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### **Diversity and Distribution of spider species in different habitats of Champaner-Pavagadh Archaeological Park a world heritage site of Gujarat**

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#### **ABSTRACT**

Spiders are widely distributed in all types of habitats and play an important role in controlling insect pests. Present work provides details about the diversity and distribution of spiders from three different habitats of Champaner-Pavagadh Archaeological Park namely Forest area, Agricultural fields and Garden area. Collection of spiders was done by pitfall, sweep net, active searching and leaf litter methods. Duration of the work was from March 2016 to February 2018. A total of 57 species of spiders belonging to 45 genera and 20 different families were found. Families Araneidae, Salticidae and Oxyopidae show maximum diversity from all the study areas. Maximum spider diversity was found in Forest habitat 55 species, as compared to Agricultural fields 42 species and Garden areas 38 species. Difference in the distribution and diversity of the spiders was found to be influenced by habitat type, vegetation structure, temperature, humidity and anthropogenic activities.

**KEYWORDS:** Spiders, Diversity, Distribution, Different habitats, Pavagadh

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## INTRODUCTION

Biological indicators play an important role to assess the ecological conditions. Spiders are also considered as important biological indicators like ants and dragonflies<sup>1</sup>. They serve an important role in keeping the insect population under control by feeding on insect pests such as Aphids, Thrips, Leafhopper, Grasshopper, Coccinellid beetles, Flies etc. Spiders belong to the order Araneae and are the most diverse and dominant amongst Arachnids. Currently there are 117 families, 4118 genera and 47928 species of spiders throughout the world<sup>2</sup>. More than 1685 spider species belonging to 438 genera and 60 families have been reported from India<sup>3</sup>. In Gujarat 415 species belonging to 169 genera and 40 families were reported<sup>4</sup> and this will continue to increase. In this region most of the research work has been done on its geochemical stratigraphy<sup>5</sup> its conservation<sup>6</sup> on its heritage study<sup>7</sup>. But remains unexplored by researchers for various fauna. Hence there is a need to study various invertebrates and vertebrates of this area spiders being one of them. In Gujarat till date our knowledge about the spider diversity remains confined to the works of Patel *et. al*<sup>8</sup>, Vachhani *et. al*<sup>9</sup>. Some of the work has also been reported from agro ecosystems by Solanki & Kumar<sup>10</sup>. Some research on spider diversity has been done in protected areas viz., Shoolpaneshwar Wildlife Sanctuary<sup>11</sup>; Ratanmahal Sanctuary<sup>8</sup>; Gir Protected areas<sup>12</sup> to name a few.

Champaner-Pavagadh Archeological Park is having different type of habitats viz. forest, agriculture and garden areas. This area has a good composition of trees, herbs and shrubs. Due to mixed type of vegetation there is a close space between the trees and shrubs. This helps the families like Araneidae, Pholcidae and Tetragnathidae in building orb webs of different types to trap foods. Families like Salticidae, Lycosidae and Gnaphosidae are ground spiders making funnel web in ground to trap their food. The leaf litter, forest floor and moist habitat provides the suitable environment for this group of spiders in the study site. Hore and Uniyal<sup>13</sup> also reported that diversity, distribution and abundance of spiders mostly depends on the types of vegetation, habitats and abiotic factors like temperature and humidity. The present study is the first comprehensive data of the spider fauna which will help in assessing the status of spider diversity with its conservation.

## MATERIALS AND METHODS

### *Study site*

Champaner-Pavagadh Archaeological Park in Panchmahal district of Gujarat is about 45 kms North- East of Vadodara. It is located between 22° 29' N and 73.32' E. The temperature ranges between minimum 8<sup>0</sup> C to maximum 48<sup>0</sup> C. The rainfall is erratic and irregular. It starts from June to September which is 80% of the total rainfall. Average annual rain fall is around 824 mm. Humidity

varies from 38 % - 63 %. The study site has been studied under three habitats Forest area, Agricultural fields and Garden area.

