

DIVERSITY AND DISTRIBUTION OF SPIDERS AT TWO DIFFERENT HABITATS OF JUNAGADH, GUJARAT, INDIA

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ABSTRACT : A preliminary study of spiders was carried out in July 2019 to February 2020 from two sites of Junagadh city; Bhakta Kavi Narsinh Mehta University Campus and Khalilpur Farm. As results of this study, a total of 63 species of spiders belonging to 44 genera spread over 15 families were recorded from two sites of Junagadh. The dominant family Araneidae had the highest number of species (16), followed by Salticidae (12), Lycosidae and Theridiidae (6), Thomisidae (5), Gnaphosidae (4), Tetragnathidae (3), Oxyopidae, Pholcidae and Sparassidae (2). The remaining five families had a single representative species. Season wise change in spider diversity was observed. The highest number of spiders seen during the winter and the lowest number were seen during the post monsoon. The highest number of spider species recorded during February and lowest were recorded during October and November. During this study, 47 species were recorded from Khalilpur Farm. While, 40 species were recorded from BKNM University campus. This is the first study of spider diversity at two selected sites in the Junagadh.

Key words : Spiders, diversity, distribution, arthropoda, arachnida, Junagadh.

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INTRODUCTION

Spiders are considered as one of the most studied taxonomical group of Arachnids. Spiders are sparklers of art and good architecture. They are the source of passion everyone due to their amazing transparent webs. Spiders play a vital role as biological agents. Spiders are considered as builders of ecosystem. Spider belongs to the order Araneae occupying the seventh position in the world on the basis of total species diversity (Sebastian and Peter, 2009). They are suitable biological indicators of ecosystem changes and habitat modifications due to their small body size, short generation time and high sensitivity to temperature and moisture changes (Jose *et al*, 2018). Spider diversity, distribution and feeding habits are suspected of playing a major role in the balance of nature (Whitcomb, 1974; Gertsch, 1979; Young *et al*, 1990).

45,557 spider species described (Uniyal *et al*, 2011) and are estimated to a number of 60,000-170,000 species (Coddington and Levi, 1991). In numbers, 1686 species of 438 genera belongs to 60 families are recorded from India (Keswani *et al*, 2012). Total 415 species, belonging to 169 genera and 40 families have been recorded from

Gujarat (Yadav *et al*, 2017).

With over 48,000 described species (World Spider Catalog 2020 Version 21.5 retrieved on 18/08/2020) and India is represented by 1830 species in 470 genera and 60 families (Caleb *et al*, 2019; World Spider Catalog 2020 Version 21.5 retrieved on 18/08/2020).

Majority of the studies covered the evolution (Coddington and Levi, 1991; Oxford and Gillespie, 1998; Hauber, 2002; Hoese *et al*, 2006; Vaclav, 2006) and biology of the spider (Ford, 1977; Foelix, 1996; Oxford and Gillespie, 1998). Few studied covered the web architecture of the spiders web (Lawania and Mathur, 2015). Some studies are also conducted on the diversity of spiders in groundnut crop fields in the village area of Saurashtra region (Trivedi, 2009), agro-ecosystem like irrigated rice ecosystem (Sebastian *et al*, 2005), coffee plantation (Kapoor, 2008) Soybean agro-ecosystem (Rypstra and Carter, 1995). Diversity of spider in India is well documented by several researchers (Tikader, 1980; Siliwal *et al*, 2005; Keswani *et al*, 2012). A preliminary checklist of spider in Gujarat is well documented by several researchers.

In recent years, the developmental activities result a change in the land use and land cover. This leads to large scale destruction and encroachment of the forest habitat (Bhattacharya *et al*, 2017). Due to urbanization spider population is declining day by day (Ramakrishnaiah *et al*, 2014).

MATERIALS AND METHODS

Junagadh has seventh largest population in the state of Gujarat. It is situated at the foot of the Mountain Girnar. (Fig. 1). Junagadh is situated at 355 km south west of state capital Gandhinagar. It is also known as “Sorath”. (Madan *et al*, 1990). Junagadh has a tropical wet and dry weather with three different seasons. In the present study the following seasons and the distribution of the month was considered as monsoon (July to September), post monsoon (October to November) and winter (December to February). As the work on spider diversity seems to be fragmented and incomplete, the present work on the survey for spiders at two different habitats namely agricultural field area Khalilpur farm and mixed vegetation area at BKNMU old campus, Junagadh, was undertaken.

