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Diversity Assessment with the Addition of New Locality Record of Sindh Awl Headed Snake and Ecological Assemblage from Bikaner District of Thar Desert, Rajasthan

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ABSTRACT:

Systematic diversity assessment of different snakes from Bikaner district of the Thar Desert, located at Northern western, India have reported the species inventory of this area, A total of 15 species of snakes belonging to 6 families were recorded. Among these families, Colubridae dominated the list with 7 species, Elapidae with 3 species, Boidae 2 species and Lamprophiidae, Typhlopidae and Viperidae represent only single species each. Four poisonous, four mildly poisonous and seven non-poisonous snakes were recorded. The study conducted during the spring and summer season of September 2015 to September 2018. The study area comprises various habitats such as grassland, stabilized sand dunes, Barren sand dunes, and IGNP canal area, agriculture area and human habitation sustains significant biodiversity. *Lytorhynchus paradoxus* recorded the first time from the Bikaner district of Thar Desert. Species richness also evaluated from the data set as, Black-headed Royal Snake (n = 51) shows maximum species richness (19%) and Sindh krait (n = 1) shows minimum species richness (0.3%). Habitat preference by the snake species shows maximum occurrence in of stabilized sand dunes (24%) and a minimum of Human habitation (10 %). Shannon Weiner index suggest medium kind of diversity (H = 2.26).

KEYWORDS: Thar Desert, Snake, Bikaner.

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INTRODUCTION:

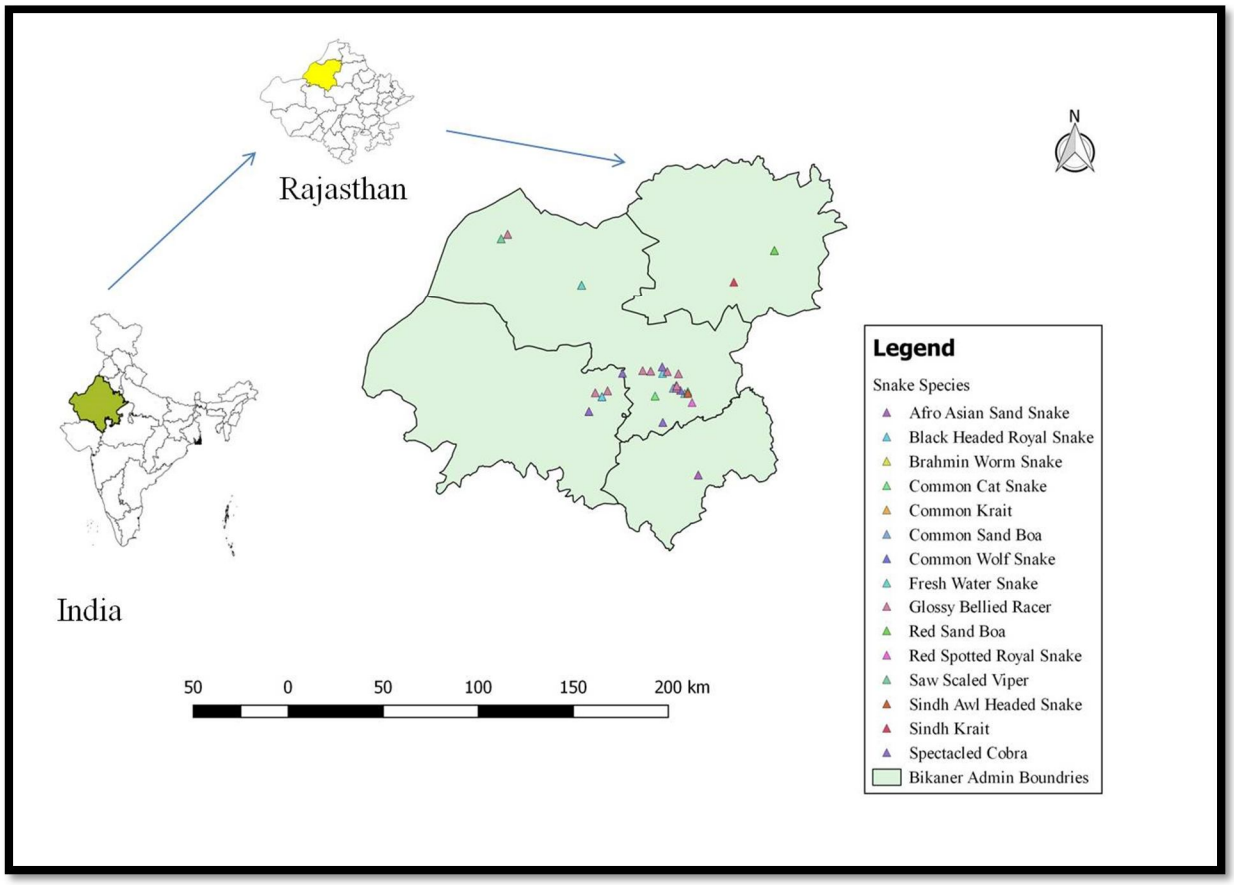
In the natural ecosystem, the snake has the role of an important paste controller by the preying majority upon rodents[1]. With this, Indian mythology has associated with the snakes as an object of fear and worships both[2]. The Thar Desert harbours a peculiar diversity of snakes possessing Saharan, Turanian, and Oriental similarity. It is situated in the northwestern part of the country and expanded in 13 districts of Rajasthan. Bikaner is a part of northwest, an important part of the Thar Desert biodiversity spot, houses a peculiar of flora and fauna. Bikaner with a total geographical area of 30247.90 km^2 is situated in the north-western part of India between 27°11' and 29°03' N and 71°54' and 74°12' E. Regardless of its topography, it is an area of global importance due to its rich biodiversity; this region has remained poorly explored. Moreover, it is evident from the report made by a few workers that there is a lack of information on the snakes of Bikaner. The global diversity of snakes is about 3709 species[3] and more than 297 species of snakes are found in the Indian boundaries[4.] Among them, In Rajasthan state 25 species are recognized (Sharma, 2003). Although various reported addressed by the different studies, still the exact count is poorly estimated[5,6]. Very few, primitive and scattered records were available about the diversity, occurrence, distribution pattern and abundance of snakes from western India especially from the Thar Desert and Aravalli Mountain Ranges [7, 8,9,10,11,12,13,14,15,16,17,18,19,20,21]. This area is mainly dominated by Family Colubridae that is most diversified and takes part with maximum numbers of species sum in the Thar area territory. However, proper ecological studies on snakes of the Thar Desert are still poorly known, such as proper distribution, activity pattern and natural history in core areas. In Bikaner districts, many microhabitats are transforming due to the impact of climate change. The major consequence is due to expansion of the Indira Gandhi Nahar Pariyojna Canal (IGNPC), particularly in Bikaner district. Agricultural exercises went in front of the thickening of the soil exterior, moisture and lowering the temperature that impact the snake fauna to great extent. Herein, we describe the snake composition at the Bikaner district providing information on diversity, richness and ecological assemblage attributes of the species.

