DIVERSITY AND ECOLOGY OF SPIDERS IN CHAMPANER-PAVAGADH ARCHAEOLOGICAL PARK A WORLD HERITAGE SITE IN GUJARAT

CONCISE SUMMARY OF Ph.D. THESIS

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INTRODUCTION

Spiders are most diverse and dominant invertebrate animals on the earth. They always create confusion with insects but are different from insects as their body is divided into two parts i.e cephalothorax and abdomen, have four pairs of legs. Most of the spiders are having four pairs of eyes and some are having three pairs of eyes. Wings and antennae are absent in spiders. They are unique among other arachanids due to the presence of spinnerets, which produce silk. Spinnerets make them different among other Arachnids. They are having six types of silk producing glands at the end of abdomen.

They belongs to the class Arachnida order Araneae under Phylum Arthropoda, are an ancient group of invertebrate animals. There are currently 48,182 described spider species belonging to 4,139 genera and 120 families (World Spider Catalog, 2019) in the world and there are many species yet to be discovered and described. Out of these, 1686 species belonging to 438 genera and 60 families have been reported from India (Keswani *et al*., 2012). From Gujarat 415 species belonging to 169 genera and 40 families were reported (Yadav *et al*., 2017). Out of these 1074 species of spiders are endemic to India (Siliwal *et al.*, 2005).

Biological Role of Spiders

Spiders are the most-diverse and dominant invertebrate predators in terrestrial ecosystems (Nyffeler, 2000).They play an important role in controlling the insect pest population under control by feeding on insect pest such as thrips, caterpillars, aphids, plant bugs, leaf hoppers, flies, etc. (Nyffeler & Benz, 1987). Hence, spiders play an important role in reducing the usage of pesticides in agriculture fields by eating harmful insects (Riechert , 1999). Therefore spider needs attention in research and conservation and have been recognized as excellent insect for research studies based on their diversity and ecological role. In the resent research most of studies have been done on application basedbenefits of spiders as bio control agents in agricultural fields. Hence spiders have been used in integrated pest management (IPM), due to their potential benefits as bio-controller of agricultural pests (Abrol, 2014). Thus spiders help in reducing pesticide in agriculture fields and increase significant economic values. Spider silk and venom are being used in medicinal research (stroke treatment) in pest control (pesticides) and in fiber technology.

Biology of Spiders: Spiders are mainly of two types Weavers and Non-Weavers (Tikader, 1987). Their life span is about one year but few live for 10 or 25 years (Smith, 1971). The life cycle of the spider consists of egg, spiderlings, and adult spiders.

Egg: Spiders are oviparous. Eggs are laid in large number in a protected silk shelter called eggcocoon or eggsac. Eggsacs are laid on leaves and stems of plants and hidden in earth crevices, on the bark of trees under stones or on walls or may even be kept strung in webs Few to several hundreds of eggs are present in an eggsac depending on the species.

Spiderlings (Young ones): Eggs hatch in 10 to 14 days and spiderling remains in the eggsac for 2 to 6 weeks, and leave the eggsac after the first moult.

Adults: Sexual dimorphism occurs in many species. Females normally being significantly larger than the males. The male spider can be distinguished by the swollen or knobbed tip of the palps**.** Males of some species die soon after mating. Spiders of many families show parental care. Female wolf spider (Family: Lycosidae) carries the cocoon attached beneath the abdomen or held by the jaws (Family Pholcidae) (Figure 1). The females of family Theridiidae and Pholcidae (*Crossopriza lyoni*) do not leave the cocoonun till the young ones hatch out. However, in Lycosidae, after the spiderlings hatch out, the brood continues to ride on the mother's back for about a week.

Morphology of Spiders: Spiders belong to the class Arachnida of the phylum Arthropoda that possess two main body parts, anterior prosoma or cephalothorax, and posterior opisthosoma or abdomen, joined by a narrow pedicel. They have four pairs of legs, six or eight eyes are present, wings and antenna are absent. They are unique arachnids as they have spinnerets located at the end of the abdomen which produces silk.

Cephalothorax: The cephalothorax consists of head and thorax which is fused into a single segment called cephalothorax

Abdomen: The abdomen is the largest and wide part of spider body with a remarkable variation in shape, size, coloration, markings and fine hairs.

Legs: On the lateral side of cephalothorax four pairs of legs are present I, II, III and IV respectively.

Eyes: On the cephalic region six or eight simple eyes are present and their size and arrangements are different which are used for identification of spiders till family level. Two different types of eyes are known to exist i.e. diurnal and nocturnal eyes. (Figure 2)

Spinnerets: Spinnerets are six in numbers (three pairs) present below the anal tubercle which is present at the end of the abdomen.

