AMBIENT APPRAISAL

Bio-inventory of Spiders Located Inside the Maneknath Caves of Banaskantha, Gujarat, India

Bhavesh M. Parmar

Central Laboratory, Dudheswar waterworks, Amdavad Municipal Corporation, Ahmedabad - 380004, Gujarat, India.

Study Area: Maneknath Caves, Danta Taluka, North Gujarat, India

Coordinates: $24^{\circ}07'01''\text{N}$; $72^{\circ}52'57''\text{E}$

Key words: Archinida, Cave biodiversity.

Abstract

Spider bio inventory from five numbers of caves of Maneknath, of Gujarat was studied from 2016 to 2018. A total of 1332 Spider samples were collected using the Hand-picking method. Out of 1332 samples, a total of 59 species and 48 genera from 22 families of spiders were identified. Araneidae was a diverse family with 11 species. Maneknath caves represented a total of 36.06 % of the total families recorded earlier in India. This is the first documentation of the cave-dwelling spiders from the study area.

Introduction:

The cave is an exclusive environment with a quite stable climatic condition. This environment is characterized through the absence of light, high humidity, almost steady temperature, excessive CO_2 , and frequently restricted food resources (Vandel., 1965; Biswas, 2009; White *et al.*, 2019). This extreme environmental circumstance turns into a selective force for many lives so that only particular species can stay and succeed in the traditional cave environment (Howarth, 2009; Romero, 2009; White *et al.*, 2019). Arthropods are the most diverse and dominant assemblage of animals dwelling in a cave ecosystem, not solely in terms of species richness however, also in its roles in the ecosystem (Romero, 2009). Arthropods can act as predators, decomposers, and additionally food sources for various cave organisms (Vandel *et al.*, 1965). Arthropods play important roles in preserving cave ecosystem stability (Rahmadi, 2002). Disruption of the Arthropod community in the cave ecosystem can disrupt different organisms' existence or destroying the whole cave ecosystem.

Spiders are common residents of caves (Howarth, 2003) with an extensive range of physiological and morphological adaptation. Naturally, spiders are usually well represented in caves given their exaptations to subterranean existence including, for most families, low dependence on vision and low metabolism allowing them to survive months except feeding (Foelix, 2011). There are more than a thousand species of troglobiont spiders and at least an equal number of troglophile spiders belonging to forty-eight families out of 47 000 described species of spiders in 113 families (Mammola *et al.*, 2017). This survey aimed to provide data on the bio-inventory of spiders within the Maneknath Caves.

Materials and methods:

The Survey and documentation were conducted from the period of 2016 to 2018 at different sites from Maneknath Caves. Maneknath Caves (Table-1) were located in Danta taluka, North Gujarat. In General, The cave was separated into three communities, determined based on cave zones: entrance, twilight and dark zones (White *et al.*, 2019), as per cavian habitats, cavern, tops, holes, cracks, under a stone, debris, and grounds of the entrance, twilight, and dark zones of the caves were examined. Samples collection was made using the handpicking method. Spiders were collected in plastic bottles and later transferred in 70% ethyl alcohol-filled airtight vials for preservation purposes. All captured spiders were identified based on morphological characters to the lowest possible taxon level using relevant literature (Tikader, 1977; Tikader, 1987; Patel, 1972; Parmar, 2018; Gajbe, 2007; Sebastian *et al.*, 2009; WSC, 2020). The data were analyzed by calculating indices and cluster analyses using the PAST (Paleontological Statistics Software).

Table-1: Geographical locations (Caves of Maneknath)

No	Sites name	Geographical location
1.	Main Cave	$24^{\circ}06'58''\text{N}$; $72^{\circ}52'59''\text{E}$
2.	Cave-I	$24^{\circ}06'52''\text{N}$; $72^{\circ}52'58''\text{E}$
3.	Cave-II	$24^{\circ}06'51''\text{N}$; $72^{\circ}53'05''\text{E}$
4.	Cave-III	$24^{\circ}06'49''\text{N}$; $72^{\circ}53'03''\text{E}$
5.	Cave-IV	$24^{\circ}06'45''\text{N}$; $72^{\circ}53'02''\text{E}$

