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Author-formatted, not peer-reviewed document posted on 05/09/2022

DOI: <https://doi.org/10.3897/arphapreprints.e94479>

**A contribution to taxonomy and biology of
Spalerosophis diadema diadema Schlegel, 1837 along
with new record of *Spalerosophis atriceps* Fisher, 1885
from district Poonch of Jammu and Kashmir, India
(Reptilia, Squamata, Colubridae).**

 Sarshad Hussain, Asgar A. Shah, Khursheed Ahmad

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A contribution to taxonomy and biology of *Spalerosophis diadema diadema* Schlegel, 1837 along with new record of *Spalerosophis atriceps* Fisher, 1885 from district Poonch of Jammu and Kashmir, India (Reptilia, Squamata, Colubridae).

Running Title: Sarshad Hussain *et al.*, taxonomy & biology of *Spalerosophis* spp.

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Abstract

Present studies aimed to validate the occurrence of two species of Diadem or Royal snakes of Genus *Spalerosophis* Jan, 1865 from district Poonch of Jammu and Kashmir, India along with the presentation of different colour morphs and diagnostic characters. A total of 56 number of individuals belonging to genus *Spalerosophis* have been reported from the study during the period 2019-2021 during their activity period falling between spring to fall (May to October). 56 individuals encompass 8 different colour morphs viz., 4 different colour morph of *S. d. diadema* Schlegel, 1837 (total 47 individuals), 2 colour morph of *S. atriceps* Fisher, 1885 (3 individuals), 1 colour morph of subadults (5 individuals) and 1 colour morph though resembles much with *S. d. diadema* but identification remain inconclusive on the basis of low numbers of sub-caudal scales which are hinting towards *S.d.cliffordi* Schlegel, 1837 (one specimen only) whose identity is subjected for further investigations. Distribution, activity, habitat and behaviour of the individuals has also been reported along with the morphological, morphometric and meristic characters. Among two identified species *S. atriceps* is a new report from Poonch district. Among the examined specimens only dead specimens have been preserved in Mendhar College Museum of Zoology (MCMZ) after taking due permission from Jammu and Kashmir Wildlife Department. Reported specimens are mapped across the study area and are depicted here in distribution map.

Key Words

Colour morphs, new report, revalidation, *Spalerosophis atriceps*, *d. diadema*, *diadema* (?).

Introduction

Spalerosophis has a very large range of distribution in arid and semiarid regions from North Africa in the west through Arabia, Iran, Pakistan to central India in the east (Marx 1959; Minton 1966; Mertens 1969; Gasperetti 1988; Sharma 2007; Schatti et al. 2010; Whitaker and Captain, 2004, 2008, 2015; Sindaco et al. 2013; Uetz 2015; Yadollahvandmiandoab et al. 2018). At the same time as reported by Schatti et al. (2010) the systematics and taxonomy of *S. diadema* from the Euphrates and the Caspian Sea to the Indian subcontinent are in need of clarification and the statement hold true despite, and partly due to, recent contribution on the topic by Baig and Masroor (2008). Probable reason behind the confusion in identification of *Spalerosophis* as cited by Schatti et al. (2010) is the different counting, printing lapses and different description of supranormal scales in the pileus region particularly the prefrontals (Dumeril et al. 1854; Gunther 1864; Zugmayer 1905; Schamidt 1930; Werners 1936; Hellmichs 1959; Marx 1959; Minton 1966; Baig and Masroor 2008) which are diagnostic characters of genus *Spalerosophis*. In present studies labelled sketch of scales of pileus region have been given to avoid confusion and misinterpretation (Fig. 2).

The Indo-Pakistan segment is represented by *Spalerosophis arenarius* (Boulenger 1890), *S. diadema diadema*, *S. diadema schirazianus* and *S. atriceps* (Minton 1966; Fischer 1885). *Atriceps* was considered a colour morph of adult *diadema* by Marx (1959), Mertens (1969) and Khan (2006). We follow Minton (1966); Baig and Masroor (2008); Schatti et al. (2009, 2010); Whitaker and Captain (2015) who have considered *atriceps* as valid species. Within Indo-Pak region *S. diadema schirazianus* was shown distributed along Iran, Afghanistan and western India, *S. arenarius* from Gujrat and only *S. diadema diadema* was shown with little wider range of distribution from central, north and north west part of India (Marx 1959). Baig and Masroor (2008) considered *schirazianus* as junior synonyms of *diadema*. Following Marx (1959), Schatti et al. (2009) reported *Spalerosophis diadema* as polytypic species represented by *S. d. diadema* and *S. d. cliffordi*, the latter from Iran. Marx (1959) had separated the *S. d. diadema* and *S. d. cliffordi* on the basis of number of subcaudals, i.e., 80 or more in *diadema* versus less than 80 in *cliffordi*. In our study, we follow the determination key given by Schatti et al. (2009) for the genus *Spalerosophis* Jan while following the data from Wall (1908); Marx (1959); Lanza (1964); Minton (1966); Pasteur (1967); Lanza (1978); Baig and Masroor (2008). Working on the herpetofauna of Jammu and Kashmir Sahi and Duda (1985) have shown the presence of *S. diadema diadema* from district Kathua, Jammu, Dumel, Udhampur, Reasi, Poonch and Ramban; *S. atriceps* from Kathua, Udhampur and Kishtawar; *S. arenarius* from

66 Jammu and Bhaderwah but none of the authors had ever reported presence of *S. d. cliffordi*
 67 from India. It is for this reason we kept a specimens representing subcaudal count of less than
 68 80 (resembling with *S. d. cliffordi*) under further investigation. Schatti et al. (2009) reported
 69 that occurrence of *S. diadema* from Northwest India (Kashmir) requires serious investigations.
 70 The lack of knowledge of the reptilian fauna of Kashmir in general and current study area in
 71 particular is supposed to be mainly caused by remoteness and by the area's instability owing
 72 to its location near border of Pakistan since 1990s. The presence of *diadema* in India was put
 73 in question for investigation and confirmation by Schatti et al. 2010 due to absence of its
 74 mapping by (Baig and Masroor, 2008) and due to reporting based on subadult specimens. In
 75 the current study occurrence of species from different localities has also been given (Fig. 1)
 76 besides mentioning of sizes of individuals along with their characters (Table 1). In addition we
 77 are presenting new report of occurrence of *S. atriceps* along with revalidation of occurrence of
 78 *S. diadema diadema* from district Poonch of Jammu and Kashmir India. *Spalerosophis* spp. are
 79 represented by different colour morphs both within the species and between its different species
 80 which has led to a great confusion in identification (Baig and Masroor, 2008). Here we are
 81 reporting 04 colour morphs of *S. d. diadema*, 02 colour morph of *Spalerosophis atriceps*, 1
 82 colour morph of subadult (*diadema/atriceps*) and 1 colour morph of a specimen whose identity
 83 has been subjected for further studies. These findings will serve the purpose of confirmation of
 84 distribution of these species from north India in general and district Poonch of Jammu and
 85 Kashmir in particular besides providing diagnostic characters for the purpose of identification.

