# SEASONAL ABUNDANCE AND DIVERSITY INDICES OF SPIDER'S WEB IN THE YEAR 2013 TO 2016 WITH SPECIAL REFERENCES OF WEB PATTERN AND ARCHITECTURE FROM DIFFERENT HABITATS OF EASTERN REGION OF RAJASTHAN, INDIA

## Krishna Kant Lawania* and Priyanka Mathur**

* Researcher, IIS University, Jaipur- 302020, Rajasthan, INDIA. E-mail: kklawania23@gmail.com
** Head department of Zoology, IIS University, Jaipur- 302020, Rajasthan, INDIA. E-mail: priyanka.1970@iisuniv.ac.in

ABSTRACT: Spiders attract special attention to the zoologist on account of their unique weaving capability of constructing webs with geometrical precision. Web weaving habit of spiders are unique because few of others insects like (silk worm) produce silk, yet the survival value of silk spinning or web weaving has never been discovered by any observers. According to their web building ability, generally the spiders are considered as weavers or non-weavers Present paper describes the web architecture and patterns of spiders with respect to their diversity and distribution in the habitat of Eastern Rajasthan. There are more than 30,000 documented species of spider in the world. These species can be broken in to two categories: web builders and ground dwellers. The type of web spider spins depends entirely on the spider's way of life. The pattern and architecture of webs varies family to family. During the study 6 types of web patterns Viz. Irregular web, Sheet webs, Funnel web, Orb web, Single-line web, Dome shaped horizontal webs were identified and analyzed between July 2012 to June 2015. These webs are thought to produce patterns that resemble patterns reflected by many flowers in U.V. light. Thus insect who are searching for their favorite type of flower see the decorated web in U.V. light and fly in to the trap. Spider web can take a variety of forms, but the most common type is the Orb web. The gradations of the web patterns can be written in the following order: Orb web > Sheet web > Irregular web > Funnel web > Single line snare web > Horizontal dome shape web. The orb web and Sheet web were very commonly observed during this study. The study focused on the spider's web behavior and their survival strategy, which will help in their conservation.

KEY WORDS: Spiders (Araneae), web architecture and web patterns, conservation

Animals in various taxa build some kinds of nest. Nests are built to protect the owner from predators, moderate harsh environmental conditions, trap food for consumption or attract females to mate. Spiders also make a nest its called web. Spiders are the most diverse and abundant invertebrate predators in terrestrial ecosystems (Wise, 1993; Sebastian, 2009). They regulate the terrestrial arthropod population (Anonymous, 2000). The global list of spider fauna is approximately 39,882 species belonging to 3676 genera and 108 families (Platnick, 2011). Tikader (1987) published the first comprehensive list of Indian spiders which included 1067 species belonging to 249 genera in 43 families. The parental care is the most interesting event among spiders. The eggs never lay singly, but are laid in one or more clusters and each cluster is protected by a covering of silk and the egg sac or cocoon. All spiders are carnivorous, spider mainly feed on large population of Insects and also feed on other spider. The spiders daily construct a new web with the help of energy help accumulated from the food they get. The

spiders specially orb weaving spiders make their webs at night time and usually take them down in the morning Blackledge et al. (2001, 2004). They eat the silk, leaving only the base line to rebuild on. Constructing the web uses a lot of the spider's energy does to the large amount of protein required, in the form of silk and after a time the silk will lose its stickiness and becomes inefficient at capturing prey. Eating their web is a way for the spider to recoup some of the energy used in spinning, the silk protein are thus recycled. The survey was conducted at Eastern Region of Rajasthan. Present survey is an attempt to revise and standardize spider fauna and their web weaving behavior and web patterns and architecture.

## MATERIAL AND METHODS

**Study area-** The present work has been carried out in forest and agriculture fields of Eastern region of Rajasthan (India). The Eastern region of Rajasthan (Map-1) covers mainly Bharatpur district and some micro habitat areas of Dholpur and Karoli district (27.2170°N 77.4895°E) in Rajasthan. It was earlier known as "Braj". This dense forest region has wide diversity of habitats ranging from marshes, grasslands, woodlands, scrublands. South-West monsoon brings rainfall during the month of June to September. The average monthly temperature is 4°C in December and 42°C in June. The humidity in winter season is as low as 42% in the month of February and as high as 89% in the month of August. Eastern Region of Rajasthan lies at the confluence of the Gambhir and Banganga rivers. The area lies between 27°2170 North Latitude and 77° 4895 East Longitude. It is a low lying area in the floodplains of river Banganga and Gambhir which are tributaries of river Yamuna covering an area of about 5099 sq. km. It is situated 180 km from Delhi, along the Delhi – Jaipur Highway, 50 km from Agra.

**Methodology-** Firstly the site identification is done, in this the site where the spiders and their webs are present are selected to do further study on their different web patterns.
**1. Site identification:** Spider build webs in shrubs, trees, along rock walls, storage rooms and corners. Many spiders live in retreat area off the web. Burrowing spiders may be found under rocks, logs in debris or old litter under plants and under sheets of wood or cardboard.
**2. Spider webs identification**: The different web patterns are then identified by taking their photographs and comparing them with photographs and reports on the spider's web pattern, which were done earlier.
**3. Study of Spider activities and designing web patterns:** Different activities of spiders are studied which includes foraging, egg laying and ecology of the spiders, simultaneously different web patterns are also studied by taking their pictures and comparing and analyzing them with the of previous work has been done on the same and different web patterns of spiders are prepared.
**4. Photography:** To know each web pattern, photograph were taken by using super –macro lens of Canon camera.

## RESULT AND DISCUSSION

The study was performed on 24 study sites of the said region. Spiders were collected and counted by most of the two quantitative methods viz- Transect method (with two transects per site and 50 m x 10 m transects,) and quadrate method (20 m x 10 m quadrates, with 5-5 quadrate per site and 10-10 quadrates

in 15th & 16th site. These transect and quadrates were treated as our basic sampling units. Transects and quadrates were placed randomly within stratified habitat types. Sampling was carried out between July 2013 – Dec.2016. Spiders were sampled along these transects and quadrates using six sampling techniques (semi-quantitative sampling and pitfall traps). The main purpose of this sampling design was to produce a relatively complete species list and associated abundance data for a representative example of each habitat type in the region, and of the region as a whole.

**Different web architectures of different spiders**

Spiders attract special attention to the zoologist on account of their unique weaving capability of constructing webs with geometrical precision. Web weaving habit of spiders are unique because few of others insects like (silk worm) produce silk, yet the survival value of silk spinning or web weaving has never been discovered by any observers. According to their web building 'ability, generally the spiders are considered as weavers or non-weavers. The weavers make the snares to trap insects for food viz. pholicidae family, while the non weavers hunt the prey by chasing viz. families' Lycosidae, Gnaphosidae, Salticidae, Oxyopidae. The spiders wait at the center or at the corner of web for capture the prey.