Study site

Site 1 : Khalilpur farm area, Junagadh (Fig. 2 A).

Site 2 : Bhakta Kavi Narsinh Mehta University old campus, Junagadh (Fig. 2 B).

The study includes weekly and seasonal observation for the period of July 2019 to February 2020. Methods referenced from Coddington *et al* (1991) and Toti *et al* (2000) aerial hand collection, ground hand collection, household goods, vegetation beating, litter sampling and visual search methods were used in the research. Photographs were taken. Further, spiders were identified by identification key provided by Sebastian, Peter and Tikader. The data were analysed and indices such as



Fig. 1 : Map of Study Area – Junagadh (Source : https://en.m.wikipedia.org/Junagadh_district)



Fig. 2 : A) Site 1- Khalilpur farm area, Junagadh (Source of Image: Google) (21°53'7" N and 70° 44' 7" E).



Fig. 2 : B) Site 2- Bhakta Kavi Narsinh Mehta University old Campus, Junagadh (Source of Image: Google) (21°43'8" N and 70° 50' 3" E).

Community similarity (Sorenson's Coefficient; Jex *et al*, 1953) were used (Tables 2 and 3).

RESULTS AND DISCUSSION

This study reveals that the spider fauna of Junagadh is rich. During the present study, total 63 species of spiders were recorded. Total 63 species including small and large spiders belonging to 15 families have been recorded within the study area. All recorded species 16 (25.39%) species from the family of Araneidae were recorded, 12 (19.04%) species from the family of Salticidae were recorded, 6 (9.52%) species from the family of Lycosidae and Theridiidae were recorded, 5 (7.93%) species from the family of Thomisidae, 4 (6.34%) species from the family of Gnaphosidae were noted, 3 (4.76%) species from the family of Tetragnathidae were recorded, 2 (3.17%) species from the family of Oxyopidae, Pholcidae and Sparassidae were noted, 1 (1.58%) species from the

Table 1 : Check list of spiders found at study site 1 and 2.

Family	Species	Study site 1	Study site 2	Guild structure
Araneidae	1. <i>Araneus mitificus</i> (Simon,1886)	+	+	Orb weavers
	2. <i>Araneus</i> sp-1.	+	-	
	3. <i>Araneus</i> sp-2.	+	-	
	4. <i>Argiope anasuja</i> (Thorell,1887)	+	+	
	5. <i>Argiope</i> sp.	+	-	
	6. <i>Cryptophora citricola</i> (Forsskal, 1775)	+	+	
	7. <i>Cyclosa bifida</i> (Doleschall, 1859)	-	+	
	8. <i>Cyclosa confraga</i> (Thorell, 1892)	+	-	
	9. <i>Cyclosa</i> sp.	+	-	
	10. <i>Gasteracantha</i> sp.	+	-	
	11. <i>Larinia chloris</i> (Audoin, 1826)	+	-	
	12. <i>Neoscona nautica</i> (Koch,1875)	+	+	
	13. <i>Neoscona</i> sp.	+	+	
	14. <i>Neoscona theisi</i> (Walckenaer, 1841)	+	+	
	15. <i>Neoscona vigilans</i> (Blackwall,1865)	+	-	
	16. <i>Thelacantha brevispina</i> (Doleschall,1857)	-	+	
Clubionidae	17. <i>Clubiona drassodes</i> (Cambrige, 1874)	+	-	Foliage runners
Eutichuridae	18. <i>Cheiracanthium</i> sp.	+	+	Yellow sac spider
Gnaphosidae	19. <i>Drassodes</i> sp.	+	-	Ground runners
	20. <i>Drassodes parvidens</i> (Caporiacco, 1934)	-	+	
	21. <i>Elicia bicolor</i> (Banks, 1896)	-	+	
	22. <i>Zelotes</i> sp.	-	+	
Hersilidae	23. <i>Hersilia savignyi</i> (Lucas,1836)	+	-	Bark spider
Lycosidae	24. <i>Lycosa</i> sp.	+	+	Ground runners
	25. <i>Hippasa partita</i> (Cambridge, 1876)	-	+	
	26. <i>Lycosa phipsoni</i> (Pocock,1899)	-	+	
	27. <i>Lycosa tista</i> (Tikader,1970)	+	+	
	28. <i>Pardosa birmanica</i> (Simon,1884)	+	+	
29. <i>Pardosa</i> sp.	+	+		
Oecobiidae	30. <i>Oecobius putus</i> (Cambrige,1876)	+	+	Star legged spider
Oxyopidae	31. <i>Oxyopes javanus</i> (Thorell, 1887)	+	+	Stalkers
	32. <i>Oxyopes sunande</i> (Tikader, 1970)	+	-	
Pholcidae	33. <i>Crossopriza layoni</i> (Blackwall, 1867)	+	+	Zunk web spider
	34. <i>Pholcus phalangioides</i> (Fuesslin, 1775)	+	-	
Salticidae	35. <i>Aelurilus</i> sp.	-	+	Stalkers
	36. <i>Chrysilia</i> sp.	+	-	
	37. <i>Epeus indicus</i> (Proszynski, 1992)	-	+	
	38. <i>Hasarius adansoni</i> (Audouin,1826)	+	+	
	39. <i>Hyllus semicupreus</i> (Simon,1885)	-	+	
	40. <i>Menemerus bitivittatus</i> (Dufour, 1831)	+	+	
	41. <i>Myrmarachne</i> sp.	-	+	
	42. <i>Phintella vittata</i> (Koch, 1846)	-	+	
	43. <i>Phintella</i> sp.	-	+	
	44. <i>Plexippus paykulli</i> (Audouin, 1826)	+	+	
45. <i>Telamonia dimidiata</i> (Simon, 1899)	+	+		
46. <i>Thyene imperialis</i> (Rossi, 1846)	-	+		
Sparassidae	47. <i>Heteropoda venatoria</i> (Linnaeus,1767)	+	-	Wandering spider
	48. <i>Olios</i> sp.	+	+	
Tetragnathidae	49. <i>Guizygiella indica</i> (Tikader and Bal, 1980)	+	-	Orb weavers
	50. <i>Leucage decorata</i> (Blackwall, 1864)	+	+	
	51. <i>Leucage</i> sp.	-	+	
	52. <i>Indoxysticus minutus</i> (Tikader, 1960)	-	+	
	53. <i>Thomisus labefactus</i> (Wacknear, 1805)	+	+	