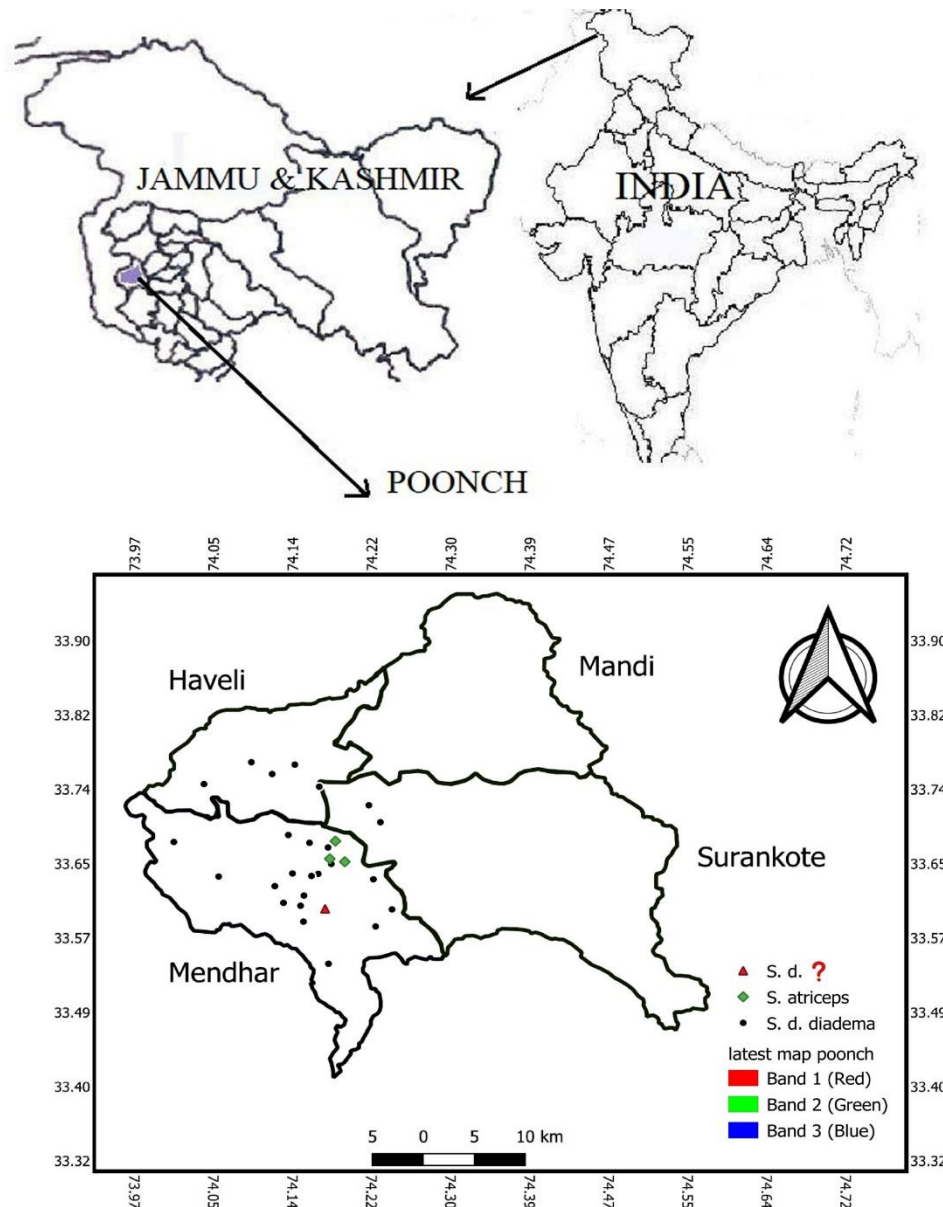


Figure 1. Map showing distribution of *Spalerosophis* in the study area, district Poonch.

Materials and acronyms

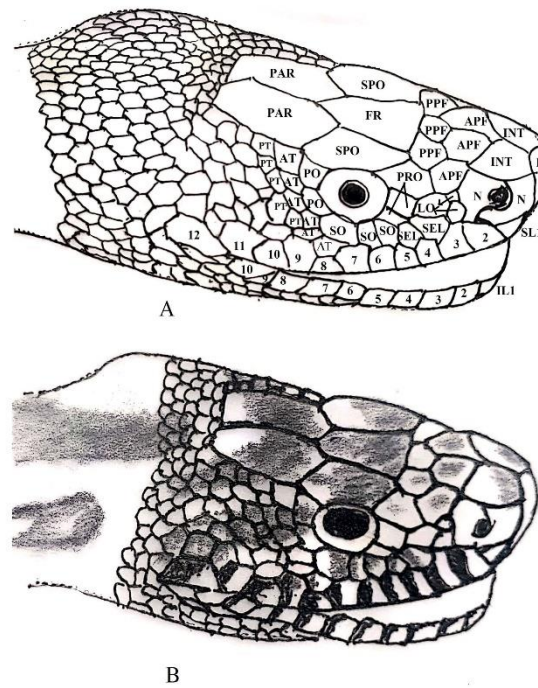
On sighting the specimens in the field -activity of snake, time, date, climate, co-ordinates and photographs had been taken. Videography has been done for presenting the behaviour of the individual. Specimens which were found dead in the field were only preserved in the museum for reference. 29 different localities of district Poonch from where 56 number of specimens belonging to genus *Spalerosophis* have been reported during the year 2019-21 (Fig. 1) exhibit 08 different colour morphs (Figs 5-7). Dead specimens were deposited in the Mendhar College Museum of Zoology (MCMZ). Their meristic and morphometric characteristics of 12 collection-vouchered non-types, including 2 photo vouchers and 10 vouchered specimens are

shown in Table 1 and 2. The unique specimen identifier ascribed to the specimens are: MCMZ 0119, 0219, 0314, 0413, 0514, 0619, 0719, 0819, 0920, 1020, PV0120 and PV0220 (First two digits indicate the S. No of Specimen ascribed on the jar at the time of characterisation and second two digits are indicating year of collection). Out of 12 preserved specimens, 1 is subadult of unknown parentage (*diadema/atriceps*, Fig. 5A) 08 specimens belongs to *S. d. diadema* (Figs 5 B,C and 6 A,B), 01 male specimen remain unidentified (Fig. 6C) and 2 specimens belongs to *atriceps* (includes 1 male and 1 female) (Fig. 7).