During the study 6 different web pattern and architectures were found in the study area. These are following types:

**(1) Irregular web (Space web):** The other name of this web is Space web. In these irregular webs, here threads are extending in all direction. Irregular web mostly built by the *Pholcus* spiders and some other spiders. These types of webs are mostly found on ceiling the roof and corner of wall. Families show the irregular type of web pattern formation like Theridiidae (*Tylorida ventralis),* Pholcidae (*Artema Atlanta, Crossopryza lyoni, Pholcus phalangiodes*).

**(2) Sheet web/ Tangle web:** Sheet web/ Tangle web: - A sheet web is flat with main lines running down the center. Sometimes it's called a triangular web. The spider shakes it when any insect lands on sheet web, causing the insect to struggle and get caught in the strands. This type of web pattern formation shows by some Families like Lyniphidae *and* Filistatidae (*Pritha* sp.).

Principal part of the web of a more or less closely woven sheet extended in a single plane and consisting of threads extending in all direction in that plane. These webs are found on two adjacent walls. Linyphiidae family shows the sheet type of web formation.

**(3) Funnel web:** A funnel web is built in the grassland and woodland areas. The spider hides in the small end and rushes out and grabs the insects as they come down the web. Spider (Funnel web weaver) is agroup of spiders that make funnel-shaped webs, which the use to trap insects. They are among the most abundant and conspicuous spiders in temperate grassland area. They are also known as grass spiders. Worldwide there are about 700 known species of funnel web spiders.

The principal part of a funnel web is sheet like in structure, but webs of this type different from sheet web in having a tube extending from one edge these found near water cooler.

Families like Agelenidae and Lyniphidae show funnel type of web pattern formation.

**(4) Orb webs:** An orb web is shaped like a circle. An orb-web the characteristics feature is that the center portion, the part laying within the supporting frame work, the web of Aranidae consist of a series of radiating lines an excellent illustration of orb web.

The

**Dominance of web-**
**Orb web > Sheet web > Irregular web > Funnel web > Single line snare web > Horizontal dome shape web**

In the present study the seasonal abundance of spider's web was studied. We studied web pattern and architecture of 9 families in the study area. During the study six types of web pattern formation are identified and analyzed by comparing with the studies and reports related to the same topic. Web formation by the spiders was also been studied during this study. The dominance of Web pattern was this manner- Orb web > Sheet web > Irregular web > Funnel web > Single line snare web > Horizontal dome shape web. The orb web and Sheet web were very commonly observed during this study.

These results indicated that web's diversity in Eastern Region of Rajasthan is mostly dependant on the presence of food and paste species in the said area. Due to presence of ample food and paste diversity the Monsoon season represented high diversity of spider's web in this region. In the present investigation, the important observation is hunters or and ground dweller spiders dominated the study area over the web builders irrespective of the said area. This could possibly be due to the agricultural practices used in different crop fields. During the crop season, workers work in the field and their movements disturb the webs. Therefore, only those web constructing spiders were reported, which could construct their webs in a limited space and secondly most of them are nocturnal. During evening, they construct the web, prey whole the night on the pests caught in the web and by dawn, they eat their webs (*Neoscona*). Among web builder, *Argiope* and *Cyclosa* dominated all the three seasons. Cyclosa is thus the most successful web builder as they require a small space to construct mostly the basal webs.

The webs built by the spiders are used mainly for three purposes: for capturing the prey, for egg laying and their development, and for defense.

Spider's web richness was estimated in each Season. Similarity of spider species among different seasons was examined using the diversity indices including, Simpson index, Shannon – weiner index and Margalef richness index. The diversity, richness, and evenness indices for spiders were calculated using the Biodiversity calculator (www. Alyoung.com/labs/biodiversity calculator_html).

Spider web diversity indices were calculated and are shown in table- 11. The dominance index (1-Simpson index) of spider's web calculated for the year 2013-14 is 0.7594 and the Shannon index as 2.323. The Shannon indices of webs calculated for 2014-15 and 2014-15 years were 2.195 and 2.28 respectively. Margalef richness index is the highest (0.6391) for spider web diversity in year 2015-16. The Margalef richness indices are in the order year 2015-16 (0.6391) > 2013-14 (0.6062) > 2014-15 (0.6038).

**Web spinning behaviour**

How to spider make web: In spiders spinnerets are present at the base of abdomen. These glands produce a thread like material for making a web. There are seven different types of glands. Generally a spider has three pairs of spinnerets, but the no. of web may vary with species from one to four pair. Each spinneret has its own special function. The orb weavers make their webs during night time and usually take them down in the morning times. They eat the silk thread, leaving only the base line to re-build on. The large amount of protein required at the time of constructing the web. After some time silk becomes inefficient at capturing prey and will lose its stickiness. Eating own web is a

process for the spider to regain some of the energy it's used in spinning. The silk proteins are thus 'recycled'.

The process of web making start by creating an initial base line where spider uses air to carry its sticky thread. The silk which is produced by the spinnerats, sticks to a surface area then the spider slowly and carefully walk over the thread and strengthen it with a second thread. The same process is repeated until the primary thread is strong enough to support the rest of the netting. After strengthening the primary thread, the spider will continue to make Y shaped netting. The first three radials of web are now constructed. More others radials are added making sure that the distance between each radial is short enough to cross.

Then spiral of non-sticky, evenly spaced, circular threads are helpful for the spider to easily move around its own web during construction. After this, beginning from the outside in, spider will methodically create the spiral and adhesive threads. It will use initial radiating lines as well as the non-sticky spirals as guide lines. The spaces between each spiral thread will be directly proportional to the distance from the tip of its back legs to its spinners. Spider uses its own body as a measuring or spacing device. While the sticky spirals threads are formed, the non-adhesive spirals are removed as they are not needed any more.

After completed its web, the spider will chew off the initial three centre spiral threads then wait with its head down, in the web for prey to come along. If the web and its thread are broken without any structural damage during the construction, the spider does not try to repair it as this would use up too much energy and it will probably be taken down in the morning or repaired the next night.