STUDY AREA:

In 1486, the city of Bikaner was founded by Rao Bika Ji. It is transformed into the fourth largest city in Rajasthan. The landscape of this district has covered with dense, scrub forest, with xerophytes, thorny, stunted and sparse trees, herbs, shrubs, and grasses. Jorbeer conservation reserve, Deshnok, Gajner wildlife sanctuary, Kolayat, RD 680 IGNP canal, Khajuwala, Lunkaransar, Shridungargarh and Bikaner area the main points where the study was undertaken. Chinkara, Blue-bull, Wild boar, Desert Fox, Jackal, Desert gerbil, Spiny-tailed lizard, Monitor lizard and variety of raptors as Vultures, Long Legged Buzzards and Short Toed Snake Eagles are the main wild fauna in

the Bikaner district. The annual rainfall varies between 200 to 400 mm. The minimum temperature varies between -1° to 2.6°C; the maximum temperature ranges 43°C to 47.7°C (Map 1).

Map 1: Depiction of 15 snakes species in Bikaner area. Overall 15 species recorded from the 10 sites from various habitats. The map is generated with the assistance of QGIS Desktop version 2.18.6.



MATERIAL AND METHODS:

To accomplish the objective of assessment and identification of the presence of snake species in Thar Desert of Rajasthan, ten sites of Bikaner District was surveyed extensively in September 2016 to September 2018. Every site was surveyed in Pre-monsoon (March-May), monsoon (June - August) and post-monsoon (September to October) period supported by gathering the climatic information like time of day, temperature and humidity. These seasons are characterized with active kinematics of the snake species. Date, locality and coordinates (latitude, longitude, and altitude) also have been recorded by a GPS. Digital SLR Camera (Canon 70D), Digital hygrometer, Montana-680 GPS and torch were use to study the thrust area day and night. With the high temperature of 48^0C at the day, early morning, evening and night drive preferably at most of the survey protocol. Visual encounter and snake trek following methods were implemented to search the snakes. Reptilian fauna was recorded in different types of snake potential habitats viz. Grassland, Stabilized sand dunes Barren sand dunes, Human habitation and IGNP water canal area. The observed fauna was categorized as Common(C) and

Uncommon (UN) and Rare (R) on the basis of encountered frequency. The Snakes were photographed, examined, and released at the previously desert habitat to around. The correct identification of snakes was done by referring available literature [15, 7,20,22,23,24,17,25]. Systematic scale counting also implemented for the taxonomic validation of species followed by[26].

STATISTICAL ANALYSIS:

Diversity indices applied for the measure the species diversity in a community with the help of Microsoft Excel, 2007. Simpson's biodiversity index (D) and Shannon Weiner Index (H) both calculated the species diversity observed in the Bikaner district in the study period of time[27, 28.] We also estimated species richness as (ni / N * 100) (where ni - the number of samples observed per species/ N - total number of observation in the study) [29.]