Terminology used for describing meristic and morphometric characters (Figs 2,3; Table

1): In order to avoid terminological confusion while interpreting the number of head scales, we are giving labelled head sketches in Figs 2, 3. While counting the scale even a small granule has also been taken into consideration. ‘anterior scale rows -asr’ denote anterior dorsal scale rows counted one head-length behind the head excluding the ventrals. ‘midbody scale rows -msr’ are the dorsal scale rows counted at the level of mid ventral scale. ‘posterior scale rows -psr’ refers to the dorsal scale rows one head length anterior to anal plate. ‘anterior temporal -at’ is a vertical row of scales immediately behind the postocular touching below the supralabials and above the parietals. ‘Broken -br’ means when a part of body is broken to the extent that scales are not countable. ‘Circumocular -co’ means scales in contact with the eye (i.e., ‘preocular-pro’ + ‘subocular-so’+ ‘postocular-po’) except the large ‘supraocular- spo’ scale. ‘Dorsal blotches - db’ are mid-dorsal large dark spots running behind the head down the tail. ‘Infra labials -il and supralabials -sl, are scales of lower lip and upper lip respectively. ‘Loreals -lo’ are the scales situated on or above a straight line parallel to the mouth from the lower posterior tip of the nasal to the circumocular ring and below the prefrontals. ‘Photo vouchers -pv’ a characterised specimen whose proof is available only in the form of photograph. ‘Prefrontals -pf’ are the scales on the dorsal side of head, often arranged in two rows, between ‘internasal-int’ at their anterior and ‘frontal-fr’ at their posterior, bordering laterally with loreal and preocular. ‘Anterior prefrontals-apf’ is the horizontal row of prefrontal scales touching internasal anteriorly while ‘posterior prefrontals- ppf’ is the horizontal row of scales touching frontal and supraocular posteriorly. ‘Secondary labials - sel’ are the scale below the loreals, anterior to scales of circumocular ring and in contact with the supralabials. ‘Rostral’ is the single scale present at the tip of snout. ‘Ventrals - vent’ are the scale counted from first transverse scale on the ventral side of the head just posterior to gular upto the anal plate. ‘Anal - an’ is the last ventral scale covering the anal opening. ‘Sub-caudal -scd’ are the scales on the ventral side of tail. If left and right counts are different, they are separated by a

130 slash. ‘Temporals’ are the scale rows immediately behind the postocular and extending
 131 between ‘parietal- par’ above and supralabials below. ‘Anterior temporal- at’ and ‘posterior
 132 temporal- pt’ are the rows of temporals present anteriorly and posteriorly. Specimen ‘MCMZ
 133 0119’ whose identity is yet to be established is referred to as *Spalerosophis diadema* (?).



134

135 **Figure 2A, B.** Dorsolateral sketch of Head of *Spalerosophis diadema diadema*
 136 (MCMZ0314). **A.** The characteristics head scales pattern; **B.** The characteristics black
 137 marking on supralabials scales. (*diadema* /atriceps).

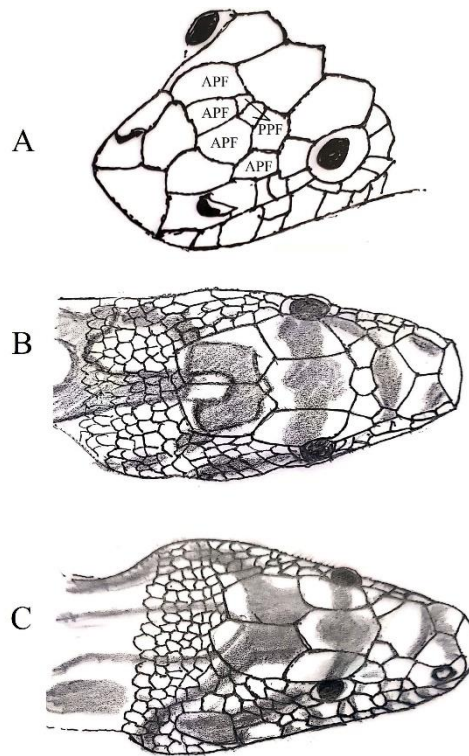


Figure 3A-C. Showing the variations in the arrangement of head scale of *Spalerosophis* spp (*diadema diadema*/ *diadema* (?)/ *atriceps*) with special focus on prefrontals. **A.** MCMZ0119; **B.** MCMZ0819; **C.** MCMZ0514.

Results

The *Spalerosophis* spp. in the study area are represented by moderately large population. A total of 56 individuals are seen at different locations from the study area over a period of two years, out of which 03 individuals represent *S. atriceps* and 47 number of individuals represent *S. d. diadema*, 5 individuals represent subadults of unknown parentage (*diadema*/*atriceps*) and 01 specimen is kept for further investigation for establishing its likelihood of *S. d. cliffordi* (?)/ *S.d.diadema* (?). Observed specimens have shown distinctive colour and marking on the body. As described by Wall (1914) head is elongated, oval and well demarcated from neck. The Snout is long and moderately obtuse. Eye has round pupil with golden iris. Body surface is ribbed longitudinally with mid dorsal rows of weak keeling in *S. d. diadema*, *S. diadema* (?) and keeling in *S. atriceps*. The tail is round. Male has shorter tail as compared to females. The two identified species viz., *S. d. diadema*, *Spalerosophis atriceps* and one unidentified species namely *S. diadema* (?) share following characters in common:

1. Rostral broader than high.

2. Orbit is completely surrounded from all sides by ring of ocular scales viz., preocular (pro), postocular (po), supraocular (spo) and subocular (so). Thus, no supralabials directly touches the eye. (Fig. 2A, B).
3. Prefrontals and loreals broken up into small scales (Figs 2A,B and 3A-C).
4. High number of temporal scales (4 to 6 in first row) (Fig. 2A, B).
5. One undivided sub-pentagonal frontal
6. Two parietals which are not in contact with postoculars.
7. Nasal is divided.
8. There are two inter-nasals.
9. Mid body scale rows 27-31.
10. Each supralabials scale have vertical dark marking /band on posterior margin (Fig. 2B and Fig. 4A-J).
11. Underside of head and chin is white (Figs 5-7 ventral).
12. Anal plate entire.
13. Males are smaller in size than females.