## CONCLUSION

The spider constitutes a very interesting group of primitive animal. Which are cosmopolitan in nature. Spiders attract special attention to the zoologist on account of their unique weaving capability of constructing webs with geometrical precision. They are best friends of mankind as they feed on insects, which are generally harmful to mankind. In the present study the seasonal abundance of spider's web was studied. We studied web pattern and architecture of 9 families in the study area. During the study six types of web pattern formation are identified and analyzed by comparing with the studies and reports related to the same topic. Web formation by the spiders was also been studied during this study. The gradations of the web patterns can be written in the following order: Orb web > Sheet web > Irregular web > Funnel web > Single line snare web > Horizontal dome shape web. The orb web and Sheet web were very commonly observed during this study. These results indicated that web's diversity in Eastern Region of Rajasthan is mostly dependant on the presence of food and paste species in the said area. Due to presence of ample food and paste diversity the Monsoon season represented high diversity of spider's web in this region. In the present investigation, the important observation is hunters or and ground dweller spiders dominated the study area over the web builders irrespective of the said area. This could possibly be due to the agricultural practices used in different crop fields. During the crop season, workers work in the field and their movements disturb the webs. Therefore, only those web constructing spiders were reported, which could construct their webs in a limited space and secondly most of them are nocturnal. During evening, they construct the web, prey whole the night on the pests caught in the web and by dawn, they eat their webs (*Neoscona*). Among web

builder, *Argiope* and *Cyclosa* dominated all the three seasons. Cyclosa is thus the most successful web builder as they require a small space to construct mostly the basal webs. The webs built by the spiders are used mainly for three purposes: for capturing the prey, for egg laying and their development, and for defense. It was concluded that a long-term study is needed to know more about spiders and their webs. This helps in their conservation.

## ACKNOWLEDGEMENTS

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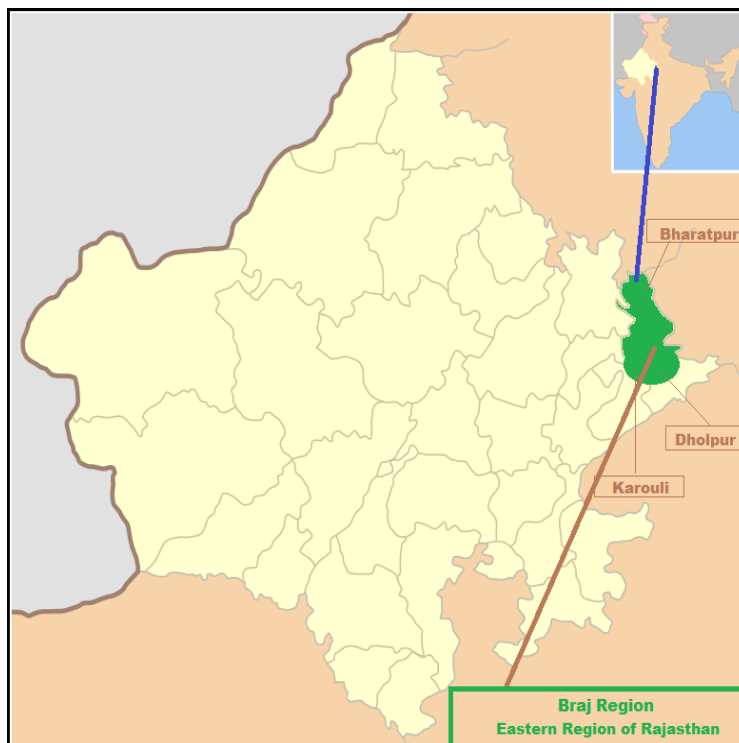


Map 1. Location Map of Eastern region of Rajasthan.
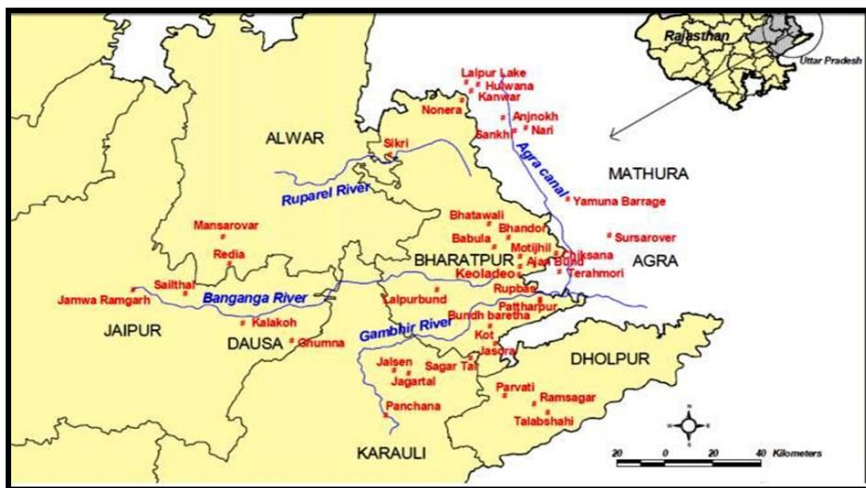
Map 2. High value biodiversity areas (HVBA) of Eastern region of Rajasthan.
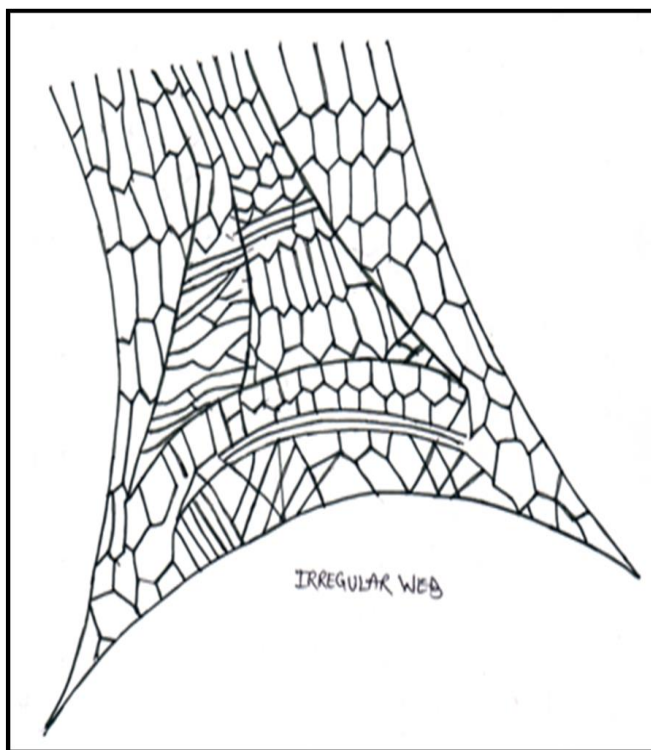


