent length	391	416	435	638	398	638	437	406	437	406	437	406	595	595	376	376	376	376
Scalation																		
Ventrals	211	222	215	230	211	230	221	211	221	211	221	211	196	196	215	215	215	215
Subcaudals	33	26	31	26	30	26	30	28	30	28	30	28	36	36	32	32	32	32
Dorsal formula	13:13:13	13:13:13	13:13:13	13:13:13	13:13:13	13:13:13	13:13:13	13:13:13	13:13:13	13:13:13	13:13:13	13:13:13	13:13:13	13:13:13	13:13:13	13:13:13	13:13:13	13:13:13
Infralabials touching the sublabial	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	2/2	2/2	2/2	2/2	2/2
Number of supralabials	7/7	7/7	7/7	7/7	7/7	7/7	7/7	7/7	7/7	7/7	7/7	7/7	7/7	7/7	7/7	7/7	7/7	7/7
Supralabials touching the eyes	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	2/2	2/2	2/2	2/2	2/2
Number of infralabials	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6
Number of temporal	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+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+1/1+1	1+1/1+1	1+1/1+1	1+1/1+1	1+1/1+1
Number of 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	2/2	2/2	2/2	2/2	2/2
Anal shield divided	Yes																	

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Figure 1. *Sinomicrurus maclellandi maclellandi*, adult female of variety Type I (MZMU 272).



Figure 2. *Sinomicrurus maclellandi maclellandi*, adult female of variety Type II (MZMU 242).



Figure 3. *Sinomicrurus macclellandi macclellandi*, adult female of variety Type III (MZMU 269).

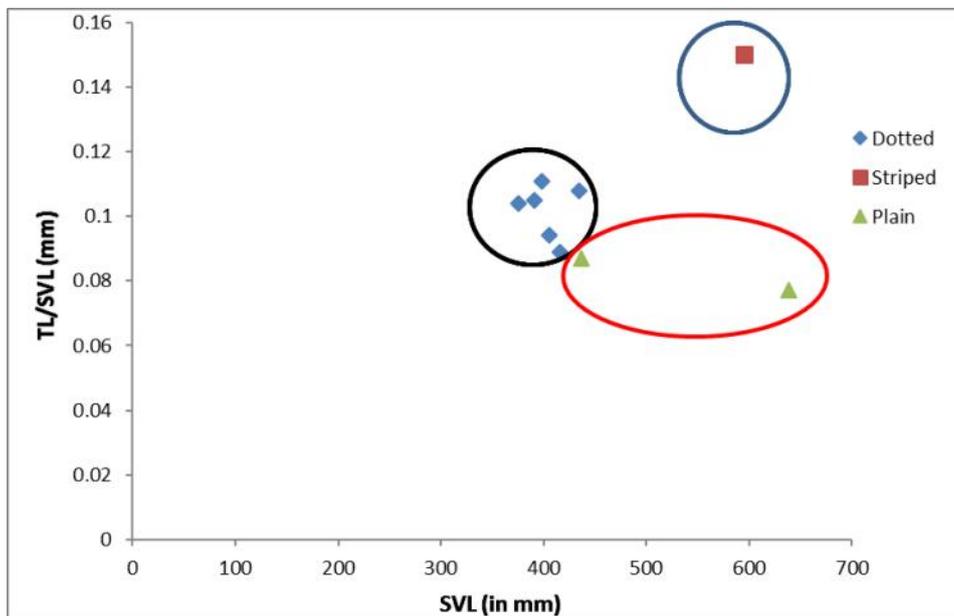


Figure 4. A scatter plot graph showing the ratio of tail length (TL) to snout-vent length (SVL) against the snout-vent length (SVL) of the three varieties. Type I (striped), Type II (Dotted) and Type III (plain/uniform).

Upper Myanmar.⁷ Recently, it was also mentioned from Mizoram by Das.¹⁰ Our specimens of Type III variety differs from other described varieties, due to absences of black transverse bars (present in the common form) and small dots on the mid-dorsal (found in *Sinomicrurus maclellandi* var. *gorei*). Other variety, *Sinomicrurus maclellandi* var. *nigriventer*, from Kasauli, Himachal Pradesh with three rings on the tail against no rings on the tail of our specimens. From another described variety, *Sinomicrurus maclellandi* var. *concolor* which is either uniform or with three longitudinal series of indistinct black spots on above, it differs in having uniformly reddish-brown above (vs. purplish brown) and venter with smaller black spots (vs. large black subquadrangular spots).

From the present survey on this species in Mizoram, the smallest one, *Sinomicrurus maclellandi* var. *gorei* (type II) is the most common form while the largest one (type I), though it is regarded as “the common form” is the rarest one. Extensive survey, verification on road-killed specimens and collection yielded only a single specimen till date. In addition to this, there is a huge variation on the size between type I (tail length: 89; snout-vent length: 595) and type II (tail length: 37-47 mm; snout-vent length: 376-435).

Data analysis

Statistical analysis reveals that there are significant variations on seven meristic parameters of three morphologically variety of coral snake. However, snout width, snout length and subcaudals did not showed variations among the three varieties of coral snake (Table 2).