### ***Forest Area***

Forest area is undisturbed having large number of trees, climbers, shrubs and grasses. The dominant vegetation of this area comprises of trees like *Anogessus latifolia*, *Tectona grandis*, *Mitragyna parvifolia*, etc. Shrubs like *Zizyphus lotus*, *lantana camara*, *Cassia auriculata*, *Cassia tora*, *Calotropis gignentia* etc. Forest is dry deciduous type.

### ***Agriculture Fields***

Adjoining the foothill of Champaner- Pavagadh are the agricultural fields mainly having, Pigeon pea, Maize and Jowar crops; a major source of livelihood for the locals.

### ***Garden Area***

Visited by tourists and locals. Having herbs, shrubs, ornamental plants like *croton*, *lantana camara* *Acacia catechu*, *Ixora arborea* etc.

### ***Sampling methods***

The sampling of spiders was done by different methods. Line transects were used for random sampling of spiders. Spiders were searched for maximum two hours in each habitat. Active search, pitfall trap, sweep net and leaf litter were used to collect the spiders<sup>14</sup>. Sampling was carried out for two years from February 2016 to March 2018. All the surveys were conducted in the morning hours from 7.00 a.m. to 11.00 a.m. of alternative days every month. GPS was used to record the geographical location of study areas.

### ***Preservation and Labelling***

The Collected spider specimens were kept separately on vials with 70% ethyl alcohol. The vials were labelled with following information: Date, Place and Habitat on each vial.

### ***Identification***

All the preserved specimens of spiders were identified under stereo. The immature species were identified up to the genus level using various identification keys<sup>15, 16, 17, 18, 19</sup>. Species level identification was done by dissecting the epigyne in case of females and Padipalps in case of male. Diversity of spider species was analyzed using following diversity indices Shannon-Wiener, Simpson, Margalef and Pielou's<sup>s</sup> Evenness using PAST biodiversity index version 3.

## **RESULTS AND DISCUSSION**

The present study revealed the occurrence of 57 species of spiders belonging to 45 genera and 20 families.

Among the 20 families the most dominant family was Araneidae consisting of (11 sp.) followed by Salticidae (8sp), Lycosidae (5sp.) Oxyopidae (4sp.), Sparacidae (3sp.), Clubionidae, Gnaphosidae, Oonopidae, Philodromidae, Pholcidae, Scytodidae, Tetragnathidae, (2 sp. each). Rest of the families Clubionidae, Corrinidae, Eresidae, Eutichuridae, Hersiliidae, Palpimanidae, Thomisidae, Uloboridae and Zodaridae were represented by single species (Figure 1).

### ***Generic Diversity***

The maximum generic diversity was observed from forest habitats (41 genera, 50 species) followed by agricultural fields (33 genera, 42 species) and garden areas (31 genera, 37 species). Forest area had 20 families namely Araneidae (11), Salticidae (8), Lycosidae (5), Oxyopidae (4), Gnaphosidae, Oonopidae, Philodromidae, Pholcidae, Sparassidae, Tetragnathidae having two species and Clubionidae, Corrinidae, Eresidae, Hersiliidae, Palpimanidae, Thomisidae, Uloboridae, Zodaridae with single species.

Agricultural fields had 17 families namely: Araneidae (10), Salticidae(8), Lycosidae, Oxyopidae (4), Sparassidae (3), Scytodidae (2), Clubionidae, Corrinidae, Eresidae, Gnaphosidae, Hersiliidae, Philodromidae, Pholcidae, Tetragnathidae, Thomisidae, Uloboridae and Zodariidae have single species.

Garden area had 16 Families namely Araneidae (7) Salticidae (7), Lycosidae, Oxyopidae (5) Clubionidae, Sparassidae (2), Eresidae, Gnaphosidae, Hersiliidae, Oonopidae, Philodromidae, Pholcidae, Scytodidae, Tetragnathidae, Thomisidae, Zodaridae with single species as shown in (Table 1).