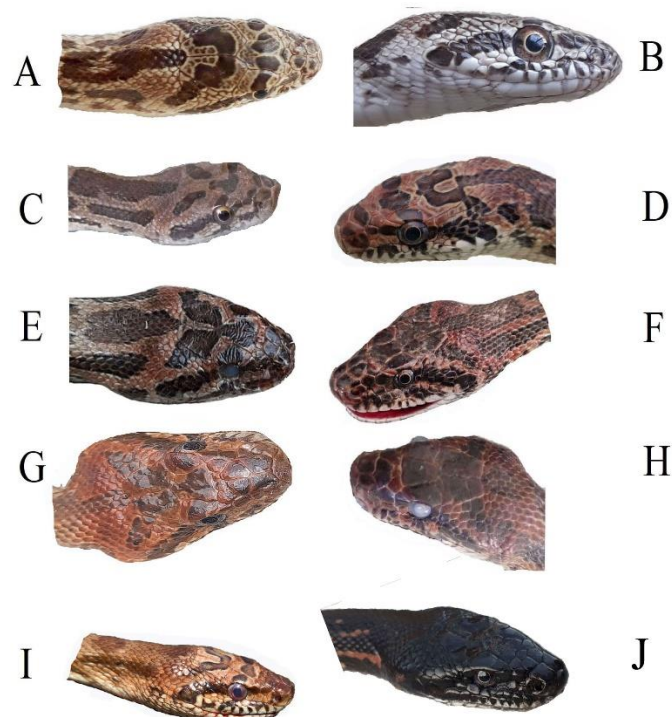


Figure 4A-J. Showing colouration and dark markings of heads of *Spalerosophis diadema diadema* (A, B. MCMZ0619; C. MCMZ0719; D. MCMZ0819; E. Photo Voucher; F. MCMZ0219; G. Photo Voucher), *Spalerosophis diadema* (?) H. MCMZ0119 and *Spalerosophis atriceps* (I. MCMZ0920; J. MCMZ1020).

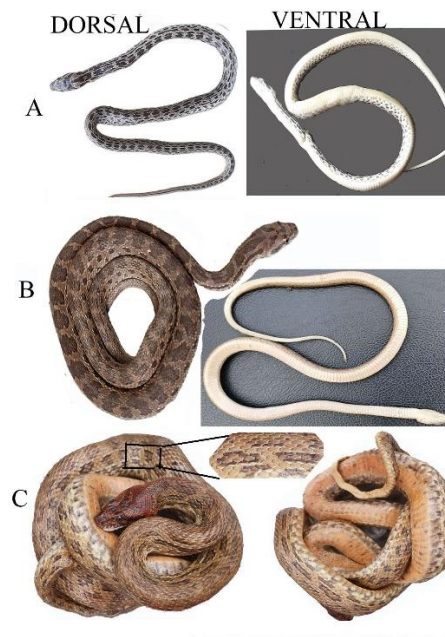


Figure 5A-C. Dorsal and ventral view of *Spalerosophis diadema diadema*. **A.** Subadult, MCMZ0619 and **B.** Adult, MCMZ0719. Both have uniformly white ventrals. **C.** Adult, Photo Voucher showing fading of dark spot on the body.

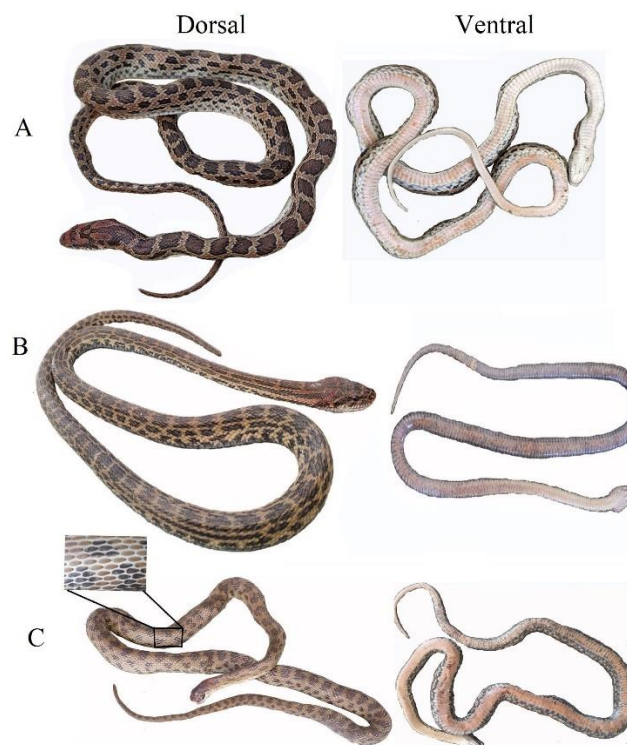


Figure 6A-C. Dorsal and ventral view of adults of *Spalerosophis diadema diadema*. (**A.** MCMZ0819; **B.** MCMZ0219) and *S. diadema* (?) (**C.** MCMZ0119). Ventrals of all are mottled with dark marking.

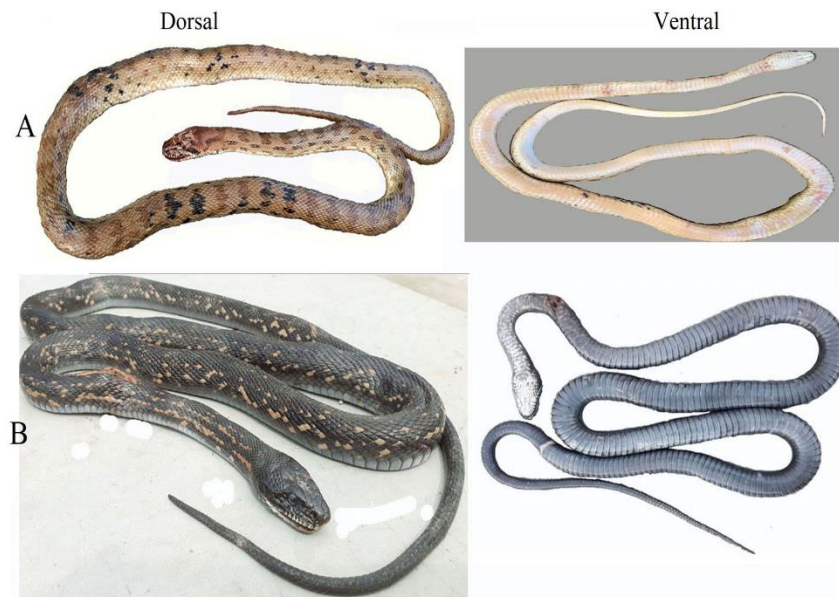


Figure 7A,B. Dorsal and ventral view of *Spalerosophis diadema atriceps*. **A.** Moderately melanistic, MCMZ0920; **B.** Intensely melanistic, MCMZ1020

Colour (Figs 4-7)

Spalerosophis genus shows a great variant of inter- and intra-specific colouration.

Body colour. Colour and marking in young and adults are more or less similar in *diadema diadema* but differ in *atriceps*. Background colour of dorsal body in 5 numbers of subadults was observed as light brown (Fig. 5A) and dark brown (Fig. 5B,C) to ruddy brown (Fig. 6 A,B dorsals) in 57 numbers of adults of *Spalerosophis diadema diadema* with five rows of large darkish spots passing down the back from the nape well on to the tail. Spots on median row are large, rounded or rhomboid in outline alternating with the two rows of smaller spots on each lateral side. Unidentified specimen (MCMZ 0119) also has ruddy brown body colour with similar pattern of spots as depicted by *diadema diadema* except that dark colour of scales is restricted to a group of 4-6 scales (Fig. 6C).