Reproductive Organ: Pedipalps and Epigyne

Ecology and Diversity of Spiders: The present work deals with the diversity and ecology of spiders of Champaner- Pavagadh Archaeological Park. This site was announced as a World Heritage Site in the year 2004 by UNESCO. Few studies on the flora of Champaner- Pavagadh Archeological Park have been conducted by the Department of Botany, The M.S. University of Baroda (Oza, 1961) and (Alpana, 2015) and Modi 2008 from heritage concern, Surat worked on managing and conserving of water in Champaner Pavagadh Archeological Park. But this important heritage site remains unexplored by taxonomists for various fauna. Hence there is a need to study various invertebrates and vertebrates of the Champaner-Pavagadh Archaeological Park; spiders being one of them.

Objectives of the study

- To study the systematic and ecological distribution of spiders in Champaner Pavagadh Archaeological Park
- To explore diversity patterns of spiders along the slope of Pavagadh hill
- To analyze the guild structure of spider species obtained from the study area.
- To study the web structure of spiders found in Champaner-Pavagadh Archeological Park.
- ***The next time you see a spider web, plea pause and look a little closer. You will be seeing one of the most high-performance materials known to man…….***

Cheryl Hay

Figure 1

Crossopriza lyoni carrying their eggs

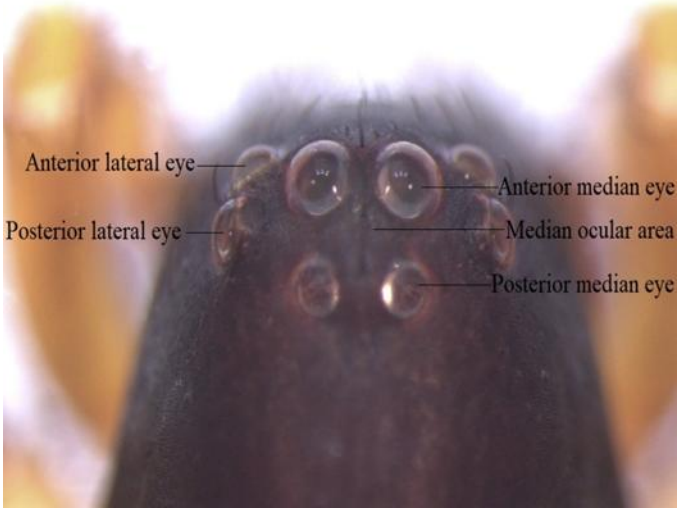


Figure 2

Eye arrangement of typical spider

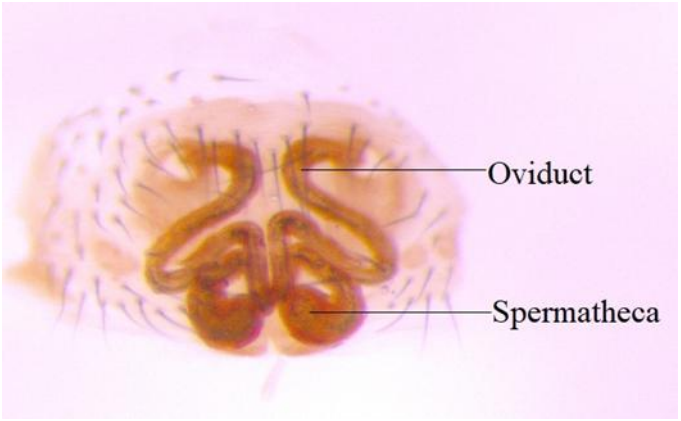


Figure 3

Enlarged view of female epigynum

REVIEW OF LITERATURE

According to the World Spider Catalog, version 20.0 (2019), the updated lists documented 42,473 species of spider belonging to 3849 genera and 120 families from the world. Spiders are one of the widely distributed groups of predators in the animal kingdom (Riechert and Lockley, 1984). They play an important role in controlling insect pests in agriculture fields (Nyffeler and Benz, 1987)

National Studies on Spiders

From the literature review it was revealed that the pioneer works on Indian spiders was done by Simon (1887); Thorell (1895) and Pocock (1900). The earlier detailed account of Indian spiders was done by Pocock in 1900 which lists 216 spider species under 17 different families. A prominent portion of spider study in Indian Arachnology has been done by Tikader at the beginning of 1960. This study gave solid knowledge of Indian Arachnology and inspired many other researchers into this field. The most comprehensive description of Indian spiders was done by Tikader (1987) has listed 1066 species under 43 families. Each of the family viz. Lycosidae, Salticidae, Gnaphosidae, Thomisidae, and Araneidae were the most dominant spiders reported by Tikader in 1987. Sebastian and Peter in 2009 have published a handbook of Indian spider which gives detailed information of spiders and described some common spider species observed in the fields. Quasin and Uniyal (2010) studied spider diversity from Kedarnath Wildlife Sanctuary, Uttarakhand has compiled 244 species belonging to 108 genera and 33 families. Patel (2003) reported 91 species belonging to 53 genera and 16 families from Parabikulum Wildlife Sanctuary, Kerala. Siliwal *et al.*(2005) published a checklist of Indian spiders' compiled 1442 species belonging to 361 genera of 59 families and provided a taxonomic re-description of previously described species.