RESULTS:

During the present study, a total of 15 species of snakes belonging to 6 families observed (Graph 1). They inhabit six types of habitats (Stabilised sand dunes, Barren Sand dunes, Grassland, Agriculture area, Human habitation, and IGNP water canal area) in Bikaner district. Out of these 15 species maximum of 7 species belong to Colubridae family (*Boiga trigonata, Lycodon aulicus, Xenochorpis piscator, Sphalerosophis arenarius, Sphalerosophis atriceps, Lytorhynchus paradoxus*, and *Platyceps ventromaculatus*). Elapidae family includes three species (*Bungarus caeruleus, Bungarus sindanus,* and *Naja naja*), Family Boidae has two species (*Eryx johnii, and Gongylopis conicus*). While, single member represented of family Lamprophiidae (*Psammophis schokari*), Typhlopidae (*Ramphotyphlops braminus*) and Viperidae (*Echis carinatus carinatus*) in study period. Some of most adapted snake is depicted in (Image 1).

Graph 1: Species richness shows by 15 snakes in Bikaner district.

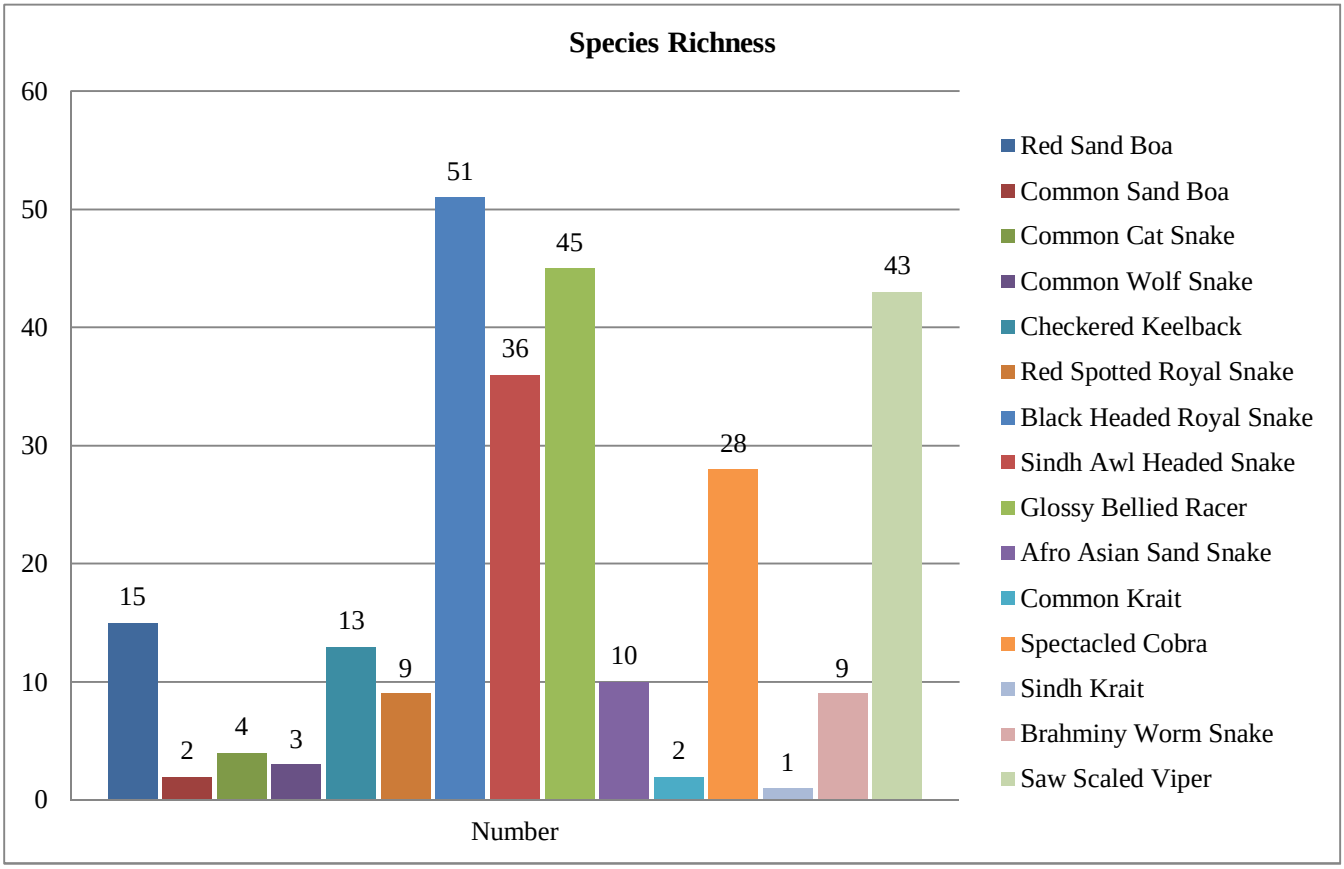


Image 1: Snake species observed in study area of Bikaner (A to L). Common Krait, Sindh Krait Saw scaled viper and Spectacled Cobra are venomous snake recorded from the study area.