Results & Discussion:

Out of a total of 1332 individuals from order- Araneae distributed among 22 Families a total of 48 genera which included 59 species were collected during this study. Those organisms are generally found in caves, but also found in some other habitats are considered as troglophiles (Vandel,

*Corresponding Author: parmarbhaveshkumar@gmail.com

Table -2: Spiders collected from Various Caves

#	Family	Genus/Species	M	I	II	III	IV
1.	ARANEIDAE	<i>Araneus</i> sp.	A	A	P	P	P
2.		<i>Argiope anasuja</i>	A	P	P	P	P
3.		<i>Cyclosa bifida</i>	A	P	P	P	P
4.		<i>Cyrtophora cicatrosa</i>	A	P	P	P	P
5.		<i>Eriovixia excelsa</i>	A	A	P	P	P
6.		<i>Neoscona mukerjei</i>	P	P	P	P	P
7.		<i>Neoscona nautica</i>	A	P	P	A	P
8.		<i>Neoscona odites</i>	A	A	P	A	P
9.		<i>Neoscona theisi</i>	P	P	P	P	P
10.		<i>Neoscona</i> sp.	A	A	A	P	P
11.		<i>Poltys bhavnagarensis</i>	A	P	P	A	A
12.	CLUBIONIDAE	<i>Clubiona drassodes</i>	A	P	P	P	P
13.		<i>Clubiona</i> sp.	P	A	P	A	A
14.	CORINNIDAE	<i>Castianeira tinae</i>	A	P	A	P	A
15.		<i>Castianeira razetes</i>	A	P	P	P	A
16.	CTENIDAE	<i>Ctinus</i> sp.	P	P	A	A	A
17.	ERESIDAE	<i>Stegodyphus pacificus</i>	A	P	P	A	A
18.	EUTICHURIDAE	<i>Cheiracanthium</i> sp.	A	P	A	A	A
19.	FILISTATIDAE	<i>Filistate</i> sp.	P	A	A	A	A
20.		<i>Pritha</i> sp.	P	A	P	A	A
21.	GNAPHOSIDAE	<i>Drassodes</i> sp.	A	A	P	P	P
22.		<i>Gnaphosa stoliczkai</i>	A	P	A	P	A
23.		<i>Zelotes</i> sp.	A	P	A	P	A
24.	HERSILIIDAE	<i>Hersilia savignyi</i>	P	P	P	P	P
25.	LYCOSIDAE	<i>Hippasa agelenoides</i>	A	P	P	A	A
26.		<i>Lycosa tista</i>	A	P	P	A	A
27.		<i>Lycosa</i> sp.	A	P	P	P	P
28.		<i>Pardosa birmanica</i>	A	P	P	P	A
29.	OECOBIIDAE	<i>Oecobius</i> sp.	P	A	A	A	A
30.		<i>Uroctea manni</i>	P	A	A	A	A
31.		<i>Uroctea indica</i>	P	A	A	A	A
32.	PHILODROMIDAE	<i>Philodromus</i> sp.	P	A	A	A	A
33.	PHOLCIDAE	<i>Physocyclus globosus</i>	P	A	A	A	A
34.		<i>Crossopriza lyoni</i>	P	P	P	P	P
35.		<i>Pholcus phalangioides</i>	P	P	P	P	P
36.	PSECHRIDAE	<i>Psechrus</i> sp.	P	A	A	A	A
37.	SALTICIDAE	<i>Carrhotus viduus</i>	P	A	A	A	A
38.		<i>Hasarius adansoni</i>	P	A	A	A	A
39.		<i>Menemerus bivittatus</i>	P	P	P	P	A
40.		<i>Menemerus fulvus</i>	P	P	P	P	A
41.		<i>Phintella vittata</i>	P	P	A	A	A
42.		<i>Plexippus paykulli</i>	P	P	P	A	A
43.	SCYTODIDAE	<i>Scytodes thoracica</i>	P	A	A	A	A
44.	SELENOPIIDAE	<i>Selenops</i> sp.	A	P	P	P	P
45.	SPARASSIDAE	<i>Heteropoda venatoria</i>	P	P	P	P	P
46.		<i>Heteropoda</i> sp.	P	P	P	P	P
47.	SICARIIDAE	<i>Loxosceles rufescens</i>	P	P	P	P	A
48.	TETRAGNATHIDAE	<i>Meta</i> sp.	P	P	P	P	A
49.		<i>Tetragnatham axillosa</i>	P	A	A	A	A
50.		<i>Tylorida ventralis</i>	A	P	A	A	A
51.	THERIDIIDAE	<i>Achaearanea triangularis</i>	A	P	P	P	P
52.		<i>Achaearaneate pidariorum</i>	A	P	P	P	P
53.		<i>Argyrodesar gentatus</i>	A	P	P	A	A
54.		<i>Argyrodes flavescens</i>	A	P	P	P	A
55.		<i>Chrysso angula</i>	A	P	P	A	A
56.		<i>Steatoda grossa</i>	A	P	A	A	A