Spider Studies in Gujarat

Dr. B. H. Patel was a pioneer to study spider fauna in Gujarat. He described 56 new species of 18 families from Gujarat. Siliwal *et al.* (2003) reported 116 species of spider belonging to 66 genera and 25families from the Purna Wildlife Sanctuary. Kumar & Kumar (2004) reported 33 species of spidesr belonging to 10 families from rice agro-ecosystem of Vadodara. Kumar & Kumar (2006) reported 21 species belonging to 9 families of spiders in rice agro-ecosystem of Vadodara. Kumar (2007) reported 11

speciesof spiders belonging to 10 genera and 9 families from the agricultural fields of Vadodara. Kumar & Kumar (2010) reported and listed the insect species that is being preyed upon by *Oxyopes shweta* (Araenidae: Oxyopidae) Vadodara. Trivedi (2009) reported 37 species of spiders belonging to 22 genera and 10 families from groundnut crop fields of Rajkot. Solanki & Kumar (2015a) worked on spiders from five major agroecosystems of Jambughoda Village, Panchmahal district and reported 67 species belonging to 43 genera and 17 different families. Solanki and Kumar (2015b) studied web structure and efficiency of prey capture in *Neoscona vigilant.* However the information from Champaner- Pavagadh Archaeological Park on diversity and ecology study of spiders is still unknown. Keeping this in mind the present study has been proposed. The aim of the present work is to make an inventory of the spider species in different habitats with a slope of Pavagadh hill.

MATERIALS AND METHODS

Champaner-Pavagadh Archaeological Park is the gateway to Panchmahal district of Gujarat India.

It is located at a distance of approximately 50 kms north-east of The M. S. University of Baroda, Vadodara and 45 km south of Godhra. The area is spread in 1,329 hectares. Pavagadh hill is the highest point in the district, rising to a height of 830 m from sea level. The study was carried out for a period of 3 years i.e. December, 2015 to December, 2018 in all the four seasons of the year.

Collection Methods: Using single sampling method was not enough.Therefore a systematic collection was done using different sampling methods as employed in (Koh and Ming, 2013).

1. Pitfall Trapping
2. Sweep-Netting
3. Vegetation Beating
4. Ground Hand Collection
5. Arial Hand Collection
6. Leaf litter Method

Specimen Preservation: After collection spider samples were brought to the laboratory for identification. The alcohol of the samples was changed to avoid contamination of microorganisms. All the samples were transferred to the glass petri plate with 70% alcohol and were sorted out with the help of paint brush and forceps.

Taxonomic Identification: Spider identification was done by observing specimens under stereo-zoom microscope (Leica MPS) with magnification from 20X to 75X in the lab. Spiders at all the stages were identified till genus level because their colour and abdomen patterns are almost same as adult. However species level identification was done in mature specimens because pedipalp and epigyne are well developed .In immature spiders epigyne and pedipalps were not well developed thus cannot be identified till species level. Mature pedipalp and epigyne structure are shown in **Error! Reference source not found.**. All the mature female spider's epigynum were dissected and cleaned in lactic acid for 10–15 minutes. After that the structure of epigyne was compared with the available literature. These dissected epigyne were stored in 1 inch long glass microvials plugged with cotton and placed in the respective spider species vial number after identification.

Similarly in case of mature male spiders the pedipalp of left hand side were plucked and its structures were compared with the available literature. All the collected spider identification was done by me till species level and further confirmation was done by renowned Arachnologist Dr. Manju Siliwal, Women Scientist, Wildlife Institute of India, Chandrabani, Dehradun, Uttarakhand. Standard literatures used for identification of spiders were:World Spider Catalog, 2019;Gajbe, 2008, 2007;Patel, 2003; Reddy & Patel, 1993 Majumdar & Tikader, 1991;

Photography

In field spider photography was done using Lumix Panasonic DMC- FZ60 with 24x optical zoom. In case of preserved specimens photography was done by SONY DSC-WX50 camera, which was attached to Stereomicroscope.

STUDY SITE

Figure 4

Pavagadh

Figure 5

Pitfall trap method

Figure 6

Stereomicroscope

RESULTS

Champaner- Pavagadh Archaeological Park led to the documentation of 189 species of spiders belonging to 106 genera and 32 different families during the study period (Table1).

New records of genus and species of spiders from Champaner-Pavagadh Archaeological Park

Gujarat spider fauna is diverse but poorly documented especially in Champaner-Pavagadh Archaeological Park. There were several new records of spiders possibly few new genera and species to science have been reported from this region. We have documented two genera and eight species that are new records to India. Moreover, three genera and nine species is also been recorded for the first time from Gujarat. Ten species which are new to science is also documented from Champaner-Pavagadh Archaeological Park.