Table 1 continued...

Table 1 continued...

Thomisidae	54. <i>Thomisus lobosus</i> (Tikader, 1965)	+	-	Ambushers
	55. <i>Thomisus onustus</i> (Walckenaer, 1805)	+	-	
	56. <i>Thomisus</i> sp.	+	+	
Theridiidae	57. <i>Achaearanea mundula</i>	+	-	Space web builders
	58. <i>Parasteotoda mundula</i> (Koch, 1872)	+	+	
	59. <i>Parasteotoda</i> sp.	+	-	
	60. <i>Parasteotoda tepidariorum</i> (Koch, 1841)	+	-	
	61. <i>Steotoda</i> sp.	+	-	
62. <i>Theridione</i> sp.	+	+		
Uloboridae	63. <i>Uloborus plumpies</i> (Lucas, 1846)	+	-	Orb weavers

family of Clubionidae, Eutichuridae, Hersilidae, Oecobidae and Uloboridae were recorded (Table 4, Fig. 4). In this graph 6 families we have collectively shown as “others” (Fig. 6). These 6 families are Uloboridae, Clubionidae, Eutichuridae, Hersilidae, Gnaphosidae and Tetragnathidae. The highest recorded family was Araneidae. Season wise change was observed in spider diversity. During this study, highest numbers of species were recorded from farm than BKNMU.

At study site-1, a total of 232 individual of spiders, belonging to 15 families, 32 genera and 47 species, were recorded during the study period of eight months and a total 150 individual, belonging to 14 families and 32 genera and 40 species have been recorded from study site-2 during the research work (Table 1). Total 382 spiders were studied.

Sorenson’s coefficient (similarity index) is monsoon to post-monsoon (1.27), post-monsoon to winter (1.16) and monsoon to winter (1.21) from site 1 and 2 and Sorenson’s coefficient combine the both sites is monsoon (1.66) and post-monsoon and winter (1.85) (Tables 2 and 3).

The guild structure of spiders were studied. The maximum guild frequency was of the Orb weavers (31.34%) > Stalkers (22.22%) > Ground runners (15.87%) > Space web builder (9.52%) > Ambushers (7.93%) > Zunk web spider and Wandering spider (3.17%) > Foliage runner, Yellow sac spider, Bark spider and Star legged spider (1.58%) (Fig. 3).