Figure 1. Irregular web of spiders of Theridiidae family.
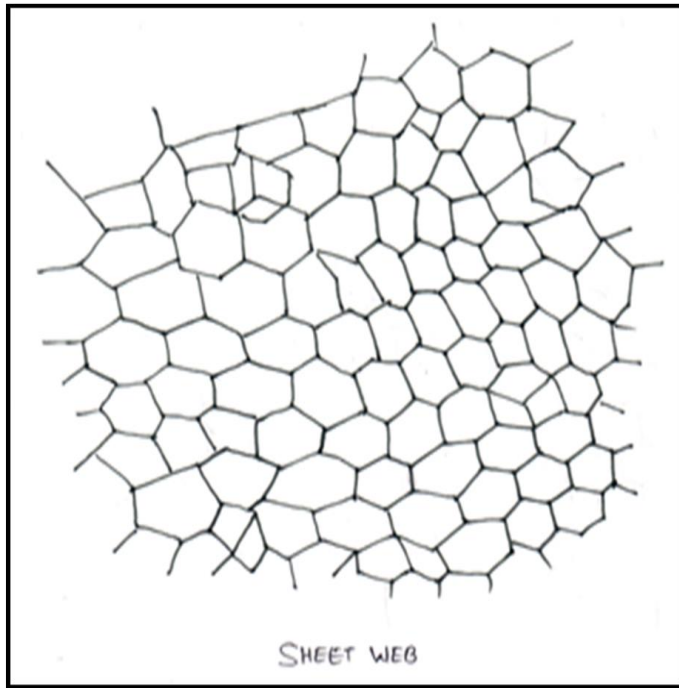
Figure 2. Sheet web of spiders of Lyniphidae family.
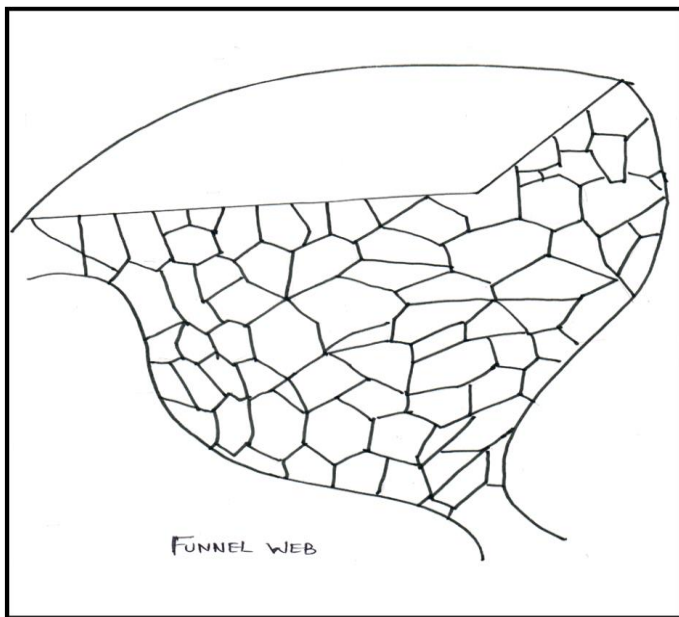


Figure 3. Funnel web of spiders of Lycosidae family.
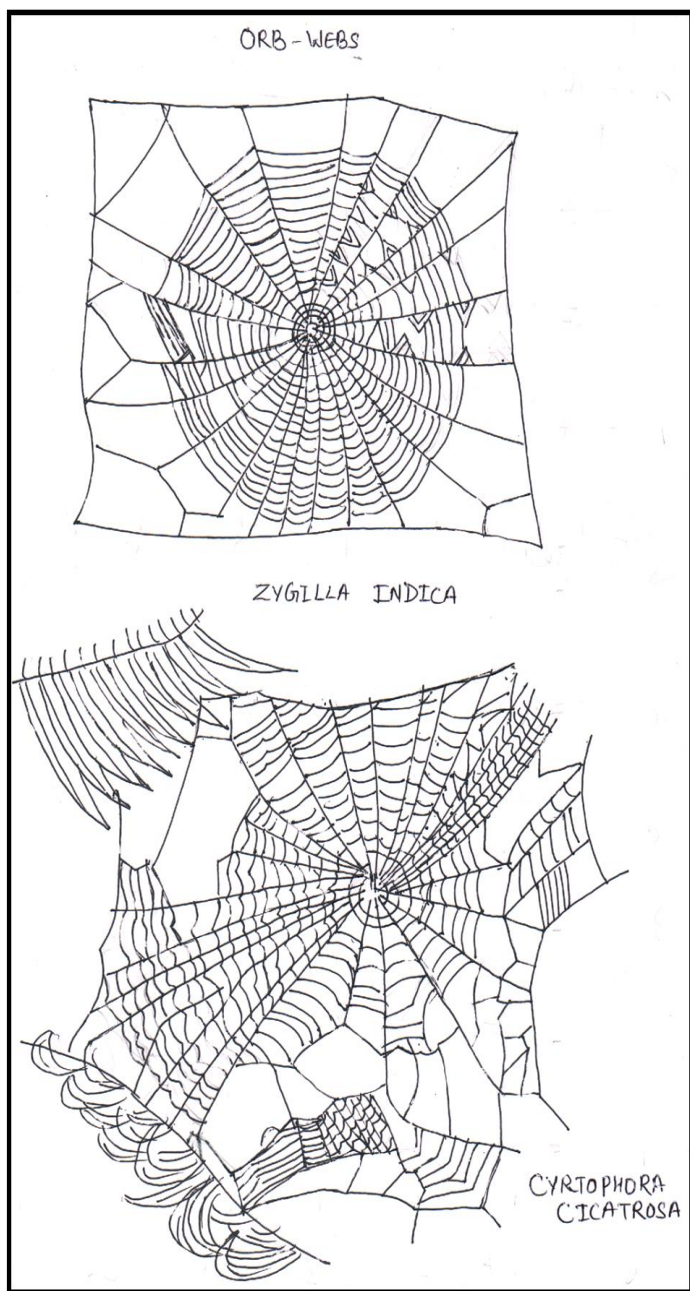
Figure 4. Orb web of spiders of Aranidae family.
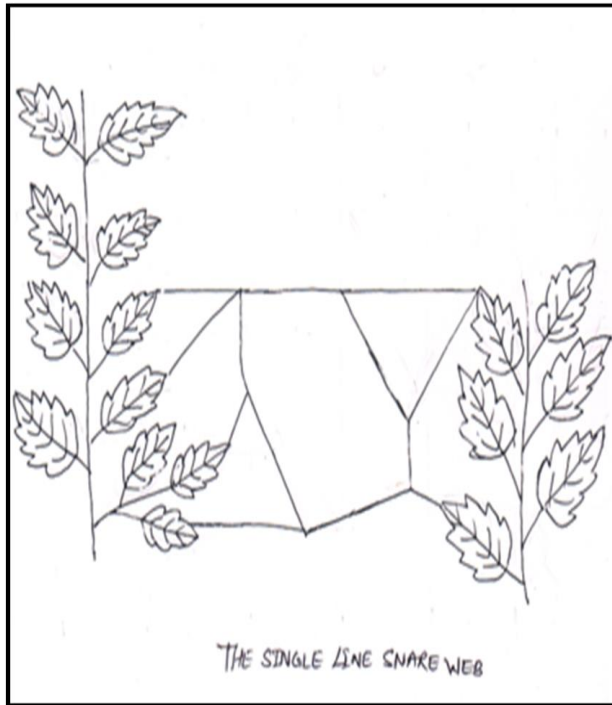
Figure 5. Single line snare web of spiders of Uloboridae family.
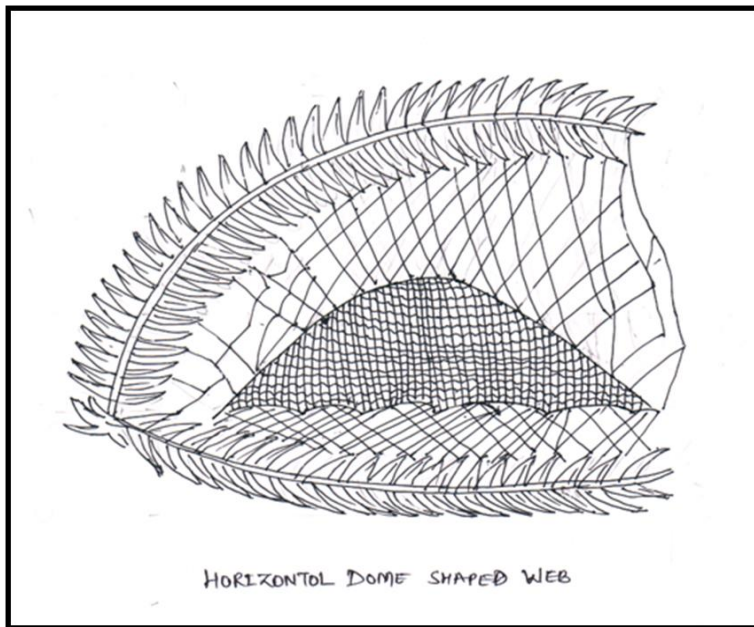