Only three specimens of *Spalerosophis atriceps* were encountered during the study period. One was alive and two were dead/killed and later were preserved. Alive one was showing exactly similar colour pattern with MCMZ1020 (Fig. 7B). In case of *S. atriceps* ground colour of body is a pinkish buff in smaller sized individuals with dull claret colour spots on the body exactly in a pattern of *S. d. diadema*. Scattered here and there are dark bluish to black spots restricted to few scales (Fig. 7A). Their spots differ from our *Spalerosophis diadema*(?) (Fig. 6C) in the manner that here they are not present in rows and uniform pattern. More grown individuals of

205 *atriceps* has highly melanistic dark bluish to black body with few ruddy brown scales (Fig.
206 7B).

207 In *Spalerosophis diadema diadema* belly is whitish in all the younger specimens (Fig. 5A,B
208 ventrals) but in adults it is suffused with pink especially in the middle line(Figs 5C and 6A
209 ventrals), or there are frequently greyish spots or mottling at the lateral edges of the ventrals
210 (Fig. 6B ventral). *Spalerosophis diadema*(?) (Fig. 6C ventral) resemble with ventral of *diadema*
211 *diadema* (Fig. 6B ventral). Whereas *S. atriceps* has ruddy white or uniform rosy pink belly in
212 younger (Fig. 7A ventral) and black in fully grown individual (Fig. 7B ventral).

213 **Head marking.** The head is light brown or copper colour or ruddy brown, variously spotted or
214 mottled with dark spots in almost all the sizes of *Spalerosophis diadema diadema* (Figs 2B and
215 4 A-J) and *S.diadema*(?) (Fig. 4H). The dark markings of head are well distinct in young but
216 become less distinct as age advances and this is true for both the species viz., *S. d. diadema*
217 and *S. atriceps*. It is often broken up but the most constant is a band between the eyes, an
218 oblique strip from behind to the angle of mouth and a quoit like mark on the parietals (the
219 diadem mark). The diadem mark is often connected with the band between the eyes by a median
220 stripe (Fig. 4E-H) or remain quite detached (Fig. 4 A-D, I), or throw back 1 to 3 short stripes
221 posteriorly (Fig. 4A, D, F-I). Many departures from this arrangement may be seen either
222 towards a confluence or a disintegration of these marks, and in many specimens the interorbital
223 and diadem marks are not or barely suggested (Fig. 4F, G, J). Smaller sized individuals of
224 *atriceps* has brilliant strawberry scarlet on head and neck (Fig. 4I). Fully grown *atriceps* has
225 complete black colour head (Fig. 4J). Very constant feature observed in all specimen of both
226 the species is the one light and one dark vertical band present on each supralabials scale (Fig.
227 2B). This feature is so common that it is retained by intensely melanistic form of *atriceps* (Fig.
228 7B) where all the rest of the marking of head are not visible.

229 **Morphology**

230 **Body marking and blotches.** Blotches on the body are dark spots whose number and form
231 vary a great degree from individual to individual. In present study number of blotches remain
232 countable (54-88) in all sizes of *S. d. diadema* and *S. diadema*(?) but remain observable only
233 in younger and moderately melanistic form of *S. atriceps* (Table 1 and 2). Generally they have
234 five rows of darkish spots quincuncially arranged passing down the back from the nape well
235 on to the tail, decreasing in size from mid-dorsal towards lower lateral margins. Spots on

median row are large, rounded or rhomboid in outline alternating with the two rows of smaller spots on each lateral side (Figs 5-6).

With little deviation from the 2 lateral rows on each lateral side of the body of adult forms, younger forms have 3 rows of smaller spots laterally on each side of forebody which get reduced to 1 or 2 rows on tail (Fig. 5A).

Pattern of marking is quiet variable in *atriceps*. Their body is either straw yellow with irregular black flecks and faded dorsal blotches as if the snake had been spattered with tar, head giving pink hue and mottled with black marking similar to *forma typica* (Fig. 7A) or the body is heavily melanistic with straw yellow small spots scattered here and there on the body (Fig. 7B).

Variation in mid-dorsal body blotches. In younger forms of *Spalerosophis diadema diadema* vertebral line of spots seems broken down into three spots: a median rhomboid large dark spot with a lateral slightly narrow band on each side. On tail, a single narrow long mid-dorsal dark streak is present.

In older forms the three small spots (a median rhomboid larger sized dark spot and two lateral narrow bands) on mid-dorsal line of the body may get completely fused to form a single large rhomboidal dark spot (Figs 5B, 6A of *S. d. diadema* and Fig. 6C of *S. diadema*(?) or the median rhomboid remain connected at their middle with two lateral smaller band (Fig. 6B). In addition to this these dorsal spots may fade away and may look quite dull rendering them almost invisible (Fig. 5C). As observed in the young ones the mid-dorsal spots on tail of adult individual may sometime fuse to form a single dark line at mid-dorsal position (Fig. 6B).

Variation in lateral body blotches. Lateral spots of the body in *S. d. diadema* form a complete dark blotch in majority of the cases (Figs 5AB, 6AB) while sometime the lateral blotch may get faded from inside thus forming a dark ring on its margin (Fig. 5C). These lateral blotches are seen restricted to few scales only in *S. diadema* (?) (Fig. 6C).

Morphometric and meristic characters.

Scalation pattern and body sizes of *Spalerosophis diadema diadema*, *S.atriceps* and unidentified *S. didema* (?) are given in Table 1 and 2.

In all the specimens rostral is broader than high, nasal is divided, there are two internasal, one undivided sub-pentagonal frontal and two parietals which are not in contact with postoculars.

Table 1. Morphometric and meristic characteristics of *Spalerosophis diadema diadema*, *S. diadema* (?) and *S. atriceps*. Abbreviations: **asr** - anterior scale rows, **alt** - altitude, **at** - anterior temporal, **br** - broken, **co** - circumocular (**pro** - preocular + **so** - subocular + **po** - postocular), **db** -dorsal blotches, **ds** - dorsal scales, **f** – female, **il** - infralabials, **k** - keeled, **lo** - loreal (when 2 - one behind the other, when 3- two anterior and one posterior, when 4- two anterior and two posterior), **m** – male, **MCMZ** - Mendhar College Museum of Zoology (unique specimen identifier), **msr** - midbody scale rows, **p** – photo voucher, **psr** - posterior scale rows, **pf** - prefrontals (**apf** - anterior prefrontal + **ppf** - posterior prefrontals), **sa** – subadult, **sca** - subcaudal, **sel** - secondary labials, **sl** - supralabials, **SVL** - snout-vent length, **TL** - tail length, **vent** - ventrals, **wk** - weakly keeled. If left and right counts are different, they are separated by a slash.