The highest number of spiders were seen during the winter and lowest seen during the post monsoon. The highest number of spider species is recorded at the month of February, followed by January, whereas the lowest number is recorded during month of October and November, followed by September. In our study we found total 63 species (Fig. 5). we have collectively shown the following species as “others”. We have included a total of 51 species in the others. These species were having less than 10 individuals found in our observation. These “others” species are *Larinia chloris* (Audoin, 1826),

Thelacantha brevispina (Doleschall, 1857), *Thomisus lobosus* (Tikader, 1965), *Thomisus* sp., *Drassodes parvidens* (Capporiaco, 1934), *Drassodes* sp., *Eilica bicolor* (Banks, 1896), *Zelotes* sp., *Crossopriza layoni* (Blackwall, 1867), *Olios* sp., *Leucage decorata* (Blackwall, 1864), *Leucage* sp., *Pholcus phalangioides* (Fuesslin, 1775), *Cheiracanthium* sp., *Pardosa birmanica* (Simon, 1884), *Pardosa* sp., *Plexippus paykulli* (Audouin, 1826), *Indoxysticus minutus*

Table 2 : Sorenson’s coefficient of Site 1 and 2.

Seasons	Sorenson’s Coefficient	
	Site-1	Site-2
Monsoon - Post monsoon	1.29	1.25
Post monsoon - Winter	1.12	1.21
Monsoon - Winter	1.18	1.25

Table 3 : Sorenson’s Coefficient between of both site 1 and 2.

Seasons	Sorenson’s Coefficient
Monsoon	1.66
Post monsoon	1.85
Winter	1.85

Table 4 : Species distribution of spiders of different families at both sites.

No.	Family	Genera	Species	% Species
1.	Araneidae	8	16	25.39
2.	Clubionidae	1	1	1.58
3.	Eutichuridae	1	1	1.58
4.	Gnaphosidae	3	4	6.34
5.	Hersilidae	1	1	1.58
6.	Lycosidae	3	6	9.52
7.	Oecobidae	1	1	1.58
8.	Oxyopidae	2	2	3.17
9.	Pholcidae	2	2	3.17
10.	Salticidae	11	12	19.04
11.	Sparassidae	2	2	3.17
12.	Tetragnathidae	2	3	4.76
13.	Thomisidae	2	5	7.93
14.	Theridiidae	4	6	9.52
15.	Uloboridae	1	1	1.58
	Total	44	63	100

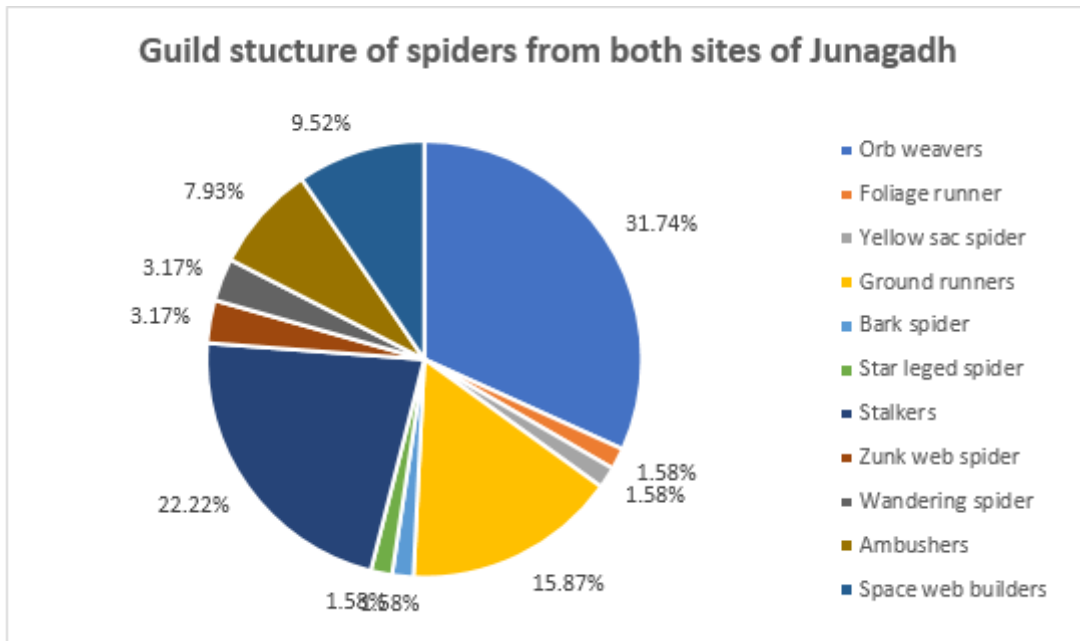


Fig. 3 : Guild structure of spiders from both sites of Junagadh.