Figure 6. Horizontal dome shape web of *Cyrtophora* genus of family Aranidae.
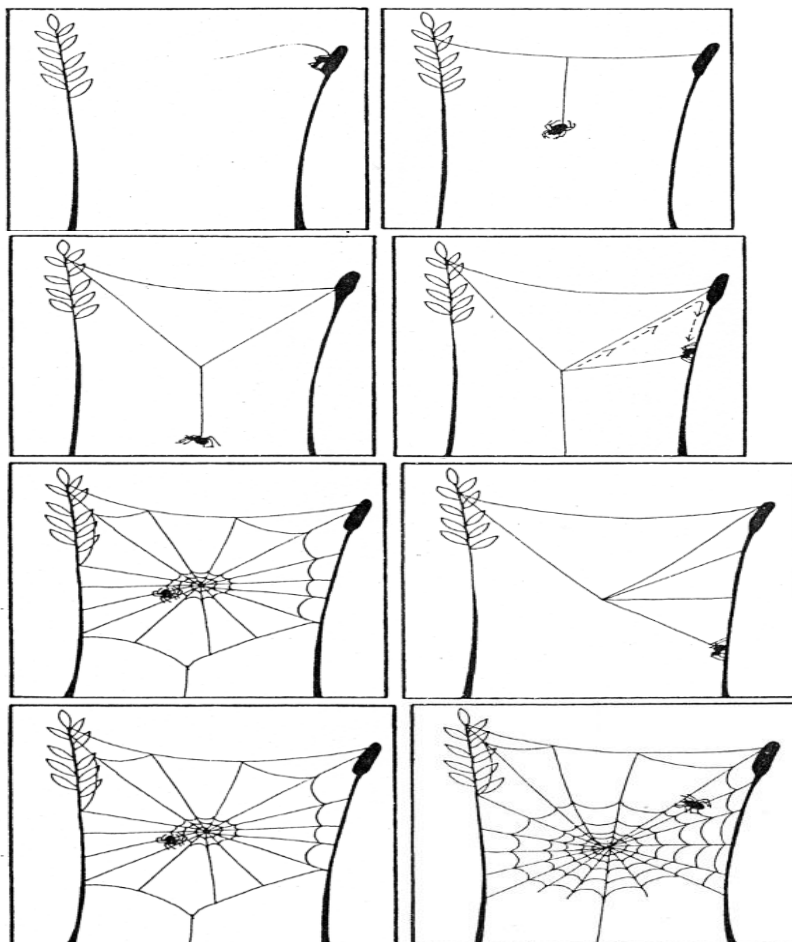
Figure 7. Process of spider web formation.

Table 1. Number and percentage of Irregular web of different families in different seasons of 2013-2016.

| Family | No. of Irregular/ Space webs in 2013-2016 | | | Percentage of Irregular/ Space webs in 2013-2016 | | |
|---|---|---|---|---|---|---|
| | Monsoon | Winter | Summer | Monsoon | Winter | Summer |
| Pholcidae | 433 | 356 | 196 | 77.19% | 70.92% | 53.56% |
| Theridiidae | 128 | 146 | 170 | 22.81% | 29.08% | 46.44% |
| Total | 561 | 502 | 366 | 100% | 100% | 100% |

Table 2. Number and percentage of Sheet web of different families in different seasons of 2013-2016.

| Family | No. of Sheet webs in 2013-2016 | | | Percentage of Sheet webs in 2013-2016 | | |
|---|---|---|---|---|---|---|
| | Monsoon | Winter | Summer | Monsoon | Winter | Summer |
| Filistatidae | 127 | 213 | 185 | 36.82% | 34.08% | 34.14% |
| Lyniphidae | 218 | 412 | 357 | 63.18% | 65.92% | 65.86% |
| Total | 345 | 625 | 542 | 100% | 100% | 100% |

Table 3. Number and percentage of Funnel webs of different families in different seasons of 2013-2016.

| Family | No. of Funnel webs in 2013-2016 | | | Percentage of Funnel webs in 2013-2016 | | |
|---|---|---|---|---|---|---|
| | Monsoon | Winter | Summer | Monsoon | Winter | Summer |
| Agelenidae | 68 | 201 | 118 | 29.06% | 42.50% | 33.53% |
| Lyniphidae | 166 | 272 | 234 | 70.94% | 57.50% | 66.47% |
| Total | 234 | 473 | 352 | 100% | 100% | 100% |

Table 4. Number and percentage of Orb webs of different families in different seasons of 2013-2016.

| Family | No. of Orb webs in 2013-2016 | | | Percentage of Orb webs in 2013-2016 | | |
|---|---|---|---|---|---|---|
| | Monsoon | Winter | Summer | Monsoon | Winter | Summer |
| Aranidae | 639 | 875 | 754 | 47.26% | 46.77% | 59.23% |
| Nephilidae | 112 | 170 | 137 | 8.29% | 9.09% | 10.77% |
| Tetragnathidae | 392 | 503 | 118 | 29.00% | 26.88% | 9.27% |
| Uloboridae | 209 | 323 | 264 | 15.45% | 17.26% | 20.73% |
| Total | 1352 | 1871 | 1273 | 100% | 100% | 100% |

Table 5. Number and percentage of Single line- snare webs of different families in different seasons of 2013-2016.

| Family | No. of The single - line snare web in 2013-2016 | | | Percentage of The single - line snare web in 2013-2016 | | |
|---|---|---|---|---|---|---|
| | Monsoon | Winter | Summer | Monsoon | Winter | Summer |
| Theridiidae | 69 | 156 | 103 | 37.10% | 42.74% | 40.56% |
| Uloboridae | 117 | 209 | 151 | 62.90% | 57.26% | 59.44% |
| Total | 186 | 365 | 254 | 100% | 100% | 100% |