Meristic Characters																Morphometric Characters	
MCMZ	sex	asr	msr	psr	ds	vent	sca	pf	lo	co	sel	at	sl	il	db	SVL (mm)	TL (mm)
0619 diadema/ atriceps	sa	27	29	19	wk	248	106	7 (4+3)	2	7 (2+3+2)	1	4/5	10/12	12	64	309	87
0719 diadema diadema	f	27	29	21	wk	244	106	8 (4+4)	2	8 (3+3+2)	2	5	11/12	14	63	640	200
0819 diadema diadema	f	25	27	19	wk	249	96	7 (3+4)	2	8 (2+4+2)	1	5	11	12/13	88	860	241
0514 diadema diadema	f	br	29	19	wk	241	102	5 (3+2)	2	8/7 (3+3+2/ 2+3+2)	2	4	11	13/14	54†	1130	340
PV0220 diadema diadema	m	26	29	19	wk	246	86	8 (4+4)	2	8 (2+3+3)	2	5	11	12	60†	1280	230
0314 diadema diadema	f	25	29	19	wk	242	110	7 (4+3)	2/3	8/9 (3+3+2/ 3+3+3)	2	6	11/12	12	61	1203	384
0219 diadema diadema	m	26	29	19	wk	248	52 br	8 (4+4)	2	7 (2+3+2)	1	4/5	11	13	62	1545	210
0413 diadema diadema	f	29	29	19	wk	234	111	7 (3+4)	3	8 (3+3+2)	1	4	11	13	60	1340	450
PV0120 diadema diadema	m	26	29	19	wk	254	82	7 (4+3)	2	7 (2+3+2)	2	5	11	12	64	1440	325
0119 diadema (?)	m	26	29	19	wk	240	78	7 (4+3)	2	7 (2+3+2)	1	4	11	11/12	85	1415	321
0920 atriceps	m	27	29	19	k	238	105	8 (4+4)	2	6/7 (2+3+2/ 2+2+2)	1/0	4/5	11	13	57‡	1110	285
1020 atriceps	f	28	31	21	k	250	109	7 (4+3)	3/4	8/10 (3+3+2/ 3+3+4)	2/2	4/6	12/13	13	nil	1230	333

† faded on tail, not seen clearly.

‡ dull shades of blotches only.

Table 2. Altitudinal range of occurrence along with range of characters of *Spalerosophis diadema diadema*, *S. diadema* (?) and *S. atriceps*. Number in parenthesis are number of specimens; means are in brackets; M=Male; F=Female. Different left and right counts are separated by a slash.

S.No	Characters	<i>S. d. diadema</i>	<i>S. diadema</i> (?)	<i>S. atriceps</i>
1	Altitudes in metres	780-1920	990	1120-1630
2	Number of Individuals for meristic characters	8	1	2
3	Anterior Dorsal Scale Rows	25-29	26	27-28
4	Midbody Dorsal Scale Rows	27-29	29	29-31
5	Posterior Dorsal Scale Rows	19-21	19	19-21
6	Ventrals	$\frac{234-249 \text{ F (5)}}{246-254 \text{ M (3)}}$	240 M (1)	$\frac{250 \text{ F (1)}}{250 \text{ F (1)}}$
7	Subcaudals	$\frac{96-111 \text{ F}}{82-86 \text{ M}}$	78 M	$\frac{109 \text{ F}}{105 \text{ M}}$
8	Prefrontals	5-8	7	7-8
9	Loreals	2-3	2	2-4
10	Circumocular	7-9	7	6-10
11	Secondary Labials	1-2	1	1-2
12	Anterior Temporals	4-6	4	4-6
13	Supralabials	10-12	11	11-13
14	Infralabials	11-13	11/12	11-14
15	Dorsal Blotches	54-88	85	Not present
16	Total length	$\frac{840-1790 \text{ F (5)[1357.6]}}{1510-1765 \text{ M (3)[1752]}}$	1736 M (1)	$\frac{1736 \text{ M (1)}}{1395 \text{ M (1)}}$
17	Tail Body Ratio	$\frac{0.31 \text{ F}}{0.17 \text{ M}}$	0.22 M	$\frac{0.27 \text{ F}}{0.25 \text{ M}}$

Loreals (Fig. 2). *S. d. diadema* and *S. diadema* (?) have same range of loreal count (2-3) whereas *atriceps* differ in having loreal scale range of 2-4. As for as arrangement of loreal is concerned, when they are two then they are positioned one behind the other; when more than 2, they are partially arranged in two rows i.e., when 3, two anterior one above the other and one posterior; when 4, two anterior and two posterior positioning one above the other.

288 **Prefrontals** (Figs 2, 3). Scales in prefrontal range between 5-8 in *S. d. diadema* and *S. diadema*
 289 (?) and 7-8 in *atriceps*. Lowest number of prefrontals are presented by MCMZ514 and highest
 290 by MCMZ0719, -0219 and -0920. They are always found arranged in two rows, the anterior
 291 prefrontal and posterior prefrontals (Fig. 2A). Scale of both the rows show a variable size,
 292 shapes and configuration. As shown in Table-1, the number of scales in anterior prefrontal and
 293 posterior prefrontal may be 3-4 and 2-4 respectively. Scales of two rows may be restricted in
 294 their own respective rows as depicted in specimen MCMZ0314 (Fig. 2) or one scale of anterior
 295 prefrontal row may be so large that it touches the frontal scale directly as in MCMZ0119 and
 296 MCMZ0514 (Figs 3A, C) or simply wider enough to restrict the number of anterior prefrontals
 297 to 2 as in MCMZ0819 (Fig. 3B).

298 **Circumocular**. Number of scales in circumocular have slight lower range i.e., 7-9 scales in *S.*
 299 *d. diadema* and *S. diadema*(?) than that of *atriceps* where this range is 6-10. This count excludes
 300 one large supraocular whose number remains constant in all individuals and includes 2-3
 301 preocular, 2-4 postocular and 3-4 subocular completely separating the supralabials from the
 302 eye.

303 **Labials**. Count of supralabials and infralabials is also lower in *S.d. diadema* and *S.d. cliffordi*
 304 (?) i.e., 10-12 supralabials and 11-13 infralabials when compared with *atriceps* where it is 11-
 305 13 and 11-14. Secondary labials range between 1-2 in *S.d. diadema* and *S. diadema*(?) and 0-
 306 2 in *S. atriceps*.

307 **Temporals**. Temples range of 4-6 is same in all the three species.

308 **Ventrals**. Ventrals in males of *S.d. diadema* range between 246-254 and in females 234-249.
 309 The male specimen whose identity is put in question has 240 ventrals which are within the
 310 range of *S. d. diadema*. In case of *atriceps* ventrals count is 238 in male and 250 in female.
 311 Anal is entire in all the species.

312 **Subcaudals**. Subcaudals range is 96-111 and 82-86 in females and males of *diadema diadema*
 313 respectively. Unidentified male specimen *S. diadema*(?) has lowest number of subcaudals i.e.,
 314 78. In the *atriceps* subcaudal count of female is within the range of *diadema diadema* i.e., 109
 315 whereas the males have much higher number of subcaudals i.e., 105 as compared to males of
 316 *diadema diadema*.