By the nature of all the 15 species, four snakes found venomous (*Bungarus caeruleus*, *Bungarus sindanus*, *Naja naja* and *Echis carinatus carinatus*), and four mild venomous (*Boiga trigonata*, *Psammophis schokari*, *Lytorhynchus paradoxus* and *Platyceps ventromaculatus*) and rest of the seven are identified as non-venomous (Table 1).

Table 1: List of 15 snake species observed in Bikaner District of Thar Desert of Rajasthan during the study period of 2016 to 2018. Abbreviation used as Status: C – Common, NC – Not Common and R – Rare, Nature: NV – Non Venomous, V – Venomous, MV – Mild venomous, Habitat: SSD – Stabilised sand dunes, BSD – Barren Sand Dunes, GL – Grassland, WC – Water Canal, HH – Human Habitation, AG – Agriculture area.

S. No	Common Name	Zoological Name	Status / Activity Pattern	Nature (V/NV/ MV)	Habitat Preference (SSD, BSD, GL,AA, WC, HH)
Family Boidae					
1.	Red Sand Boa	*Eryx johnii* (Russell, 1801)	C/N	NV	GL, SSD, AA
2.	Common Sand Boa	*Gongylopis conicus* (Schneider, 1801)	NC/D	NV	GL
Family Colubridae					
3.	Common Cat Snake	*Boiga trigonata* (Schneider in Bechstein, 1802)	C/N	MV	GL, SSD, AA
4.	Common Wolf Snake	*Lycodon aulicus* (Linnaeus, 1758)	C/D	NV	WC
5.	Checkered Keelback	*Xenochrophis piscator* (Schneider, 1799)	C/D	NV	WC
6	Glossy Bellied Racer	*Platyceps ventromaculatus* Gray, 1834	C/D	MV	GL, SSD, HH, WC, AA
7.	Red Spotted Royal Snake	*Sphalerosophis arenarius* Boulenger, 1890	C/N	NV	GL, SSD, BSD
8.	Black headed Royal Snake	*Sphalerosophis atriceps* Fischer, 1885	C/D	NV	GL, HH, SSD, AA
9.	Sindh Awl headed Snake	*Lytorhynchus paradoxus* Gunther, 1875)	R/C	MV	SSD, BSD
Family Lamprophiidae					
10.	Afro Asian Sand Snake	*Psammophis schokari* (Forskal, 1775)	NC/D	MV	GL, SSD, BSD
Family Elapidae					
11.	Common Krait	*Bungarus caeruleus* (Schneider, 1801)	C/N	V	WC, GL
12.	Cobra	*Naja naja* (Linnaeus, 1758)	C/N	V	HH, GL, WC, SSD, BSD, AA
13.	Sindh Krait	*Bungarus sindanus* (Boulenger, 1897)	NC/N	V	SSD
Family Typhlopidea					
14.	Brahminy worm Snake	*Ramphotyphlops braminus* (Daudin, 1803)	C/D	NV	WC, HH
Family Viperidae					
15.	Saw Scaled Viper	*Echis carinata* (Schneider, 1801)	C/N	V	GL, SSD, BSD, WC, AA

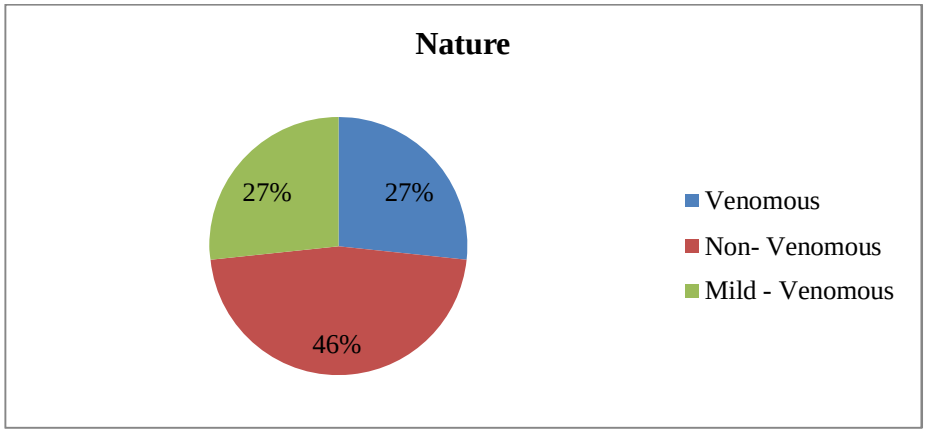
The status examined on the basis of regional occurrence and distribution, one species found rare *Lythorhynchus paradoxus*, three are not common (*Gongylopis conicus, Psammophis schokari Bungarus sindanus)* and rest of eleven species are common.