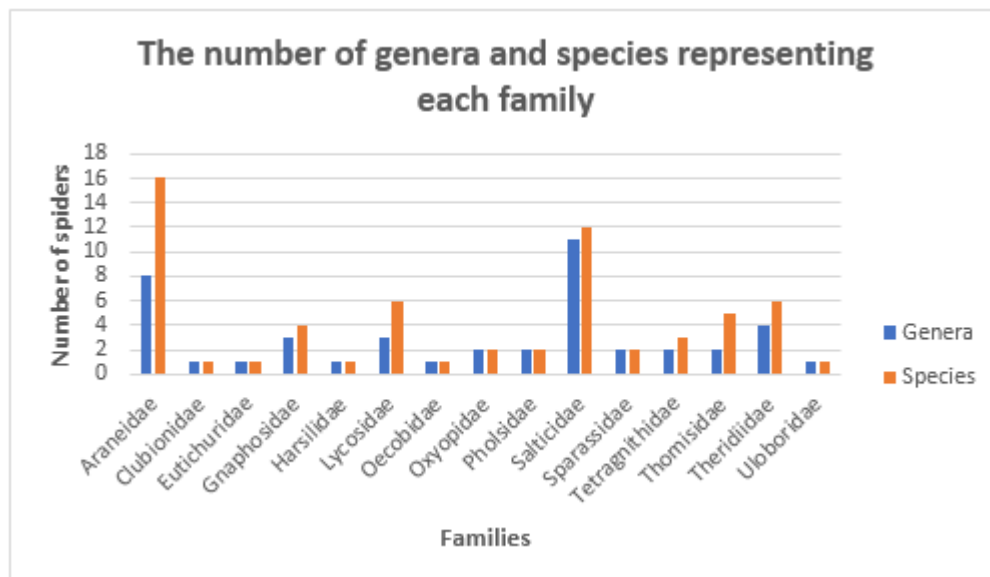


Fig. 4 : The number of genera and species representing each family.

(Tikader, 1960), *Thomisus onustus* (Walckenaer, 1805), *Clubiona drassodes* (Cambridge, 1874), *Hasarius adansonii* (Audouin, 1826), *Phintella vitata* (Koch, 1846), *Phintella* sp., *Uloborus plumpies* (Lucas, 1846), *Gasteracantha* sp., *Aelurilus* sp., *Oxyopes sunande* (Tikader, 1970), *Telamonia dimidata* (Simon, 1899), *Guizygiella indica* (Tikader and Bal, 1980), *Theridion* sp., *Thomisus labefactus* (Tikader, 1965), *Hersilia savignyi* (Lucas, 1836), *Epeus indicus* (Proszynski, 1992), *Hyllus semicupreus* (Simon, 1885), *Myrmarachne* sp., *Thyene imperialis* (Rossi, 1846), *Hippasa partita* (Cambridge, 1876), *Heteropoda venatoria* (Linnaeus, 1767), *Cyclosa bifida* (Doleschall, 1859), *Cyclosa confraga* (Thorell, 1892), *Argiope* sp., *Parasteotoda mundula*

(Koch, 1872), *Cyclosa* sp., *Achaearanea mundula*, *Parasteotoda* sp., *Steotoda* sp., *Neoscona vigilans* (Blackwall, 1865), *Parasteotoda tepidorium* (Koch, 1841), *Lycosa* sp., *Neoscona* sp., *Araneus* sp-2 (Table 5, Fig. 5).

If we compare our results with a few previous research findings, we found that, presence of spider species and their richness. Prajapati *et al* (2016) studied a total of 77 species of spiders under 20 families and 53 genera, Salticidae was recorded as the most dominant family in terms of number of species family, represented by 18 species followed by Araneidae (12), Thomisidae (9), Lycosidae (6), Theridiidae (5), Sparassidae and