Families Araneidae, Salticidae and Lycosidae were most dominant and found in all habitats due to the presence of mix type of vegetation, food availability and microhabitats. Maximum diversity of spiders are from forest habitat (50 sp.) followed by agricultural fields (42 sp.) and garden areas (37 sp.). Forest area hosted maximum diversity due to the presence of food availability, natural and undisturbed habitat. Forest area having mixed type of vegetation provides maximum space for making orb web in different sizes and different patterns for spiders filled with leaf litters. Hence the orb web spiders like Araneidae, Lycosidae and Oxyopidae were maximum in the forest area.

Agricultural fields were having less number of families as compared to forest habitat due to the intercropping and a use of insecticides. This study brought out the fact that agricultural fields

adjoining the forest has the potential to maintain richness of spiders diversity in the agriculture fields. The lowest diversity was hosted from garden areas because of human activities.

The present study on the diversity and distribution of spiders was carried out and found to be affected by environmental parameters like types of vegetation, habitat types and anthropogenic activities.

The compiled data were analyzed for species richness, evenness, and diversity index of different habitats (Table 2). The Sorenson similarity coefficient between forest and agricultural fields is 0.971, agricultural and garden 0.903 and forest and garden is 0.882 (Table 3).

Study was planned to compile the checklist and compare its distribution in different habitats. The two year regular survey shows that diversity, distribution and composition of spider species depends on types of habitats and vegetation structure as reported by Rosenzweig<sup>20</sup>. According to Ried & Miller<sup>21</sup> diversity generally increases when a greater variety of habitat types are present in the ecosystem. Earlier work by Solanki & Kumar<sup>10</sup> from Jambughoda Wildlife Sanctuary, Bhatt<sup>11</sup> from Anand Kheda district and Siliwal *et. al*<sup>23</sup> from Purna wildlife Sanctuary suggest similar results that Araneidae and Salticidae were the dominant families in their study region.

**Table 1: Number of individuals observed in each habitat site with their microhabitats**

Sr. No.	Family	Species	Forest areas	Agricultural fields	Garden areas	Microhabitat
1.	Araneidae	<i>Argiope aemula</i> (Walckenaer, 1841)	2	1	0	Builds orb web in between the branches of the trees and shrubs or on mix type of vegetation, resting at the center of the web
2.		<i>Argiope anasuja</i> Thorell, 1887	8	4	5	
3.		<i>Chorizopes</i> sp.	2	1	0	
4.		<i>Cyclosa hexatuberculata</i> Tikader, 1982	3	1	2	
5.		<i>Cyrtophora cicatrosa</i> (Stoliczka, 1869)	4	2	5	
6.		<i>Cyrtophora citricola</i> (Forsskål, 1775)	4	2	2	
7.		<i>Eriovixia excelsa</i> (Simon, 1889)	0	3	1	
8.		<i>Gasteracantha hasselti</i> C. L. Koch, 1837	3	1	1	
9.		<i>Neoscona mokerje</i> Tikader, 1980	4	0	2	
10.		<i>Neoscona nautica</i> (L. Koch, 1875)	1	1	0	
11.		<i>Neoscona theisi</i> (Walckenaer, 1841)	1	1	0	
12.	Clubionidae	<i>Clubiona drassodes</i> O. Pickard-Cambridge, 1874	0	2	1	Found resting inside the folded leaf, under the bark of trees, wandering on leaf litters