SPECIES RICHNESS:

Relative abundance of snake species in Bikaner shows uneven distribution. With the exception of a few species, relative abundance of most species was low. Most species were observed only once (Sindh Krait) or twice (Common Sand Boa and Common Krait) during the entire course of our study. Of the 15 species, Black-headed Royal Snake contributed a maximum of 19 % and Sindh

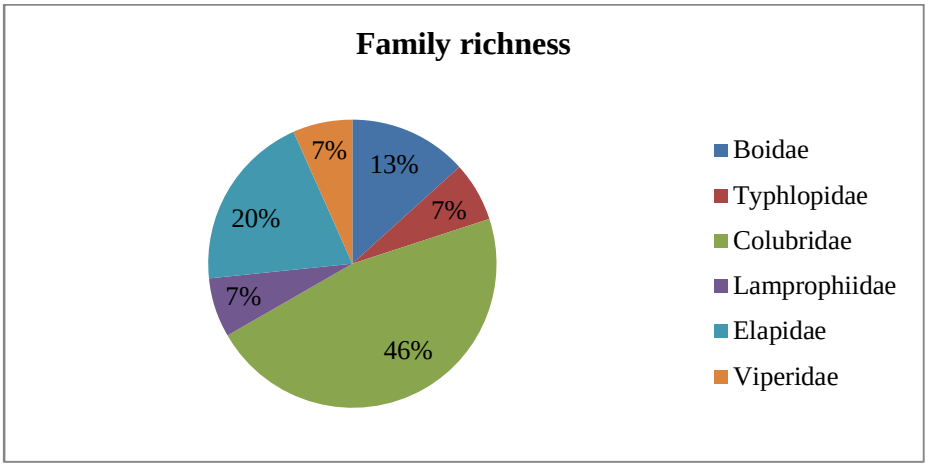
krait records minimum as 0.3%. Both Venomous snakes and Mild venomous snake (n = 4) composed of 27% richness and non-venomous has 46% (n= 7) in the study area (Graph 2).

Graph 2: Nature of Snake Observed in Bikaner district.



Shannon Weiner Index evaluated as (H =2.26) as medium kind of diversity in the study, where Simpson's diversity index resulted (D =0.89) is good diversity as the value is near 1. Maximum richness contributed by Cubridae family 46 %, whereas, 20% of Elapidae, 13% of Boidae and 7% of richness observed by Viperidae, Typhlopidae, and Lamprophiidae family (Graph 3).

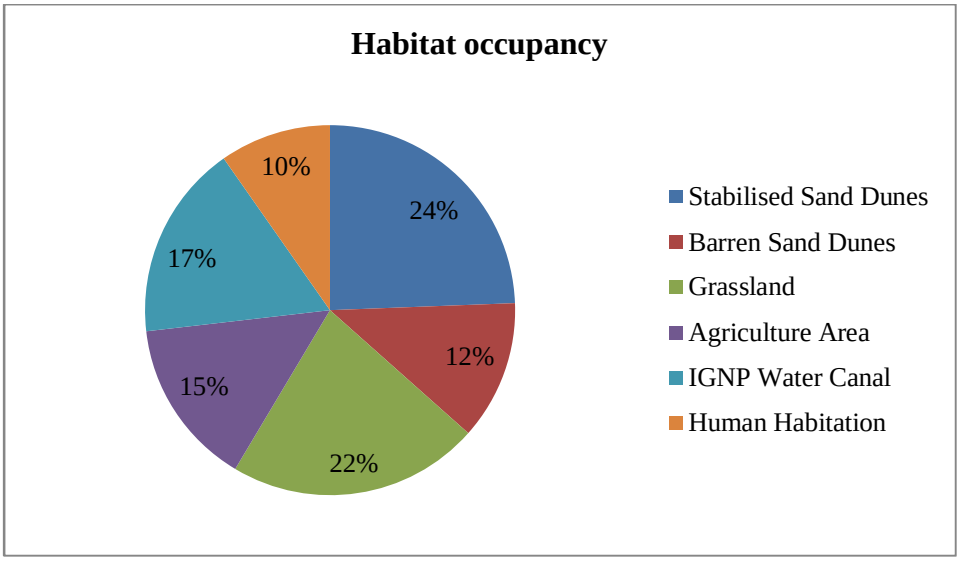
Graph 3: Percentage occurrence of snake families in Bikaner.