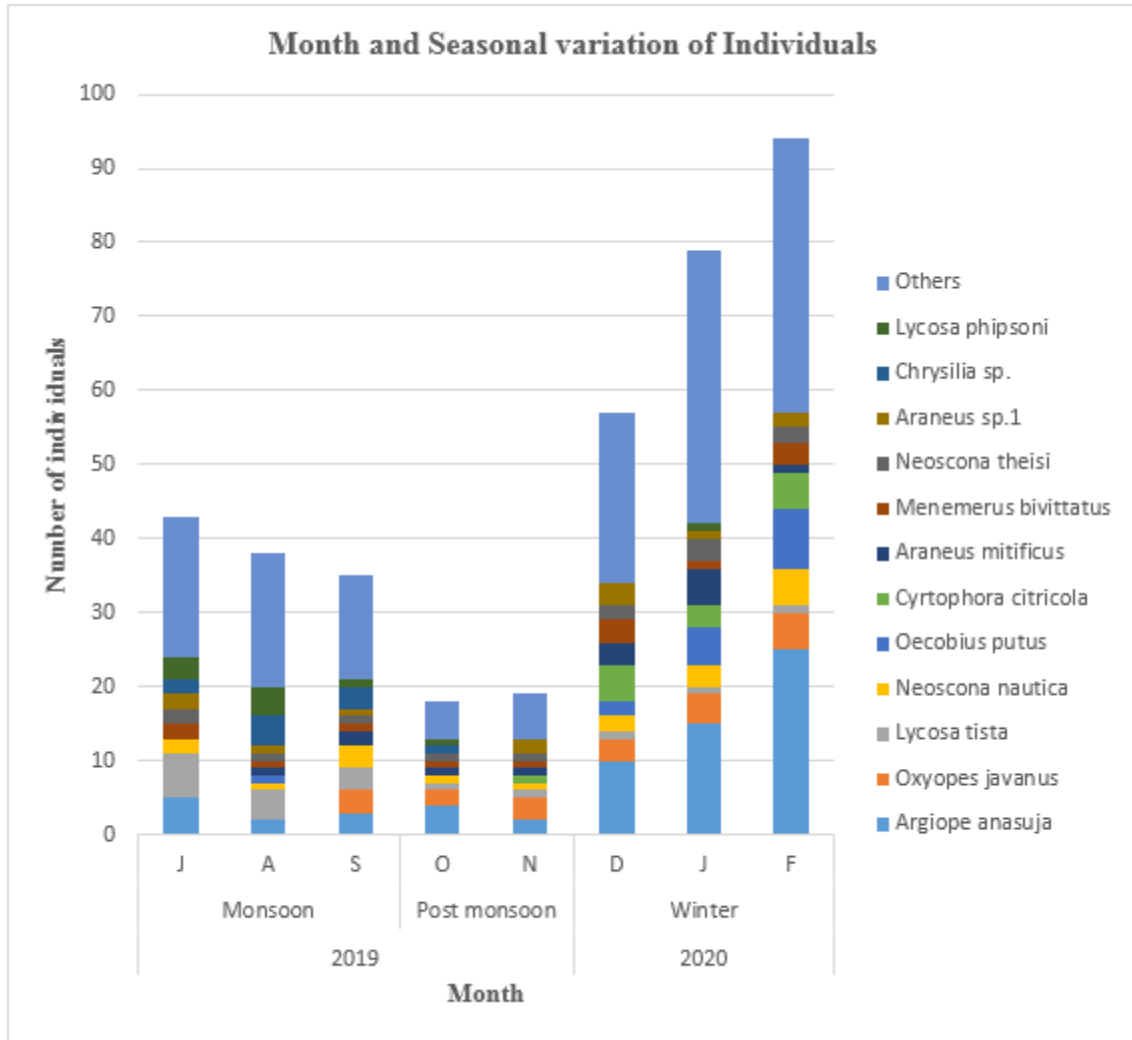


Fig. 5 : Month and Seasonal Variation of Individuals.