57.	<i>Theridion</i> sp.	A	A	A	A	A
58. ULOBORIDAE	<i>Uloborus krishnae</i>	P	P	A	A	A
59.	<i>Uloborus plumipes</i>	P	P	A	A	A
Total		29	40	36	29	21

Table -3: Diversity Indices

Indices	Main	Cave I	Cave II	Cave III	Cave IV
Individuals	29	40	36	29	21
Dominance_D	0.03448	0.025	0.02778	0.03448	0.04762
Shannon_H	3.367	3.689	3.584	3.367	3.045
Simpson_1-D	0.9655	0.975	0.9722	0.9655	0.9524
Evenness_e^H/S	1	1	1	1	1

Figure-1: A dendrogram showing similarities between caves

1965). The list of spider's taxa is showing in Table-2.

Cave-I had the maximum number of species(40), Cave-II had 36 species followed by Cave-III (29), Main Cave (29), and Cave-IV (21). This indicates that Maneknath Caves supports a high diversity of organisms including spiders representing different trophic levels (Shetty et al. 2013). Cave-I and Cave-II had a Maximum number of spiders, because of this caves were absent of anthropogenic activities. Caves-III, Main Cave, and Cave-IV had the minimum number of spiders, due to having maximum human disturbance. The anthropogenic activity could negatively disturb some spiders while others are more tolerant of changes (Maya-Morales et al., 2012). It seems that Maneknath Caves acting a very significant role in the food web of the cave ecosystem, because, deprived of it, biotic components will not survive. The existence of groups of organisms in caves is actually dependent on the Caves micro-environment (Ferreira et al., 1999).

The diversity indices, Dominance_D, Simpson_1-D, Shannon_H, and Evenness_e^H/S were determined using PAST: (Paleontological statistics software) for each site (Table-3). The value D will increase with decreasing diversity. Thus, Simpson's index is commonly suggested as its complement 1-D. Since D takes on values between zero and one and strategies one in the restriction of a monoculture, (1-D) offers an intuitive proportional measure of diversity that is much less sensitive to species

richness. The diversity indices Shannon's index (J') and Simpson Diversity (D) are measures widely used as these indices to include each species richness and evenness to measure range the amount the quantity of abundant species in a sample and therefore the number of abundant species. Simpson index (D) that varied from zero to one given the likelihood that two individual species drawn at random from a population belong to the same species. Bray-Curtis's dissimilarity index was used for the formation of the dendrogram. The result of cluster analysis can be considered that the Cave-III community tended to be more similar to the Cave-IV community, whereas Main Cave tended to be different. This cluster analysis result potential that the community's similarity between Cave -III and Cave-IV was not only from the species composition aspect but also from the population of each species in these communities.

Finally, this was the first attempt to survey and observation of spider diversity in the cave ecosystem. The diversity both at the ecosystem and microhabitat level supports a huge amount of spiders in the Study Area. Changes in environmental circumstances due to mining, local tourism, and pilgrimage and tourism activities can threaten the survival of the spider communities inside it. Sustainable organizations of these caves should be applied to minimize the destructive impact of tourism on caves spider communities.

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