First record of Genera from India reported from Champaner-Pavagadh Archaeological Park

- *Opopea* sp.
- *Myrmatheca alticephalon* (Yamasaki & Ahmad, 2013)

First record of Species from India reported from Champaner-Pavagadh Archaeological Park

- *Stenaelurillus* sp. nov
- *Asceua* sp.1 nov
- *Asceua* sp.2 nov
- *Asceua* sp.3 nov
- *Asceua* sp.4 nov
- *Asceua* sp.5 nov
- *Brignolia carlmulleri* Ranasinghe & Benjamin, 2016
- *Brignolia meemure* Ranasinghe & Benjamin, 2016

First record of genera from Gujarat

- *Callilepis* sp.
- *Lepthyphantes* sp.
- *Cosmophasis* sp.

First record of species from Gujarat

- *Neoscona inusta* (C. L. Koch, 1871)
- *Cambalida dhupgadensis* Bodkhe, Uniyal & Kamble, 2016
- *Cambalida flavipes* (Gravely, 1931)
- *Drassyllus mahabalei* Tikader, 1982
- *Sosticus nainitalensis* Gajbe, 1979
- *Zelotes nainitalensis* Tikader & Gajbe
- *Oedignatha scrobiculata* Thorell, 1881
- *Scytodes pallida* Doleschall, 1859
- *Selenops radiatus* Latreille, 1819

New species reported fromChampaner-Pavagadh Archaeological Park (New to Science)

- *Plesiophrictus* sp.
- *Singa* sp.
- *Mimetus* sp.
- *Brignolia* sp.1
- *Brignolia* sp.2
- *Brignolia* sp.3
- *Brignolia* sp.4
- *Ischnothyreus* sp.
- *Palpimanus* sp.
- *Ariadna* sp.

Web Structure: Orb webs**,** Funnel web, Sheet web, Single line web**,** Tent web, Irregular web

Family – Araneidae

Figure 7

Argiope anasuja

Thorella,1887

Family – Salticidae

Figure 8

Plexippus paykullii

(Audouin, 1826)

Family – Lycosidae

Figure 9

Pardosa mukundi

Tikader& Malhotra, 1980

New records

Figure 10
Brignolia meemure
Ranasinghe & Benjamin, 2016

Figure 11
Opopea sp.

Figure 12
Myrmatheca alticephalom
(Yamasaki & ahmad ,2013)

New to Science

Figure 13

Plesiophrictus sp.

Figure 14

Asceua sp.1

Figure 15

Mimetus sp.

Table 1: Checklist of spider species from Champaner- Pavagadh Archaeological Park, Gujarat

Sr. No.	Family	Species	Sex
1	Agelenidae	*Agelena gautami* Tikader, 1962	M,F
2	Araneidae	*Araneus sp.*	F
3		*Argiope anasuja* Thorell, 1887	M,F
4		*Cyclosa bifida* (Doleschall, 1859)	M,F
5		*Cyclosa confraga* (Thorell, 1892)	M,F
6		*Cyclosa moonduensis* Tikader, 1963	M,F
7		*Cyclosa spirifera* Simon, 1889	F
8		*Cyrtophora cicatrosa* (Stoliczka, 1869)	M,F
9		*Cyrtophora citricola* (Forsskål, 1775)	M,F
10		*Eriovixia excelsa* (Simon, 1889)	M,F
11		*Eriovixia laglaizei* (Simon, 1877)	M,F
12		*Gasteracantha hasselti* C. L. Koch, 1837	F
13		*Larinia chloris* (Audouin, 1826)	F
14		*Neoscona inusta* (L. Koch, 1871)	F
15		*Neoscona mukerjei* Tikader, 1980	M
16		*Neoscona theisi* (Walckenaer, 1841)	M,F
17		*Nephila pilipes* (Fabricius, 1793)	F
18		*Poltys bhabanii* (Tikader, 1970)	F
19		*Singa* sp.	F
20		*Thelacantha brevispina* (Doleschall, 1857)	M,F
21	Cheiracanthiidae	*Cheiracanthium danieli* Tikader, 1975	M,F
21		*Cheiracanthium melanostomum* (Thorell, 1895)	M,F
23		*Cheiracanthium triviali* (Thorell,1895)	F
24	Clubionidae	*Clubiona drassodes* O. Pickard-Cambridge, 1874	M,F
25		*Clubiona filicata* O. Pickard-Cambridge, 1874	F
26		*Clubiona pashabhaii* Patel & Patel, 1973	M,F
27	Corinnidae	*Cambalida dhupgadensis* Bodkhe, Uniyal & Kamble, 2016	F