Sr. No.	Family	Species	Forest areas	Agricultural fields	Garden areas	Microhabitat
13.		<i>Clubiona</i> sp.	1	0	1	
14.	Corrinidae	<i>Castianeira</i> sp.	7	2	0	Found running in the leaf litter
15.	Eresidae	<i>Stegodyphus sarasinorum</i> Karsch, 1892	4	2	2	Makes tube webs in Shrubs, vegetation, tree trunk, collected from its tube web
16.	Eutichuridae	<i>Cheiracanthium</i> sp.	3	0	0	Collected while resting on the underside of leaf
17.	Gnaphosidae	<i>Haplodrassus</i> sp.	2	1	1	Found in leaf litters, on the leaves of shrubs and trees, on the bark of trees
18.		<i>Zelotes mandae</i> Tikader & Gajbe, 1979	8	0	0	
19.	Hersiliidae	<i>Hersilia savignyi</i> Lucas, 1836	5	1	2	Found on tree trunk and camouflaged on the bark of trees and shrubs
20.	Lycosidae	<i>Evipa</i> sp.	1	0	1	Collected from leaf litters, under the stones and on the shrubs, makes funnel webs on the soil surface and leaf litters
21.		<i>Hippasa pisaurina</i> Pocock, 1900	4	3	1	
22.		<i>Lycosa</i> sp.	8	3	4	
23.		<i>Pardosa birmanica</i> Simon, 1884	4	5	2	
24.		<i>Pardosa sumatrana</i> (Thorell, 1890)	6	2	1	
25.	Oonopidae	<i>Ischnothyreus</i> sp.	8	0	2	Ground spiders collected from forest floor, leaf litters, soil surface
26.		<i>Orchestina</i> sp.	3	0	0	
27.	Oxyopidae	<i>Oxyopes bharaatae</i> Gajbe, 1999	0	4	3	Found foliage on the grasses, forest floor, on the bark of trees, leaves, flowers
28.		<i>Oxyopes gujaratensis</i> Gajbe, 1999	2	1	4	
29.		<i>Oxyopes kamalae</i> Gajbe, 1999	1	1	1	
30.		<i>Oxyopes shweta</i> Tikader, 1970	3	1	5	
31.		<i>Peucetia</i> sp.	1	0	1	
32.	Palpimanidae	<i>Otiotrops namratae</i> Pillai, 2006	1	0	0	Ground spiders collected from leaf litters
33.	Philodromidae	<i>Philodromus</i> sp.	2	0	0	Found on the branches of trees, leaves and shrubs
34.	Pholcidae	<i>Crossopriza lyoni</i> (Blackwall, 1867)	3	1	1	Collected from its web between the lower vegetation, on the herbs and ornamental plants
35.		<i>Pholcus</i> sp.	1	0	0	
36.	Salticidae	<i>Asemonea tenuipes</i> (O. Pickard-Cambridge, 1869)	2	1	1	Found on the leaves of trees, mix vegetation, on the herbs and ornamental plants
37.		<i>Bianor punjabicus</i> Logunov, 2001	2	1	1	
38.		<i>Hasarius adansoni</i> (Audouin, 1826)	3	1	0	
39.		<i>Hyllus semicupreus</i> (Simon, 1885)	2	1	2	
40.		<i>Myrmarachne</i> sp.	2	1	1	
41.		<i>Phintella</i> sp.	0	1	0	
42.		<i>Plexipus paykulli</i> (Audouin, 1826)	3	0	1	