Habitat Ecology:

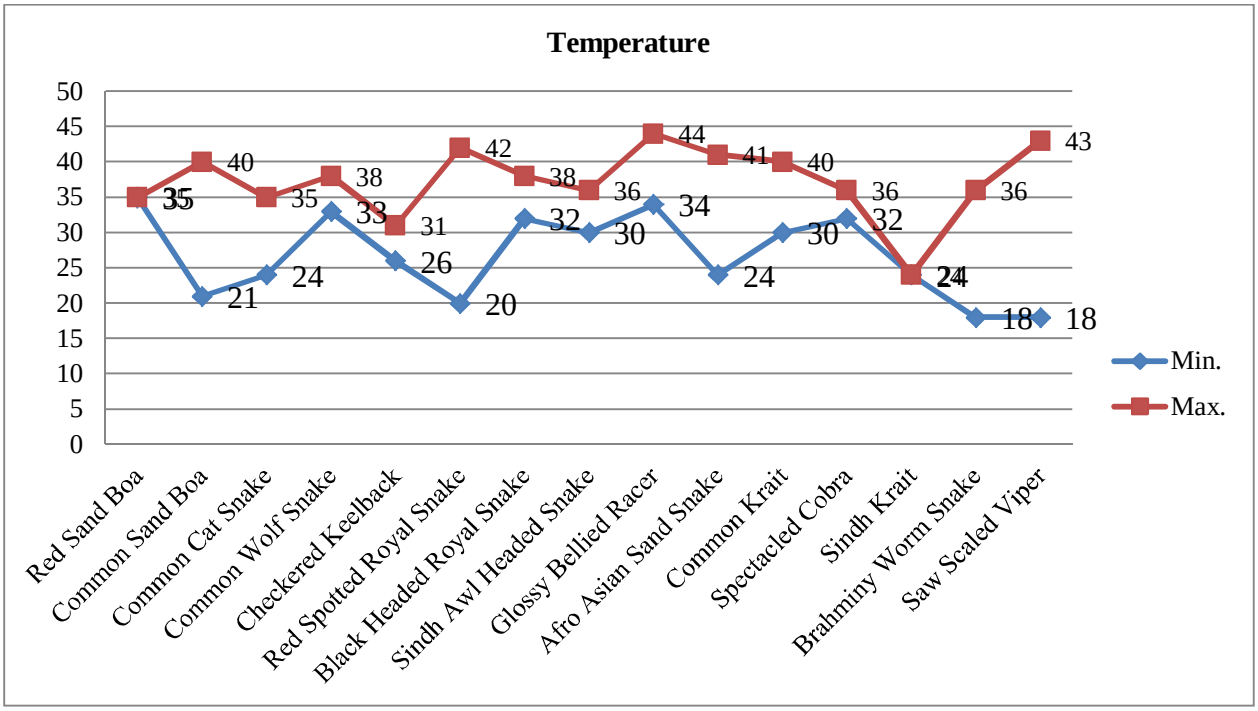
There is six type of habitat identified during the study period. Maximum of frequency of reported snake observed in Stabilised sand dunes (n = 10) is (24%), then Grassland (n = 9) is (22 %), Water canal (n = 7) is (17 %), Agriculture area (n= 6) is (15%), Barren sand dunes (5) is (12%) and the minimum of recorded in Human habitation (n = 4) i.e. (10 %) (**Graph 4**).

Graph 4: Percentage habitat occupancy by the snakes in Bikaner area.