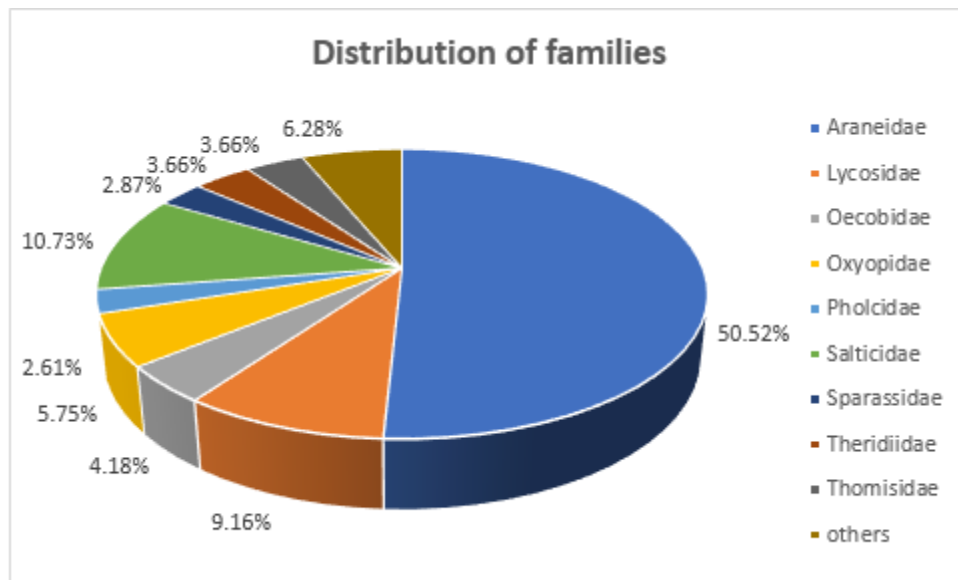


Fig. 6 : Distribution of Spider families combine both sites.

Oxyopidae (4), Uloboridae and Pholcidae (3), Hersilidae and Zodariidae (2) and Tetragnathidae, Gnaphosidae, Dictynidae, Corinnidae, Clubionidae, Eutichuridae,

Oonopidae, Oecobidae, Scytodidae (1). Shirbhate and Shirbhate (2017) studied spider diversity of Katepurna Sanctuary, Akola, India. They had studied only family

Table 5 : Seasonally and Monthly distribution of spiders individuals.

No.	Species	2019					2020			Total
		Monsoon			Post monsoon		Winter			
		J	A	S	O	N	D	J	F	
1.	<i>Araneus sp-1.</i>	2	1	1		2	3	1	2	12
2.	<i>Araneus mitificus</i> (Simon,1886)		1	2	1	1	3	5	1	14
3.	<i>Araneus sp-2.</i>	1		1	1		2		1	6
4.	<i>Argiope anasuja</i> (Thorell,1887)	5	2	3	4	2	10	15	25	66
5.	<i>Argiope sp.</i>	1	1		1		2	1		6
6.	<i>Cyclosa bifida</i> (Doleschall,1859)	1	4	4						9
7.	<i>Cyclosa confraga</i> (Thorell,1892)				1	1	2	4	1	9
8.	<i>Cyclosa sp.</i>	2	1	1						4
9.	<i>Cyrtophora citricola</i> (Forsskal,1775)					1	5	3	5	14
10.	<i>Gasteracantha sp.</i>						1	1		2
11.	<i>Larinia chloris</i> (Audoin,1826)							5	4	9
12.	<i>Neoscona nautica</i> (Koch,1875)	2	1	3	1	1	2	3	5	18
13.	<i>Neoscona theisi</i> (Walckenaer,1841)	2	1	1	1	1	2	3	2	13
14.	<i>Neoscona vigilans</i> (Blackwall,1865)						1			1
15.	<i>Neoscona sp.</i>		1					1		2
16.	<i>Thelacantha brevispina</i> (Doleschall, 1857)							3	5	8
17.	<i>Clubiona drassodes</i> (Cambrige,1874)	1	1	1						3
18.	<i>Cheiracanthium sp.</i>	1	1	1	1					4
19.	<i>Drassodes parvidens</i> (Capporiaco, 1934)			1						1
20.	<i>Drassodes sp.</i>		1							1
21.	<i>Eilica bicolor</i> (Banks, 1896)	2		1						3
22.	<i>Zelotes sp.</i>							1		1
23.	<i>Hersilia savignyi</i> (Lucas,1836)								1	1
24.	<i>Hippasa partita</i> (Cambridge, 1876)	1	1							2
25.	<i>Lycosa phipsoni</i> (Pocock,1899)	3	4	1	1			1		10
26.	<i>Lycosa tista</i> (Tikader,1970)	6	4	3	1	1	1	1	1	18
27.	<i>Lycosa sp.</i>	2								2
28.	<i>Pardosa birmanica</i> , (Simon,1884)	2	1							3
29.	<i>Pardosa sp.</i>			2						2
30.	<i>Oecobius putus</i> (Cambrige,1876)		1				2	5	8	16
31.	<i>Oxyopes javanus</i> (Thorell,1887)			3	2	3	3	4	5	20
32.	<i>Oxyopes sunande</i> (Tikader, 1970)		1						1	2
33.	<i>Crossopriza layoni</i> (Blackwall, 1867)					2	1	2	1	6
34.	<i>Pholcus phalangioides</i> (Fuesslin, 1775)	2	1	1						4
35.	<i>Aelurilus sp.</i>		1		1					2
36.	<i>Chrysilia sp.</i>	2	4	3	1					10
37.	<i>Epeus indicus</i> (Proszynski,1992)	1								1
38.	<i>Hasarius adansoni</i> (Audouin, 1826)		1	2						3
39.	<i>Hyllus semicupreus</i> (Simon,1885)	1								1
40.	<i>Menemerus bivittatus</i> (Dufour,1831)	2	1	1	1	1	3	1	3	13
41.	<i>Myrmarachne sp.</i>								1	1
42.	<i>Phintella vitata</i> (Koch,1846)						1	1		2
43.	<i>Phintella sp.</i>							1		1
44.	<i>Plexippus paykulli</i> (Audouin,1826)	1	1			1			1	4
45.	<i>Thyene imperialis</i> (Rossi,1846)							1		1
46.	<i>Telamonia dimidata</i> (Simon,1899)						1		1	2
47.	<i>Heteropoda venatoria</i> (Linnaeus,1767)							2	3	5
48.	<i>Olios sp.</i>	1				1	1	2	1	6
49.	<i>Guizygiella indica</i> (TikaderandBal,1980)								2	2