Table 6. Number and percentage of Horizontal dome shaped webs of different families in different seasons of 2013-2016.

| Family | No. of Horizontal dome shaped webs in 2013-2016 | | | Percentage of Horizontal dome shaped webs in 2013-2016 | | |
|---|---|---|---|---|---|---|
| | Monsoon | Winter | Summer | Monsoon | Winter | Summer |
| Aranidae | 142 | 194 | 171 | 57.26% | 47.09% | 56.44% |
| Lyniphidae | 106 | 218 | 132 | 42.74% | 52.91% | 43.56% |
| Total | 248 | 412 | 303 | 100% | 100% | 100% |

Table 7. Month wise abundance of spiders web (*Randomly search method, Quadrate method, line-transect method and other methods were used for searching and collection*) in the year 2013- 2014 from different habitats in Eastern Region of Rajasthan.

| Types of webs | Families | Month wise abundance of webs in the year of 2013-14 in Eastern Region of Rajasthan | | | | | | | | | | | | Sp. wise total Count of web | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | JL | A | S | O | N | D | JN | F | MA | A | MY | JU | | |
| | | Monsoon | | | | Winter | | | | Summer | | | | | |
| Irregular | Pholcidae | 44 | 52 | 18 | 30 | 40 | 59 | 32 | 29 | 17 | 16 | 21 | 21 | 379 | 536 |
| Web | Therididae | 14 | 21 | 9 | 10 | 11 | 9 | 8 | 14 | 16 | 9 | 19 | 17 | 157 | |
| Sheet web | Filistatidae | 13 | 14 | 9 | 13 | 19 | 12 | 18 | 22 | 26 | 14 | 11 | 27 | 198 | 627 |
| | Linyphidae | 28 | 23 | 14 | 17 | 42 | 61 | 33 | 32 | 49 | 53 | 34 | 43 | 429 | |
| Funnel | Agelenidae | 11 | 4 | 6 | 6 | 19 | 11 | 20 | 11 | 15 | 11 | 19 | 17 | 150 | 437 |
| Web | Linyphidae | 19 | 17 | 19 | 16 | 38 | 31 | 28 | 30 | 23 | 21 | 28 | 17 | 287 | |
| Orb web | Aranidae | 54 | 75 | 38 | 52 | 83 | 71 | 68 | 59 | 68 | 64 | 85 | 36 | 753 | 1557 |
| | Nephilidae | 6 | 4 | 3 | 6 | 11 | 7 | 8 | 13 | 21 | 16 | 14 | 6 | 115 | |
| | Tetragnathidae | 56 | 16 | 34 | 32 | 50 | 53 | 48 | 52 | 14 | 13 | 10 | 19 | 397 | |
| | Uloboridae | 22 | 18 | 20 | 23 | 36 | 26 | 14 | 36 | 24 | 25 | 28 | 20 | 292 | |
| Single-line | Aranidae | 3 | 6 | 4 | 6 | 20 | 19 | 12 | 27 | 7 | 9 | 10 | 3 | 126 | 308 |
| Web | Linyphidae | 14 | 8 | 17 | 19 | 17 | 17 | 18 | 17 | 13 | 16 | 14 | 12 | 182 | |
| Horizontal Dome- | Theridiidae | 18 | 13 | 9 | 13 | 17 | 16 | 17 | 18 | 19 | 24 | 16 | 14 | 194 | 357 |
| shape Web | Uloboridae | 11 | 9 | 7 | 4 | 27 | 20 | 12 | 24 | 13 | 16 | 9 | 11 | 163 | |

Table 8. Month wise abundance of spiders web (*Randomly search method, Quadrate method, line-transect method and other methods were used for searching and collection*) in the year 2014- 2015 from different habitats in Eastern Region of Rajasthan.

| Types of webs | Families | Month wise abundance of webs in the year of 2014-15 in Eastern Region of Rajasthan | | | | | | | | | | | | Sp. wise total Count of web | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | JL | A | S | O | N | D | JN | F | MA | A | MY | JU | | |
| | | Monsoon | | | | Winter | | | | Summer | | | | | |
| Irregular | Pholcidae | 30 | 19 | 28 | 37 | 30 | 36 | 19 | 33 | 28 | 33 | 11 | 18 | 322 | 485 |
| Web | Theridiidae | 11 | 19 | 7 | 6 | 13 | 9 | 8 | 20 | 22 | 17 | 14 | 17 | 163 | |
| Sheet web | Filistatidae | 10 | 8 | 13 | 11 | 22 | 19 | 22 | 25 | 23 | 18 | 19 | 21 | 211 | 477 |
| | Linyphidae | 22 | 19 | 18 | 20 | 17 | 10 | 14 | 27 | 29 | 21 | 39 | 30 | 266 | |
| Funnel | Agelenidae | 7 | 3 | 4 | 8 | 13 | 16 | 9 | 17 | 10 | 8 | 13 | 8 | 116 | 371 |
| Web | Linyphidae | 14 | 18 | 12 | 11 | 27 | 22 | 28 | 13 | 29 | 30 | 32 | 19 | 255 | |
| Orb web | Aranidae | 73 | 83 | 44 | 95 | 75 | 75 | 102 | 51 | 109 | 93 | 73 | 123 | 996 | 1899 |
| | Nephilidae | 19 | 14 | 16 | 7 | 16 | 19 | 14 | 9 | 10 | 25 | 14 | 16 | 179 | |
| | Tetragnathidae | 33 | 39 | 54 | 42 | 59 | 25 | 52 | 45 | 11 | 6 | 13 | 9 | 388 | |
| | Uloboridae | 18 | 23 | 20 | 15 | 31 | 18 | 28 | 65 | 34 | 30 | 14 | 40 | 336 | |
| Single-line | Aranidae | 7 | 7 | 11 | 4 | 13 | 14 | 14 | 11 | 14 | 16 | 12 | 14 | 137 | 328 |
| Web | Linyphidae | 13 | 7 | 11 | 8 | 23 | 20 | 17 | 22 | 19 | 17 | 9 | 25 | 191 | |
| Horizontal | Therididae | 16 | 14 | 21 | 7 | 23 | 19 | 16 | 20 | 16 | 31 | 9 | 11 | 203 | 385 |
| Dome-shape web | Uloboridae | 9 | 10 | 11 | 9 | 20 | 23 | 17 | 19 | 16 | 11 | 18 | 19 | 182 | |