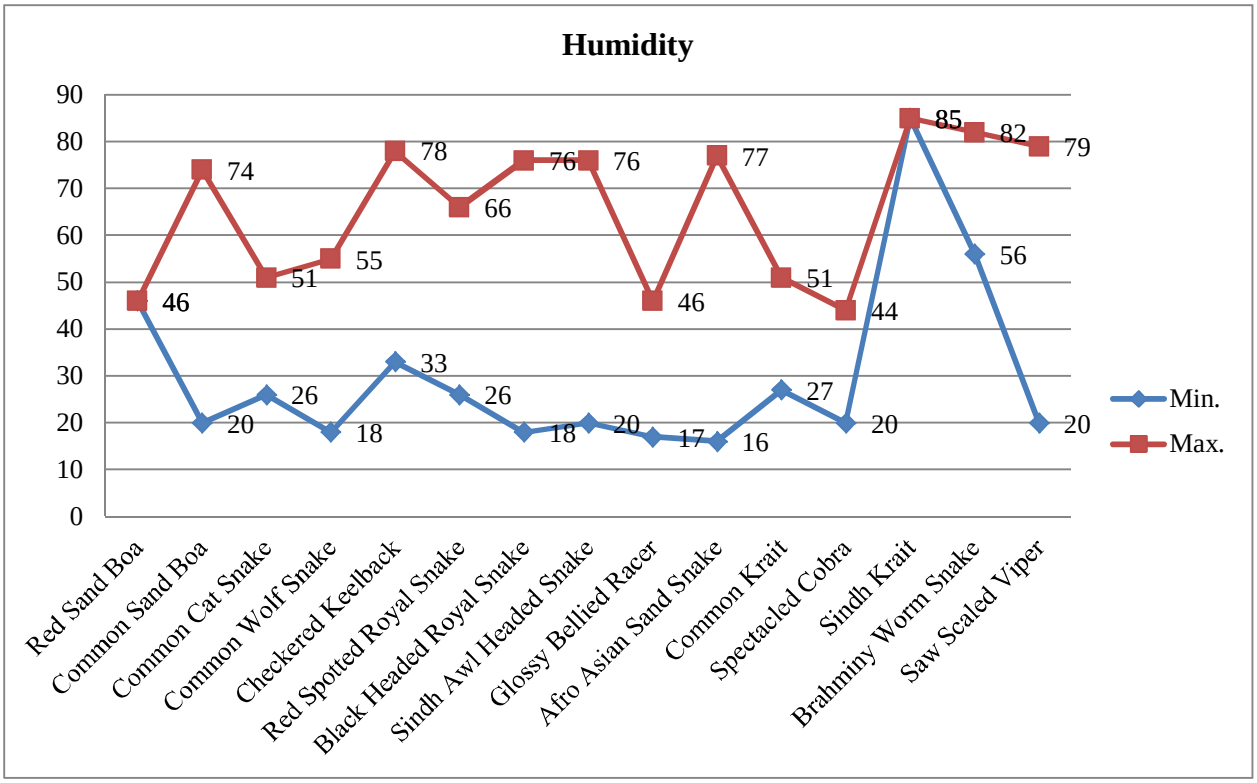


The activity patterns of the snakes also access as 7 snakes are diurnal nature, 7 are nocturnal nature and one is crepuscular species (Table 1). The landscape has covered a maximum of grassland vegetation with stabilized dunes interspersed. The vegetation composed of grasses like *Lassiurus sindicus*, Shrub *Aerva tomentosa*, *Leptadenia pyrotechnica*, and *Calligonum polygonoides* with desert plants interspersed with very scarce trees i.e. of *Prosopis cineraria*, *Salvadora oleoides*, *Capparis deciduas*, *Acacia nilotica*, *Zizyphus numularia* and *Prosopis juliflora*. Air temperature and humidity captured as minimum and maximum values on observation in the study for every species separate. In Bikaner, the minimum temperature recorded while observation taken of Brahminy worm snake and Saw scaled viper as (18^0C) and Maximum (43^0C) of glossy bellied racer (Graph 5). Data collection of relative humidity, minimum recorded is (16%) of Afro Asian sand snake and maximum of Sindh krait (85%) (Graph 6).

Graph 5: Temperature variance as Maximum and minimum recorded at per observation.



Graph 6: Humidity variance as Maximum and minimum recorded at per observation.



NEW RECORDS:

From the present Study, it was found that snakes *Lytorhynchus paradoxus* not recorded by earlier workers in the Bikaner district area. This study provides new information on the extension range of the above species in core areas of the Thar Desert. *L. paradoxus* (Sindh Awl Headed Snake)

reported firstly from the Bikaner as this was initially reported from the country boundaries with its distribution notes in Sikar District of Rajasthan state[30]. Further,[31] and[32] suggested that *Lytorhynchus paradoxus* is also found in the new habitat of Desert National Park of Sam, Jaisalmer, and Chouhtan, Barmer area. Subsequently, [33] report the habitat preferences study of this snake in agricultural areas in Mohangarh, Jaisalmer. We are providing extension and occurrence of this species occurs in Bikaner first time. The snake has crepuscular activity and strictly preferred sand dunes of both types as stabilized and barren. It is a mildly venomous snake species. Five individuals of Sindh Awl-headed Snake observed from Jorbeer locality in Bikaner observed during the Study in Bikaner district of Rajasthan. Among them, one was caught, measured and successively released after observation. It has grey colour with a series of X or H shaped dark brown and black mark connecting with a white strip to the down mid back. Top of the head bears the large brown mark (Image 2).The snake has sand dune subterranean lifestyle and very often seen in open sand and shrubs. The snake encountered in the night time in all the cases. It has typical tail curled in a spiral and hide the head when alarmed.

Image 2: Sindh Awl headed Snake (A) Typical '8' shape pattern when alarmed and (B) during foraging at night.

DIAGNOSIS:

The Snake has dark brown to greyish blotches on dorsal with median series of brown to sooty blotched and pale tan lateral series of blotches, short tail, and glossy white underside. Dorsal scale rows (DSR) smooth, in a specimens 23:19:15; Ventrals175 round (Table 2). anal divided; subcaudals 42 paired; rostral large projecting pointed interiorly and round posteriorly., nasal completely divided; 2 prefrontals, as long as wide, longer than the internasals temporal 2+3/2+4), Supralabial 8 (5th touches the eye) and infralabial 9 (5th is the largest). Pupil vertically elliptic, nostril's slit-like. Tail tip observed pointed.

Table: 2. Representation of morphometric measurements of Sindh Awl headed Snake recorded five from Jorbeer Gadwala Conservation Reserve in. Abbreviation used as SVL- Snout to Vent Length, Tal-Tail length, V-Ventrals. Comparison of external body measurements (mm) with[30, 25, 31, 32, and 33] denoted. Sign (-) is meant for no record of the data.