Table 5 continued...

Table 5 continued...

50.	<i>Leucage decorata</i> (Blackwall,1864)						2	1	2	5
51.	<i>Leucage sp.</i>						1			1
52.	<i>Achaearanea mundula</i>							1	1	2
53.	<i>Parasteotoda mundula</i> (Koch,1872)					1	2	1	2	6
54.	<i>Parasteotoda sp.</i>						1	1		2
55.	<i>Parasteotoda tepidorium</i> (Koch,1841)								1	1
56.	<i>Steotoda sp.</i>							1		1
57.	<i>Theridion sp.</i>						1	1		2
58.	<i>Indoxysticus minutus</i> (Tikader,1960)								1	1
59.	<i>Thomisus lobosus</i> (Tikader,1965)						2	2	2	6
60.	<i>Thomisus labefactus</i> (Tikader,1965)							2		2
61.	<i>Thomisus sp.</i>								2	2
62.	<i>Thomisus onustus</i> (Walckenaer,1805)						2		1	3
63.	<i>Uloborus plumpies</i> (Lucas,1846)						1		1	2
	Total	44	37	36	18	19	58	77	93	382

Araneidae. They studied 26 species of family Araneidae, belonging to 11 genera identified and recorded. They recorded that *Neoscona* was the numerically predominant genus having 9 species (34.61%), followed by *Cyclosa* (11.53%), *Larinia* (11.53%), *Cryptophora* (7.69%), *Eriovixia* (7.69%), *Poltys* (7.69%), *Araneus* (3.84%), *Argiope* (3.84%), *Chorizopes* (3.84%), *Gasteracantha* (3.84%) and *Zygiella* (3.84%).

Bhattacharya *et al* (2017) work was on the diversity of spiders at different habitats of Jaintia Hills of Meghalaya. Nearly 24 species of spiders belonging to 10 families in Jowai area of Meghalaya. Family Araneidae was represented by the highest number (5 species) of spider followed by Tetragnathidae and Thomisidae (3 species each), Nephilidae, Oxyopidae, Lycosidae and Theridiidae (2 species each) and least number of spiders was recorded from Hersilidae, Salticidae and Theraphosidae (1 species each).

In 2018 Halarnkar and Pai had studied species diversity, distribution and ecology of spiders at two different habitats. They had provided checklist of spiders from two different habitats namely Akhada, St. Estevam, Goa (Site-1) and other Tivrem-Orgao, Marcela, Goa (Site-2). Their investigation revealed the presence of 29 spider species belonging to 8 families and 19 genera at site-1 and 30 spider species belonging to 7 families, 18 genera at site-2.

CONCLUSION

The spider diversity of Junagadh city is comparatively rich. There was a difference in spider population according to the site, vegetation and season. Total 382 individuals were observed. Selected sites were visited 26 times. Seasonal variation in the diversity was observed. Season wise deviations were observed in spider

populations. The highest number of spiders seen during the winter and lowest number seen during the post monsoon. *Argiope anasuja* (Thorell, 1887) was found in highest number.

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