Sr. No.	Family	Species	Sex
28		*Cambalida flavipes* (Gravely, 1931)	F
29		*Castianeira albopicta* Gravely, 1931	F
30		*Castianeira bengalensis Biswas 1984*	M,F
31		*Castianeira zetes* Simon, 1897	F
32	Eresidae	*Stegodyphus mirandus* Pocock, 1899	F
33		*Stegodyphus pacificus* Pocock, 1900	F
34		*Stegodyphus sarasinorum* Karsch, 1892	F
35	Filistatidae	*Pritha dharmakumarsinhjii* Patel, 1978	F
36		*Pritha poonaensis* (Tikader 1963)	F
37		*Sahastata ashapuriae* Patel, 1978	F
38	Gnaphosidae	*Callilepis* sp.	F
39		*Drassyllus mahabalei* Tikader, 1982	M,F
40		*Gnaphosa poonaensis* Tikader, 1973	F
41		*Prodidomus* sp.	F
42		*Scopoides kuljitae* (Tikader, 1982)	M,F
43		*Sosticus nainitalensis* Gajbe, 1979	M,F
44		*Trachyzelotes jaxartensis* (Kroneberg, 1875)	F
45		*Zelotes mandae* Tikader&Gajbe, 1979	M,F
46		*Zelotes nainitalensis* Tikader&Gajbe, 1976	M,F
47		*Zelotes sajali* Tikader & Gajbe, 1979	M,F
48.	Hersiliidae	*Hersilia savignyi* Lucas, 1836	F
49.	Linyphiidae	*Lepthyphantes* sp.	F
50.		*Linyphia* sp.	F
51.		*Neriene sundaica* (Simon, 1905)	F
52.	Liocranidae	*Oedignatha scrobiculata* Thorell, 1881	F
53.		*Oedignatha* sp. 1	F
54.		*Oedignatha* sp.2	F
55.	Lycosidae	*Evippa* sp.	M,F
56.		*Hippasa partita* (O. Pickard-Cambridge, 1876)	M,F
57.		*Hippasa* sp.1	M,F
58.		*Hippasa* sp.2	M
59.		*Lycosa lambai* Tikader & Malhotra, 1980	M,F
60.		*Lycosa madani* Pocock, 1901	M,F

Sr. No.	Family	Species	Sex
61.		*Lycosa phipsoni* Pocock, 1899	M,F
62.		*Lycosa poonaensis* Tikader & Malhotra, 1980	F
63.		*Lycosa* sp.	F
64.		*Pardosa birmanica* Simon, 1884	M,F
65.		*Pardosa heterophthalma* (Simon, 1898)	M,F
66.		*Pardosa mukundi* Tikader and Malhotra,1980	M,F
67.		*Pardosa sumatrana* (Thorell, 1890)	F
68.	Mimetidae	*Mimetus* sp.	F
69.	Oecobiidae	*Oecobius putus* O. Pickard-Cambridge, 1876	M,F
70.		*Brignolia carlmulleri* Ranasinghe & Benjamin, 2016	M,F
71.		*Brignolia meemure* Ranasinghe & Benjamin, 2016	F
72.	Oonopidae	*Brignolia* sp.1	M,F
73.		*Brignolia* sp.2	F
74.		*Brignolia* sp.3	F
75.		*Brignolia* sp.4	F
76.		*Ischnothyreus* sp.	F
77.		*Opopea* sp.	F
78.		*Oxyopes ashae* Gajbe, 1999	F
79.		*Oxyopes bharatae* Gajbe, 1999	M,F
80.		*Oxyopes birmanicus* Thorell, 1887	F
81.		*Oxyopes javanus* Thorell, 1887	F
82.		*Oxyopes kamalae* Gajbe, 1999	M,F
83.	Oxyopidae	*Oxyopes pankaji* Gajbe & Gajbe, 2000	M
84.		*Oxyopes shweta* Tikader, 1970	M,F
85.		*Oxyopes* sp.1	F
86.		*Oxyopes* sp.2	M,F
87.		*Peucetia akwadaensis* Patel, 1978	F
88.		*Peucetia* sp.	F
89.	Palpimanidae	*Otiothops namratae* Pillai, 2006	F
90.		*Palpimanus* sp.	F

Sr. No.	Family	Species	Sex
91.	Philodromidae	*Philodromus decoratus* Tikader, 1962	M,F
92.		*Thanatus dhakuricus* Tikader, 1960	M,F
93.		*Tibellus elongates* Tikader, 1960	M,F
94.	Pholcidae	*Artema atlanta* Walckenaer, 1837	M,F
95.		*Crossopriza lyoni* (Blackwall, 1867)	M,F
96.		*Pholcus fragillimus* Strand, 1907	M,F
97.		*Pholcus phalangioides* (Fuesslin, 1775)	F
98.	Pisauridae	*Dendrolycosa gitae* (Tikader, 1970)	F
99.		*Dendrolycosa* sp.	F
100.		*Pisaura* sp.	F
101.	Salticidae	*Asemonea tenuipes* (O. Pickard-Cambridge, 1869)	M,F
102.		*Bianor punjabicus* Logunov, 2001	F
103.		*Bianor* sp.	F
104.		*Carrhotus* sp.	F
105.		*Cosmophasis* sp.	F
106.		*Harmochirus brachiatus* (Thorell, 1877)	M
107.		*Harmochirus* sp.	M
108.		*Hyllus semicupreus* (Simon, 1885)	M,F
109.		*Marpissa* sp.1	F
110.		*Marpissa* sp.2	F
111.		*Menemerus bivittatus* (Dufour, 1831)	M,F
112.		*Myrmarachne melanocephala* MacLeay, 1839	F
113.		*Myrmatheca alticephalon* (Yamasaki & Ahmad, 2013)	F
114.		*Myrmapeni* sp.	F
115.		*Phidippus calcuttaensis* Biswas, 1984	F
116.		*Phintella vittata* (C. L. Koch, 1846)	M,F
117.		*Plexippus calcutaensis* (Tikader, 1974)	M,F
118.		*Plexippus paykullii* (Audouin, 1826)	M, F
119.		*Portia* sp.	M, F
120.		*Rhene* sp.	F
121.		*Stenaelurillus* sp.	M, F