Locality	Geo-location	Habitat type	SVL (mm)	Tal (mm)	V	Costals	Date	Time (hrs)	Reference
Ramgarh Sikar	28.30983 74.99888	Barren Dunes	-	-	-	19 mid rows	August, 2003	2130	[30, 25]
Sam Jaisalmer	26.925 70.55555	Barren Dunes	-	-	-	-	-	-	[31]
Sam Jaisalmer	26.8236 70.53827	Barren & Stabilise Dunes	147	22	176	21:19:15	27.12.06	1805	[32]
Sam Jaisalmer	26.81222 70.53654	Barren & Stabilise Dunes	189	33	168	21:19:15	31.03.07	2115	[32]
Sam Jaisalmer	26.84067 70.56412	Barren & Stabilise Dunes	310	50	178	21:19:15	19.04.07	2020	[32]
Chohtan Barmer	25.42545 71.06557	Barren & Stabilise Dunes	-	-	-	-	28.07.09	1945	[32]
Mohangarh Jaisalmer	27.694 71.009	Agricultural Field	-	-	-	-	16.01.14	1330	[33]
Jorbeer Gadwala Conservation Reserve, Bikaner	27.92729 73.40585	Stabilise Dunes	380	47	175	23:19:15	08-07-18	2235	New Record

This locality of Jorbeer, Bikaner (27.92729 N, 73.40585 E), is 269 Km far from Ramgarh (28.30983 N, 74.99888 E) which is first record from Sikar district, 370 km from Sam, Jaisalmer (26.925 N, 70.55555 E), 471 km from Chohtan, Barmer (25.42545 N, 71.06557 E) And 260 km Mohangarh, Jaisalmer (27.694 N, 71.009 E) 260 km.

DISCUSSION:

Reptiles are very sensitive to habitat transformation. The expansion of IGNP canal in Bikaner region of Thar transforming the land and air that affects the texture of the soil, pH, humidity and temperature of desert micro habitats that nourishes foods and shelters to the peculiar faunal diversity of the region[34]. Some species may have tolerated the greater variety in habitat condition are expected to inhabit in a broad niche[35]. But such transformation altering the habitat characteristics that lead to the diversity fluctuation in term of a species and the major group tolerate this situation is cold poikilotherm animals. Apparently, it influences the habitat niche of particular species. For this, we have tried to analysis the diversity and richness of snake species in the Bikaner region after[17] and[36]. The present study revealed the current status on the distribution of snakes from different parts of all the 10 localities of Bikaner District. Our own field observation yields 15 species of snakes in Bikaner, of six families as Colubridae, Typhlopidae, Lamprophiidae, Boidae, Elapidae, and Viperidae. Additionally we are reporting the first occurrence of Sindh Awl headed snake (*Lytorhynchus paradoxus*) from Jorbeer Gadwala conservation reserve and Kolayat of Bikaner that is

extended locality of this snake in Thar area as well as country. Of the total 15 snake species observed specifically in Bikaner district of Thar Desert, constituted approximately 60% of the species occurred in Rajasthan and 5% in the Indian scenario. Representing such exclusive diversity, the study area serves as potential habitat for Afro Asian sand snake, black-headed royal snake, glossy bellied racer, Sindh awl-headed snake and red spotted royal snake. Importantly, abundance and occurrence of theses snake found most in the study area other than elsewhere in India. Thus, the desert habitat provides various small areas are attributed to microhabitats and ecological niches suitable for the existence of typical snake species. Systematic studied on geographical distribution and habitat ecology is a big lacuna in the most extreme parts of the country[37]. In Thar Desert of Rajasthan[38] reports 16 snake species in a herpetofauna survey in the Thar Desert. Then, [36] presented the district wise distribution note on the Snake's occurrence. According to him 20 snakes are found in the 13 districts in the Thar Desert distributed in patchy manner. They have made the presence of, Glossy bellied Racer (*Platyceps ventromaculatus*), Red Spotted Royal snake (*Sphalerosphis arenarius*) and Afro Asian Sand Snake (*Psammohis schokari)* In Bikaner district of Thar area. After this, we have planned to access the different extremities in the Thar Desert especially Jodhpur, Jaisalmer and Bikaner district and interiors to fill the lacuna in snake research after more than a decade. Collection of proper information on snake in the region is main purpose of this study, because the study area is facing habitat modifications that playing a crucial role upon ecosystem and its services to the indigenous fauna. During our Study, we have observed 15 species of snakes amongst which 7 were non-venomous, 4 mild venomous and 4 venomous snakes. The area with grassland, stabilized sand dunes, Barren dunes and IGNP canal a suitable habitat for other reptilians also but they are under threat due to habitat loss, unawareness, unplanned civilization, and industrialization and infrastructural development in these areas. Still, many common snakes haven't been reported in the current study as rat snake, common trinket snake, common kukri snake, Russell's viper, beaked worm snake, Leith's sand snake etc. The further investigation of the snake occurrence, proper distribution and ecological studies is still needed in the context of Thar Desert of Rajasthan state.

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