Table-9- Month wise abundance of spiders web (*Randomly search method, Quadrate method, line-transect method and other methods were used for searching and collection*) in the year 2015- 2016 from different habitats in Eastern Region of Rajasthan.
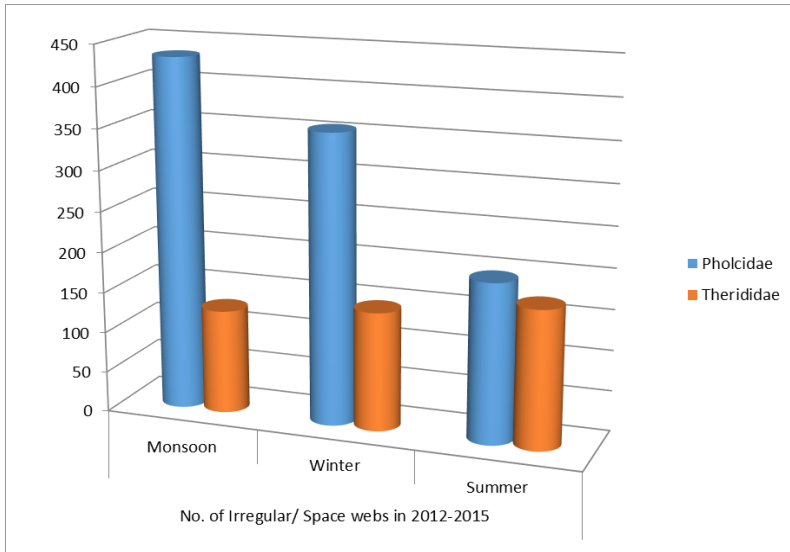
| Types of webs | Families | Month wise abundance of webs in the year of 2015-16 in Eastern Region of Rajasthan | | | | | | | | | | Sp. wise total Count of web | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | JL | A | S | O | N | D | JN | F | MA | A | | |
| | | Monsoon | | | | Winter | | | | Summer | | | |
| Irregular web | Pholcidae | 36 | 40 | 16 | 52 | 19 | 23 | 8 | 28 | 16 | 15 | 253 | 377 |
| | Theridiidae | 8 | 5 | 11 | 7 | 11 | 14 | 19 | 10 | 16 | 23 | 124 | |
| Sheet web | Filistatidae | 18 | 14 | 11 | 15 | 19 | 15 | 13 | 7 | 19 | 7 | 138 | 440 |
| | Linyphidae | 19 | 20 | 11 | 17 | 44 | 36 | 54 | 42 | 40 | 19 | 302 | |
| Funnel web | Agelenidae | 3 | 4 | 6 | 6 | 23 | 24 | 17 | 21 | 11 | 5 | 120 | 250 |
| | Linyphidae | 12 | 8 | 10 | 10 | 13 | 19 | 7 | 16 | 12 | 23 | 130 | |
| Orb web | Aranidae | 37 | 33 | 25 | 30 | 78 | 82 | 72 | 38 | 50 | 53 | 498 | 1046 |
| | Nephilidae | 13 | 9 | 9 | 6 | 18 | 16 | 14 | 25 | 9 | 6 | 125 | |
| | Tetragnathidae | 27 | 23 | 12 | 24 | 36 | 30 | 27 | 26 | 13 | 10 | 228 | |
| | Uloboridae | 19 | 17 | 13 | 12 | 24 | 21 | 18 | 22 | 25 | 24 | 195 | |
| Single-line web | Aranidae | 6 | 8 | 5 | 2 | 6 | 7 | 9 | 4 | 10 | 9 | 66 | 170 |
| | Linyphidae | 6 | 5 | 4 | 5 | 16 | 14 | 9 | 19 | 15 | 11 | 104 | |
| Horizontal Dome-shape web | Theridiidae | 8 | 6 | 4 | 13 | 12 | 16 | 13 | 7 | 19 | 12 | 110 | 216 |
| | Uloboridae | 11 | 8 | 7 | 5 | 14 | 16 | 14 | 12 | 10 | 9 | 106 | |

Table 10. Total web counts of webs in spiders families.

| Family | Irregular web | | | Sheet web | | | Funnel web | | | Orb web | | | Single-line web | | | Horizontal dome shaped web | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | W | S | M | W | S | M | W | S | M | W | S | M | W | S | M | W | S |
| 1. Agelenidae | | | | | | | 68 | 201 | 118 | | | | | | | | | |
| 2. Aranidae | | | | | | | | | | 639 | 875 | 754 | | | | 142 | 194 | 171 |
| 3. Filistatidae | | | | 127 | 213 | 185 | | | | | | | | | | | | |
| 4. Linyphidae | | | | 218 | 412 | 357 | 166 | 272 | 234 | | | | | | | 106 | 218 | 132 |
| 5. Nephilidae | | | | | | | | | | 112 | 170 | 137 | | | | | | |
| 6. Tetragnathidae | | | | | | | | | | 392 | 503 | 118 | | | | | | |
| 7. Pholcidae | 433 | 356 | 196 | | | | | | | | | | | | | | | |
| 8. Theridiidae | 128 | 146 | 170 | | | | | | | | | | 69 | 156 | 103 | | | |
| 9. Uloboridae | | | | | | | | | | 209 | 323 | 264 | 117 | 209 | 151 | | | |
| Season wise total count of web | 561 | 502 | 366 | 345 | 625 | 542 | 234 | 473 | 352 | 1352 | 1871 | 1273 | 186 | 365 | 254 | 248 | 412 | 303 |
| Total | | 1429 | | | 1512 | | | 1059 | | | 4496 | | | 805 | | | 963 | |

Table 11. Diversity indices of spider webs in Eastern Region of Rajasthan.