Sr. No.	Family	Species	Sex
122.		*Telamonia dimidiata* (Simon, 1899)	F
123.		*Thyene imperialis* (Rossi 1846)	F
124.		Thyene sp.	F
125.	Scytodidae	*Scytodes pallida* Doleschall, 1859	F
126.		*Scytodes thoracica* (Latreille,1802)	M,F
127.		*Scytodes propinqua* Stoliczka, 1869	M,F
128.		*Scytodes* sp.	F
129.	Segestriidae	*Ariadna* sp.1	J
130.		*Ariadna* sp. 2	F
131.	Selenopidae	*Selenops radiatus* Latreille, 1819	F
132.	Sparassidae	*Heteropoda bhaikakai* Patel & Patel, 1973	M, F
133.		*Heteropoda venatoria* (Linnaeus, 1767)	M, F
134.		*Olios bhavnagarensis* Sethi & Tikader, 1988	F
135.		*Olios gravelyi* Sethi & Tikader, 1988	M, F
136.		*Olios milleti*(Pocock, 1901)	F
137.		*Olios* sp. 1	F
138.		*Olios* sp. 2	F
139.		*Olios tener* (Thorell, 1891)	M, F
140.		*Olios wroughtoni* (Simon, 1897)	M, F
141.	Stenochilidae	*Stenochilus hobsoni* O. Pickard-Cambridge, 1871	M,F
142.	Tetragnathidae	*Guizygiella indica* (Tikader& Bal, 1980)	F
143.		*Guizygiella melanocrania* (Thorell, 1887)	F
144.		*Guizygiella shivui* (Patel & Reddy, 1990)	M, F
145.		*Guizygiella* sp.	F
146.		*Leucauge decorata* (Blackwall, 1864)	M, F
147.		*Opadometa fastigata* (Simon, 1877)	F
148.		*Tetragnatha mandibulata* Walckenaer, 1841	M, F
149.		*Tetragnatha maxillosa* (Thorell, 1895)	F
150.	Theraphosidae	*Plesiophrictus* sp.	F
151.	Theridiidae	*Argyrodes flavescens* O. Pickard-Cambridge, 1880	M, F
152.		*Argyrodes projeles* Tikader, 1970	F
153.		*Cephalobares globiceps* O. Pickard-Cambridge, 1871	M, F
154.		*Faiditus* sp.	F