317 **Dorsal scale rows**. Dorsal scales are weekly keeled and are present in 25-29 longitudinal series
 318 across trunk at one head length behind the head, 27-29 at midbody and 19-21 at one head length

ahead of anal in *diadema diadema* and *S. diadema*(?) . On the other hand *atriceps* have keeled dorsal scales whose anterior and posterior dorsal scales are very much in the range of scales of *diadema diadema* i.e., 27-28 and 19-21 rows respectively but differ in the number of midbody dorsal scales whose range is again on higher side i.e., 29-31.

Size. Males are smaller in size in both the species. Maximum total length of females as reported in present studies has reached upto 1790mm (tail 450) while that of male has been reported as 1765mm (tail 325) in case of *diadema diadema*. Total body length of unidentified male specimen is well within the highest range of size of male of *diadema diadema* i.e., 1736mm. Though only one individual each of male and female has been reported for the species *atriceps* but, the size of male is again on lower side (1395mm, tail 285mm) than that of the female (1563mm, tail 333mm). The tail/body length ratio is 0.31 for females and 0.17 for males of *diadema diadema* whereas 0.27 and 0.25 for females and males of *atriceps* respectively. Tail/body length ratio of unidentified specimen is 0.22.

Distribution (Fig. 1)

Both the species of *Spalerosophis* viz., *diadema diadema*, *dadema* (?) and *atriceps* have shown sympatric distribution in the study area. *Spalerosophis diadema diadema* has shown wider range of distribution as it has been recorded from semi-arid areas of three tehsils namely Haveli, Mendhar and Surankote within an altitudinal range of 780 to 1920 m. Temperate zone of study area viz., whole tehsil of Mandi and major part of tehsil Surankote have not shown the presence of even a single specimen during the period under report. *S. atriceps* has been reported from Mendhar only within the altitudinal range of 1121 to 1633 m. Among the different tehsils of study area, tehsil Surankote is typically a temperate region whereas tehsil Mendhar is a Sub-tropical region exactly depicting the dry and semi-arid type of climate. Presence of *Spalerosophis diadema diadema* has been recorded only from southern side of tehsil Surankote which is in close proximity and continuity with the border line of Tehsil Mendhar and is not geographically isolated by any stream barrier. Unidentified specimen has been reported from quiet low altitude of tehsil Mendhar i.e., 990m.

Habitat

Spalerosophis diadema diadema is often found in crop field, crevices, inside the house more often in roof (made of wood and soil) and walls. *S. atriceps* has been reported from crop field only. Unidentified specimen was also reported from a house. Vegetation of the areas under

report includes dispersed shrubs, annual grasses, maize and wheat crop field and woody trees. None of the specimen was found near water source.

Activity and behaviour

The activity period of *Spalerosophis* spp ranges between spring and fall (May to October). *S. d. diadema* has been observed from croplands, bare area rock, grass fields, inside the houses (Kaccha houses) as well as from mosaic vegetation. Inside the house they are found more active during the night time. At two occasion it was found coiled around the common house rat as if later is being killed by constricting. On being cornered they suddenly erect their forebody and glide side wise in search of escape route. On capturing they expand and contract their body, produce a hissing sound and strike quickly (see supplementary file 1: Movie <https://youtu.be/lvmFB3Dql5E>). Younger ones are more active compared to adults thus a greater number of adults get trapped while capturing. Out of the three specimens of *S. d. atriceps*, two have been reported from cropland and one from bare rocky area during daytime. Since the two specimens of *atriceps* were found dead and the one which was alive was basking in the sun after rain in the month of August and escaped, so we remain unable to ascertain the activity and behaviour. Unidentified specimen was also found dead.

Discussions

The study and their identification of species is one of the first and most important step to be taken before formulating a species-specific policy of conservation of the biological diversity. *Spalerosophis* spp. are adapted to a wide range of habitats (Rastegar-pouyani et al. 2008). As these species feed on some rodents, their role may be considerably important in biological control of rodent population (Yadollahvandmiandoab et al. 2018). Present findings of reporting of *Spalerosophis* from crop field, kaccha house and at some occasion wrapped around the common rat as elaborated under result section are clearly suggesting the role of this species in rodent control.

Despite the observation on *Spalerosophis diadema diadema* distribution from Indian region including Gujarat, Banaskantha, Kachchha and Mehsana districts, Northwestern India, Jammu and Kashmir, Punjab, Uttar Pradesh, Haryana, Rajasthan and Gujrat (Smith 1943; Sahi and Dooda 1985; Sharma, 2007); Baig and Masroor (2008) has restricted the distribution of *diadema* in Indo-Pakistan region along the Pakistan border with Iran and Afghanistan only. In addition to this Whitaker and Captain (2008, 2015) while describing the snakes of India have not depicted the *diadema* in their coloured plates and description. Sahi and Dooda (1985) have

mentioned the presence of *atriceps* from other district of Jammu and Kashmir but not from the district Poonch. Thus, the present study besides re-validating the presence of *S. d diadema* from district Poonch is also giving a new report of *S. atriceps* from the study area.

Following Marx (1959), Schatti et al. (2009) considered *Spalerosophis diadema* as a polytypic species including *S. d. cliffordi* and *S. d diadema* and ruled out any possibility of considering it as a valid separate species described earlier by Schmidt (1939) and later by Trape and Mane (2006) citing reason of unintentional citations and lack of rationale. Schmidt (1939) and Marx (1959) had separated the *S. d. diadema* and *S.d. cliffordi* on the basis of number of subcaudals, i.e., 80 or more in *S. d. diadema* versus less than 80 in *cliffordi*. Present finding of one specimen MCMZ 0119 having subcaudal scales count of 78 point about likelihood of this specimen as candidate of *S. d. cliffordi*. But we refrain from this decision of establishing this species from this area and subjected it for further investigation on the basis of the fact that none of the author ever have reported *cliffordi* from India and Baig and Maroor (2008) while following Khan (2002, 2006) have considered subcaudals range of 78-114 for *diadema diadema*. Schatti et al. (2009) have shown its presence from western Sahara to Southwest Iran. Thus the establishment of *S.d.cliffordi* from this area need more profound analysis, larger samples and additional diagnostic characters.