Our results show that the meristic parameters data of all the examined specimens fall within the range of that of type specimens described in the literatures. For example, ventrals: male 182-212, female 208-244; subcaudals: male 28-36, female 25-53. However, from the statistical analysis it is clear that each variety has a distinct range in most of the morphometric and meristic parameters, except in case of snout width, snout

length and subcaudals. Moreover, a scattered plot graph for the ratio of tail length (TL) to snout-vent length (SVL) against the snout-vent length (SVL) showed three different plots as shown in Figure 4.

Table 2. Comparisons of ten parameters of three varieties of coral snake.

Meristic Parameters	t-value	df	p
1. Eye diameters	-8.269	5	0.001*
2. Eye-Nostril distance	-3.566	5	0.016*
3. Tail length	-11.551	5	0.001*
4. Snout width	-2.405	5	0.061
5. Snout length	-2.298	5	0.070
6. Head length	-4.449	5	0.007*
7. Head width	-3.041	5	0.029*
8. Snout-Vent length	-8.649	5	0.001*
9. Ventrals	3.903	5	0.001*
10. Subcaudals	-2.130	5	0.086

Hemipenes

Hemipenes of male MZMU 824 (Fig. 5) *in situ*, slightly bifurcated near the tip, spinous, reaching level of subcaudal 6; level of insertion of *m. retractor penis magnus* not examined; the ornamentation type is *undifferentiated* with spines only but not calyces; spines numerous, present throughout the length of the organ, from base (level of subcaudal 1) to tip, almost nude at third subcaudal; spines slightly larger at level of fourth and fifth subcaudal; basal portion ornamented with sparsely distributed minute spines. Ridges visible on asulcate side at the level of one third. The *sulcus spermaticus* is bordered at the base (sinistrally) by a flap-like fold, is centripetal, and terminates distally on each lobe. There are no grooves, fleshy protuberance, papillae, or calyces.

Hemipenial study reveals that the present description differs from that of Smith for having smaller spines at the basal (vs near the tip) and the absence of calyces (vs present). In addition, the presence of ridges was not mentioned. Ex-



Figure 5. Right hemipenis of *Sinomicrurus maccllelland*, adult male of Type II (MZMU 824). Sulcate (left) and asulcate (right) views showing spinulated body from base to tips and *sulcus spermaticus* dividing towards lobes.

cept to this minor difference, most of the descriptions are more or less similar. The definition for terminology like calyces for hemipenis might depend upon the authors' purview.

Altitudinal distribution

All the specimens were collected at the elevation between 94-1150 m asl which falls in between 55-2500 m asl as per reported by Das. Wall¹⁷ mentioned that it prefer a habitat between 4000-6000 ft (=1220-1825 m). He mentioned about Mr. Gore's specimens derived from Naga Hills from an elevation of 1000 m. In Nagaland, the species was recorded up to 2000 m by Ao *et al.*,²⁰ In Nepal, recorded as low as 150-1400 m¹⁸. Cox²¹ reports the distribution species up to 1800

m in Thailand; Orlov *et al.*²² reports 200-1500 m in Tam Dao. Leviton *et al.*,²³ reported from the subtropical forests (Northern Triangle) of Kachin State at an elevation of 526 m during the day. It is also reported from 1411 m from NEHU campus, Shillong, Meghalaya.¹⁰

Microhabitats and natural history

There is no detailed study on the biology this fascinating coral snake. Das^{8,11,12} reported that it is nocturnal and terrestrial. From the present study, it is confirmed that the activity pattern is crepuscular and nocturnal. Individuals were mainly encountered near or on the public metal road during night. Some specimens were recorded from under rotten logs, loose soils, forest

floor and during road construction activities as also reported by Ahmed *et al.*²⁴ The present specimens are mainly collected from anthropogenic area in the vicinity of hill forested localities during rainy season. Wall¹⁷ remarked that this species is predominately a Jungle as well as a hill species. Pope²⁵ remarked that the snake act in a stupefied manner and cannot be made to strike. When threatened, it curls up the tail as a defense and may flatten the body considerably. A specimen from Darjeeling swallowed a juvenile *Ophisaurus gracilis*.¹⁸ Wall²⁶ reported *Argyrophis* (*Typhlops*) *diardii* and *Indotyphlops* (*Ramphotyphlops*) *brahminus* in its stomach. He reported a female measuring 598 mm killed on 8th July contained fourteen eggs in the oviduct. They are oviparous and clutches comprise 6-14 eggs measuring 20-33.3 x 10.9-12 mm). The embryos measured about 25 mm.¹² Breeding biology is still unknown.

CONCLUSION

It is evident that there are at least three different variety of *Sinomicrurus maccllelandi maccllelandi* in Mizoram. Of these, the specimens designated as type III variety does not matches with earlier described varieties from this region. Moreover, allocation of all the mentioned varieties in a single subspecies is very doubtful. To reveal this unknown hitherto, further investigation on the basis of molecular and morphological studies with larger sample size is suggested. All the recent collected materials in our hand, which are not included in this paper fall under type II. However, the species is not yet assessed under IUCN red list data due to lack of scientific data which plays an important role in making conservation plans. Like most of Indian snakes, it belongs to Schedule-IV under Wildlife Protection Act (1972). As they are rare venomous species and due to rapid loss of habitation, detail study on their biology is very important. The present report on the information of different varieties and their distribution will help future research work on this species.

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