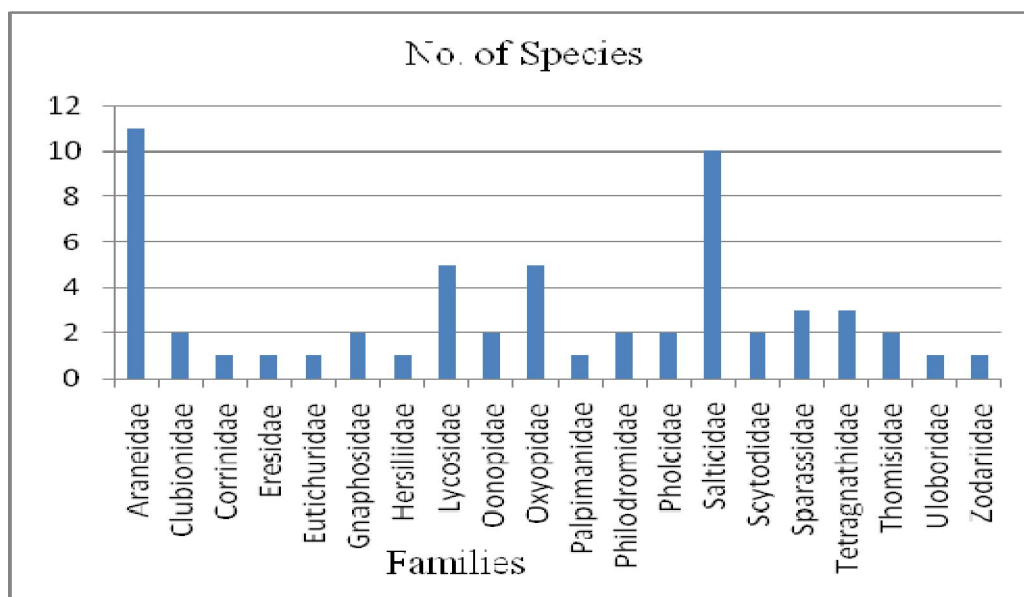
Sr. No.	Family	Species	Forest areas	Agricultural fields	Garden areas	Microhabitat
43.		<i>Rhene albigera</i> (C.L. Koch, 1846)	1	1	0	
44.		<i>Stenaelurillus albus</i> Sebastian et. al., 2015	1	0	1	
45.		<i>Telamonia dimidiata</i> (Simon, 1899)	0	1	1	
46.	Scytodidae	<i>Scytodes thoracica</i> (Latreille,1802)	2	1	1	Collected from the leaf litter and on herbs
47.		<i>Scytodes fusca</i> Walckenaer, 1837	3	3	0	
48.	Sparassidae	<i>Heteropoda</i> sp.	1	1	1	Collected from the underside of leaf , on the bark of trees
49.		<i>Olios gravely sethi</i> & Tikader, 1988	0	2	0	
50.		<i>Olios milleti</i> (Pocock, 1901)	2	1	1	
51.	Tetragnathidae	<i>Guizygiella</i> sp.	3	0	0	Collected from its orb web between branches of tree, leaves and on the herbs
52.		<i>Leucauge decorata</i> (Blackwall, 1864)	4	1	2	
53.		<i>Tetragnatha</i> sp.	1	1	1	
54.	Thomisidae	<i>Indoxysticus minutus</i> (Tikader, 1960)	2	0	0	Found resting rolling the leaves of small trees
55.		<i>Thomisus</i> sp.	0	1	1	
56.	Uloboridae	<i>Uloborus</i> sp.	1	1	0	It was found on the leaf of trees and shrubs
57.	Zodariidae	<i>Asceua</i> sp.	4	5	3	Collected from leaf litters and forest floor
	Total no. of individuals		150	71	68	
	Total no. of species		51	42	38	
	Total no. of Families		20	17	16	

Table 2: Comparison of diversity index results amongst the three habitats

Index	Forest area	Agricultural fields	Garden area
Shannon diversity	2.63	2.46	2.42
Simpson diversity	0.899	0.876	0.885
Margalef diversity	4.83	4.28	4.12
Evenness Value	0.69	0.66	0.71

Table 3: Sorenson Similarity Coefficient between three habitats

Sr. No.	Forest area, Agricultural fields & Garden area	Similarity Index
1	Similarity index between forest & agricultural fields	0.971
2	Similarity index between agricultural & garden areas	0.903
3	Similarity index between forest & garden areas	0.882



**Figure1. Numbers of spider species recorded from different families of Champaner-Pavagadh Archaeological Park.**

## CONCLUSION

Work on spider diversity is completely untouched in the study area although the habitats are rich with flora and fauna. 57 species belonging to 45 genera under 20 families were recorded (Table 1). This work serves as a base line for future research on spiders and their conservation in Champaner- Pavagdh Archaeological Park.

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