Smith (1943); Marx (1959), Sharma (2007); Baig and Masroor (2008); Whitaker and Captian (2008, 2015) reported that adults of *S. diadema* and *S. atriceps* show strikingly different head and dorsal colour pattern but this does not hold true for subadults and juveniles, thus making their identification difficult. This hold true in present finding also as less grown individual of *atriceps* MCMZ 0920 is showing faded blotches and head markings as if the individual is losing its typical subadult marking of the head and body. Specimens MCMZ 920 having a SVL 1110mm showing faded blotched pattern as well as moderately melanistic body and specimen MCMZ 1020 having SVL of 1230mm exhibiting intensely melanistic body are identified as *atriceps* on the bases of the findings of Baig and Masroor (2008) who reported that *Spalerosophis atriceps* when exceeding 1000mm in snout-vent length gradually loses the blotched pattern and changes into straw yellow colour with irregular flecks and blotches (Fig. 7A) and any other melanistic form (Fig. 7B). In addition to this the scalation pattern of these two specimens of *atriceps* as per our data are clear in line with the earlier findings of Minton (1966) and Baig and Masroor (2008) mentioned hereinafter in brackets viz., mid-dorsals 29-31 [27-31 and 29-30]; ventrals 238-250 [232-254 and 230-252]; subcaudals 105-109 [96-114 and 100-112]. Thus these two specimens are clear candidate belonging to *atriceps*.

As discussed in result section, specimens in present study show little variation with respect to range of scales when compared with those from earlier studies of Wall (1914); Smith (1943); Marx (1959); Sahi and Dooda (1985); Sharma (2007); Baig and Masroor (2008); Whitaker and Captian (2008, 2015) and these variations may be ascribed to different habitat of present study area not explored earlier. Thus, diagnostic key of *Spalerosophis* needs more inputs from its wide range of distribution areas as right pointed out by Schatti et al. (2009) that the systematic position of *Spalerosophis* was subject to modifications over the past 140 years.

Body colour pattern as reported in smaller individual of *Spalerosophis atriceps* (MCMZ 0920) having yellowish brown background with irregularly scattered dark brown or black spots either confined to individual scales, or much more thickly distributed, forming large rhomboidal dorsal spots, similar in position to the dorsal larger sized spots of *Spalerosophis diadema diadema* along with uniform rose pink belly (Fig. 7A) and colour pattern shown in present study by fully grown up individual (MCMZ 1020) having entirely black head with a deep red hue, which becomes deep red on nape and temples (Fig. 7B) are clear in line with the findings of Smith (1943) and Sharma (2007) who had reported occurrence of *S. atriceps* from Gilgit, Agra, Jeypore, AJlahabnd, Delhi and Harrand.

Though *Spalerosophis diadema diadema* and *S. atriceps* are sympatric species (Marks 1959) but latter is nocturnal in habit (Sharma 2007). Thus, the smaller number of individuals of *atriceps* found during present investigation as compared to *diadema diadema* is probably because of the nocturnal habit of the former. In addition low densities, elusiveness and long periods of inactivity are often the causes behind the low detection of the snake species (Seigel 1993) leading to underestimation of their distribution range than the other reptiles (Santos et al. 2006; Bombi et al. 2009)

Yadollahvandmiandoab et al. (2018) has reported 69-95 number of dorsal blotches from *S. diadema* of Iran. In contrary to earlier findings number of dorsal blotches in present studies in *S. d. didema* remained between 54-88 and our findings are very close to that of Baig and Masrroor (2008) who have reported the range of botches in *diadema* within the range of 56-84 from Paistan. Unidentified specimen has shown 85 number of dorsal blotches whereas the blotches were absent in fully melanistic form of *atriceps*. Number of blotches in moderately melanistic form of *atriceps* have been counted upto 85 in present studies which is highest than the range of blotches as reported by Baig and Masrroor (2008) i.e., 55-78 from Pakistan. We

opines that this variation in number of blotches in *diadema* may be attributed to different ecological conditions of Indian population of *diadema*.

Arrangement of scales as observed in present study like (1) Complete ring of ocular in which subocular are excluding the orbit from supralabials, (2) prefrontals and loreals broken up into small scales, (3) high number of temporal scales and (4) an entire anal plate are clearly the diagnostic characters of *Spalerosophis* Jan (Marx 1959).

Number of ventrals showing sexual dimorphism in both the species as observed in present studies (Table 2) is a diagnostic character of *S. diadema* (Marx 1959 and Schatti et al. 2010)

Keeled dorsals in *S. striceps* and smooth or weakly keeled dorsals in *S. d. diadema* as observed in present findings have also been reported by Minton (1966) from Pakistan. Weak keeling in *S.d.diadema* hold true for subadults also.

In our studies *atriceps* is showing higher range of number of scales vis a vis *diadema diadema* [count of scales of *diadema diadema* in brackets] in midbody dorsal scales rows 29-31 [27-29], subcaudals 105-109 [82-111], loreals 2-4 [2-3], circumocular ring excluding supraocular 6-10 [7-9], supralabials 11-13 [10-12] and infralabials 11-13 [11-14]. Count of scales of *atriceps* had also remained high in the findings of Baig and Masroor (2008) [count of *diadema* in bracket] with respect to midbody dorsal scales 29-30 [25-31], ventrals 230-252 [220-254] and subcaudals 100-112 [78-114]. Owing to less number of individuals of *atriceps* in present studies conclusion on the snout-vent-length remain inconclusive and contrary to the findings of Baig and Masroor (2008) who have reported *atriceps* as larger sized species as compared to *diadema diadema*.

Conclusion

Presence of genus *Spalerosophis* Jan, in the current study area i.e., district Poonch is validating the occurrence this species from North India in general and Jammu and Kashmir in particular. After the findings of Sahi and Duda (1985) from the current study area, present investigation is revalidating the presence of *Spalerosophis diadema diadema* after a long time period of time, besides reporting the new record of *S. atriceps* from district Poonch. Different colour morphs with labelled sketches of the scales of pileus, detailed morphometric and meristic characters as dealt in present studies are definitely going to add in the diagnostic characteristics of this species and thereby avoiding the confusion in the counting and interpretations of scales patterns unlike that of earlier studies as pointed out by many workers from time to time. Though the

adults of *diadema diadema* and *atriceps* are quite different but the juveniles need to be studied more extensively to establish their parentage. Similarly, the one unidentified specimen i.e., *S. diadema* (?) is subjected for further investigation in order to validate the thin line of difference between *diadema diadema* and *d. cliffordi* just on the basis of number of caudal scales of more than 80 and less than 80 respectively as reported by Schatti et al. (2009). S

Acknowledgements

The authors are much indebted to Department of Higher Education and Department of Wildlife Jammu and Kashmir for permitting to carry on the research work. Our thanks are due to all the students of a WhatsApp group namely “Snake Reporting Group” which have reported the snakes whenever and wherever sited. The author thanks are due to Prof Fateh Mohammed, Prof. Mohd Alyas, Mrs. Wajida Tabassum, Mr. Talib Hussain, Mrs Avneet Kour, Mr Aqeel Ahmed Bajjarh, Mr. Ismail Ahmed, Mr. Mohd Alyas, Ms Saafia Jabeen, Ms. Rukshandha Shad, Mr. Shadab ul Iman, Mr Sohail Ahemd, Ms. Tabinda Shad and many others who helped is in the current field studies. The authors has no support to report.

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