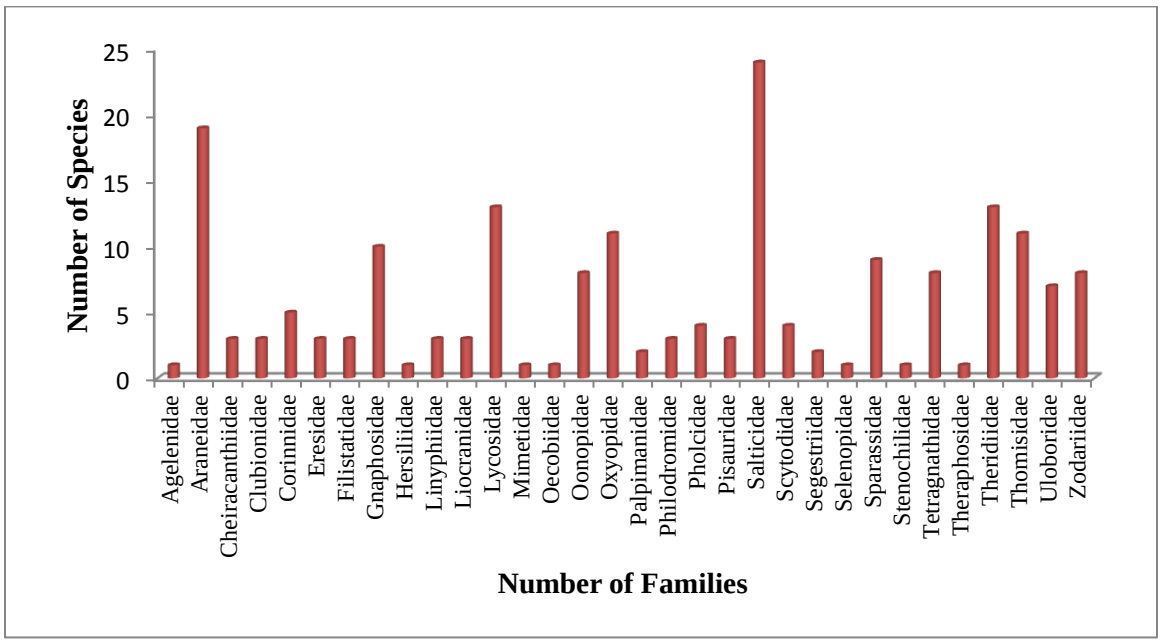
Sr. No.	Family	Species	Sex
155.		*Latrodectus geometricus* C. L. Koch, 1841	M, F
156.		*Nihonhimea mundula* (L. Koch, 1872)	M, F
157.		*Steatoda* sp.1	F
158.		*Steatoda* sp.2	F
159.		*Theridion manjithar* Tikader, 1970	M, F
160.		*Theridion* sp.1	F
163.		*Thwaitesia* sp.	F
164.	Thomisidae	*Amyciaea forticeps* (O. Pickard-Cambridge, 1873)	M, F
165.		*Camaricus sp.*	F
166.		*Indoxysticus lumbricus* Tang & Li, 2010	M, F
167.		*Indoxysticus minutus* (Tikader, 1960)	M, F
168.		*Misumena* sp.	F
169.		*Misumenoides* sp.	F
170.		*Strigoplus* sp.	F
171.		*Synema decoratum* Tikader, 1960	F
172.		*Thomisus dhakureinsis* Tikader, 1960	M, F
173.		*Thomisus krishnae* Reddy & Patel, 1992	M, F
174.		*Thomisus* sp.	F
175.	Uloboridae	*Miagrammopes* sp.	F
176.		*Philoponella* sp. 1	J
177.		*Philoponella* sp.2	F
178.		*Uloborus danolius* Tikader, 1969	M, F
179.		*Uloborus plumipes* Lucas, 1846	M, F
180.		*Uloborus* sp.	F
181.		*Zosis geniculata* (Olivier, 1789)	M, F
182.	Zodariidae	*Asceua* sp. 1	M, F
183.		*Asceua* sp.2	M, F
184.		*Asceua* sp.3	M, F
185.		Asceua sp.4	F
186.		*Asceua* sp.5	F
187.		*Suffasia gujaratensis* (Tikader& Patel, 1975)	F
188.		*Tropizodium viridurbium* Prajapati, Murthappa, Sankaran & Sebastian, 2016	M,F
189.		*Tropizodium kalami* Prajapati, Murthappa, Sankaran & Sebastian, 2016	M, F

Types of spider web

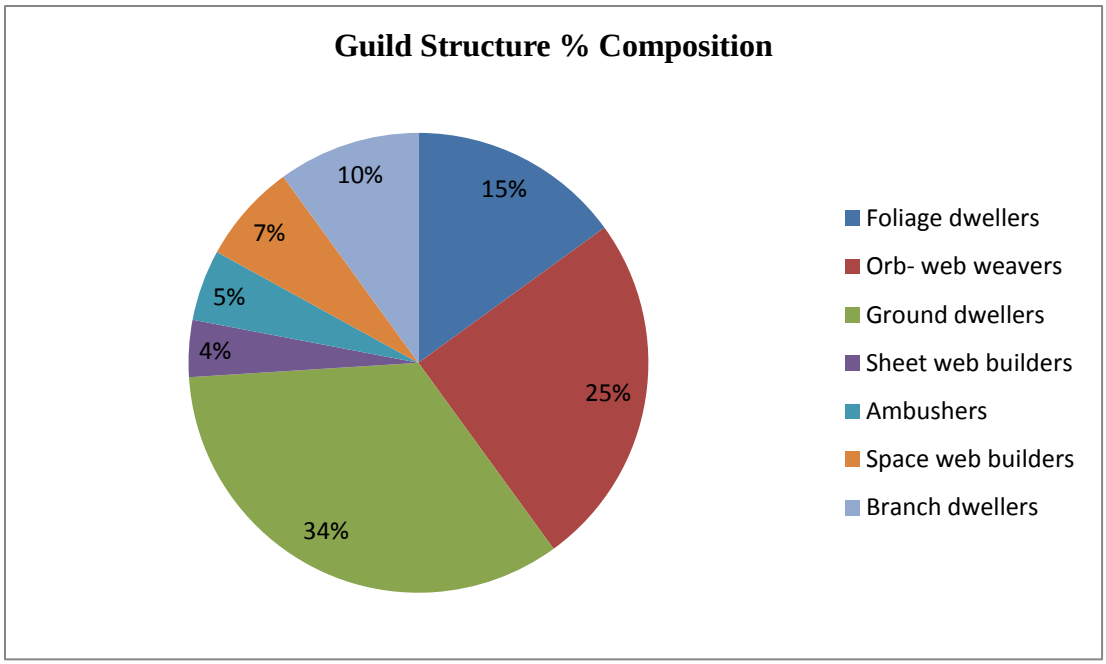
Figure 16
Orb web of
Argiope anasuja

Figure 17
Sheet web of
Stegodyphus sp.

Figure 18
Tent web of *Cyrtophora citricola*



Graph 1: Species Diversity of Spiders from Champner Pavagadh Archaeological Park



Graph 2 : Guild structure composition of spiders from Champaner Pavagadh Archaeological Park

DISCUSSION

The present study shows that diversity and ecology of spiders is closely related to the structural complexity of the environment. Maximum spiders were observed from July to December because of the moist habitat. However there are good numbers of species that are new to science. This indicates that Champaner-Pavagadh has rich diversity of spider fauna as spiders are good indicators of healthy ecosystem and maintain ecological balance by feeding on various insect pests.

Hence the information on their diversity and ecological studies would be helpful in conserving the ecosystem. This study indicates that the spider fauna in the Champaner-Pavagadh is moderately rich. Some rare and uncommon spiders were found from study sites such as Tarantula spider (Theraphosidae), *Plesiophrictus* sp. and tube dwelling spider *Ariadna* sp. during the study. Two genera and eight species that are new records from India were also found. Moreover, three genera and nine species is also been recorded for the first time from Gujarat. Ten species which are new to science were documented from Champaner-Pavagadh Archaeological Park. The high number of species recorded indicates the rich spider diversity of Champaner-Pavgadh Archaeological Park. Spiders are ubiquitous in nature and their diversity depends on many factors like habitat structure, temperature, humidity and vegetation of the areas Uniyal *et al* (2011). Therefore, keeping these factors in mind the study site was divided into different habitats.

Natural species are the library from which genetic engineers can work. Genetic engineers don't make new genes they rearrange existing ones……

Thomas Lovejoy

CONCLUSION

- Champaner-Pavagadh Archaeological Park has diverse habitats like Forest area, Agricultural fields, Garden area, Concrete structures and a hill.
- Total spider families in the world are 120 and we in our research reported 32 families.
- Among 32 families dominant spider species were from the families Salticidae, Araneidae, Lycosidae, Theridiidae, Oxyopidae, Thomisidae, Gnaphosidae, Sparasiidae, Oonopidae, Tertragnathidae and Zodariidae.
- Results have clearly indicated that amongst these families Orb-web builders, hunters and ground spiders are present almost equally.
- The entire area of study sites provides a suitable microhabitat for spiders. Spiders found foraging on barks of trees, under the rock, in leaf litter, under the leaves of small trees, wandering on leaf litter were the Salticids.
- Even the hill could support the population of spiders. In the Pavagadh hill a total of 144 species belonging to 92 genera and 29 families were collected during the entire sampling period along slope of Pavagadh hill from three different elevation points.
- Lower altitude of Pavagadh hill harbors 105 species of spiders belonging to 72 genera and 26 families. Middle altitude of Pavagadh hill has 87 species of spiders from 60 genera and 26 families. Higher altitude of Pavagadh hill sustains 62 species of spiders belonging to 47 genera and 22 families.
- The maximum spider diversity was recorded from lower altitude followed by middle and higher altitude of hill.
- From the concrete structures like mosque, small temples and residences we could find more of the family Pholcidae e.g. *Crossopriza lyoni, Pholcus fragillimus, Artema atlanta*, and family Sparassidae egs. *Heteropoda bhaikakai*, *Heteropo davenatoria*.
- In the present study six different types of webs were observed from study site namely Orb web, Funnel web, Sheet web, Single line web, Tent web and Irregular web.

- Orb web and tent webs are constructed by Families Araneidae, Tetragnathidae, Linyphiidae, Uloboridae; Funnel webs made by families Agelenidae, Lycosidae and Eresidae, Sheet webs are built by families Linyphidae, Filistatidae, Theridiidae and Pholcidae; Single line web was constructed by family Theridiidae, Uloboridae; Linyphiidae; Irregular webs were built by family Pholcidae and Theridiidae.
- Total 32 interesting records were reported from Champaner-Pavagadh Archaeological Park.
- Among the 32 species 2 genera and 8 species are first records from India
- 3 genera and 9 species are first records from Gujarat.
- 10 species are new to science from the Champaner-Pavagadh Archaeological Park.
- Active searching method is the best method for collection of Orb-web spiders and Pitfall method is the best collection method for ground spiders.
- Any spider taxonomist should have a fine neck for dissection. As species can only be identified by dissecting epigyne.

Spiders play an important role as biological indicators for monitoring biodiversity and their distribution in specific habitats which indicates the environmental conditions of the area.

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