| Diversity Indices | Formula for calculation | Diversity indices of webs in Eastern Region of Rajasthan | | |
|---|---|---|---|---|
| | | Year 2012-13 | Year 2013-14 | Year 2014-15 |
| **Alpha diversity of webs** | | | | |
| Total no. of Webs | - | 3822 | 3945 | 2499 |
| Total types of Web | - | 6 | 6 | 6 |
| Average population size | - | 637 | 657.5 | 416.5 |
| Simpson Index | $\dfrac{\sum_i n_i(n_i - 1)}{N(N-1)}$ | 0.2406 | 0.2866 | 0.2508 |
| Simpson Index Approximation | $\dfrac{\sum_i n_i^2}{N^2}$ | 0.2408 | 0.2867 | 0.2511 |
| Reciprocal Simpson Index | $\dfrac{1}{\left(\frac{\sum_i n_i^2}{N^2}\right)}$ | 4.156 | 3.49 | 3.988 |
| Alternate Reciprocal Simpson Index | $\dfrac{1}{\left(\frac{\sum_i n_i(n_i-1)}{N(N-1)}\right)}$ | 4.152 | 3.488 | 3.983 |
| Dominance index | $1-\left(\dfrac{\sum_i n_i(n_i - 1)}{N(N-1)}\right)$ | 0.7594 | 0.7134 | 0.7492 |
| Dominance index Approximation | $1-\left(\dfrac{\sum_i n_i^2}{N^2}\right)$ | 0.7592 | 0.7133 | 0.7489 |
| Shannon Index | $-\sum_i\left(\dfrac{n_i}{N}\cdot \log_2\left(\dfrac{n_i}{N}\right)\right)$ | 2.323 | 2.195 | 2.28 |
| Shannon Index | $-\sum_i\left(\dfrac{n_i}{N}\cdot \ln\left(\dfrac{n_i}{N}\right)\right)$ | 1.61 | 1.521 | 1.58 |
| Shannon Index | $\sum_i\left(\dfrac{n_i}{N}\cdot \log_{10}\left(\dfrac{n_i}{N}\right)\right)$ | -0.6993 | -0.6607 | -0.6864 |
| Berger-Parker Dominance | $\dfrac{n_{max}}{N}$ | 0.4074 | 0.4814 | 0.4186 |
| Inverted Berger-Parker Dominance Index | $\dfrac{N}{n_{max}}$ | 2.455 | 2.077 | 2.389 |
| Margalef Richness Index | $\dfrac{S-1}{\ln N}$ | 0.6062 | 0.6038 | 0.6391 |
| Menhinick Index | $\dfrac{S}{\sqrt{\sum_i n_i}}$ | 0.09705 | 0.09553 | 0.12 |
| Renyi Entropy/ Hill Numbers (r=0,1,2,∞) | $\dfrac{1}{1-r}\cdot \ln\left(\sum_i p_i^r\right)$ | 6, 5.005, 4.152, ≈∞ | 6, 4.58, 3.488, ≈∞ | 6, 4.859, 3.983, ≈∞ |
| In ( ) of Hill Numbers (0,1,2,∞) | - | 1.792, 1.61, 1.424, ≈ - ∞ | 1.792, 1.522, 1.249, ≈ 0.7319 | 1.792, 1.581, 1.382, ≈ - ∞ |
| Buzas and Gibson's Index | $\dfrac{e^{-\sum_i\left(\frac{n_i}{N}\cdot\ln\left(\frac{n_i}{N}\right)\right)}}{S}$ | 0.834 | 0.763 | 0.8095 |
| Gini Coefficient | - | 2.277 | 2.125 | 2.191 |
| Equitability Index | $\dfrac{-\sum_i\left(\frac{n_i}{N}\cdot \ln\left(\frac{n_i}{N}\right)\right)}{\ln N}$ | 0.8987 | 0.849 | 0.8821 |
| **Beta diversity of webs** | | | | |
| Absolute Beta Value | $((S_0\text{-c})\text{-}(S_1\text{-c})...)$ | 5 | 5 | 5 |
| Whittaker's Index | (S/alpha) | 1 | 1 | 1 |
| Alternate Whittaker's Index | Index (S/alpha-1) | 0 | 0 | 0 |
| Sorensen's Similarity Index | - | 1 | 1 | 1 |
| Sorensen's Similarity Index (%) | - | 100% | 100% | 100% |
| Jaccard Index | - | -1 | -1 | -1 |
| Jaccard Index (%) | - | -100% | -100% | -100% |
| Routledge beta-R Index | - | 2 | 2 | 2 |
| Mountford Index | - | -0.5 | -0.5 | -0.5 |
| Mountford Index (%) | - | -50% | -50% | -50% |
| Bray Curtis Dissimilarity | - | 0 | 0 | 0 |
| Number of Common web | - | 6 | 6 | 6 |
| **Gamma diversity of webs** | | | | |
| Absolute gamma | $(S_0+S_1...\text{-c})$ | 0 | 0 | 0 |

Graph 1. Number and percentage of Irregular web of different families in different seasons of 2013-2016.
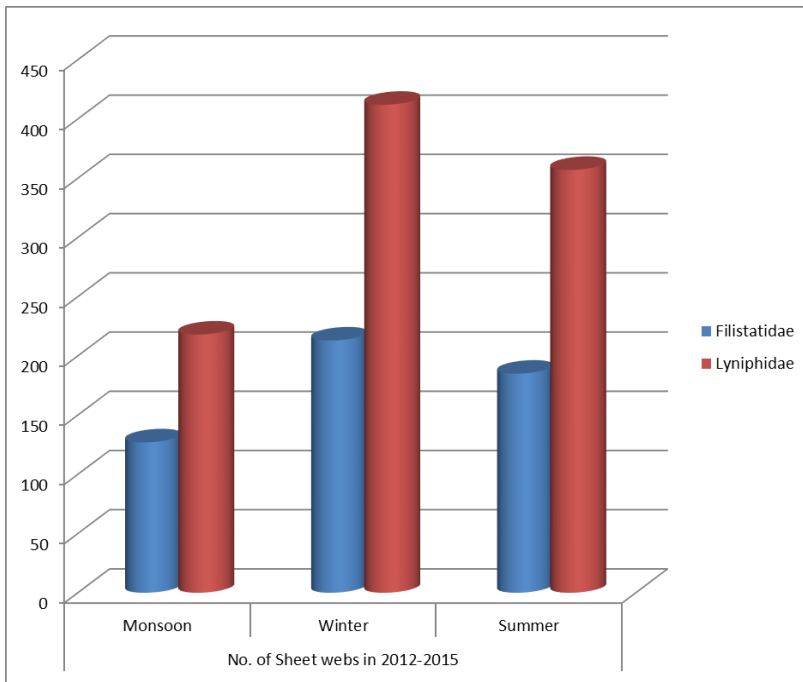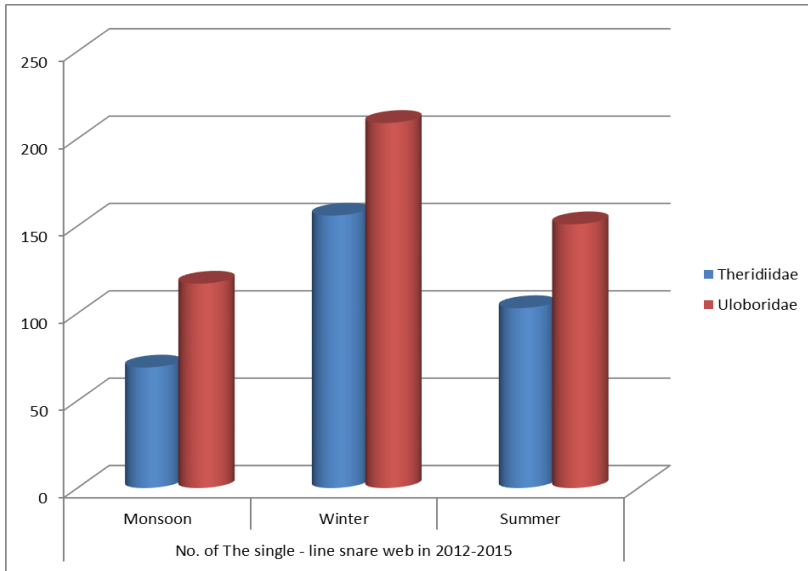


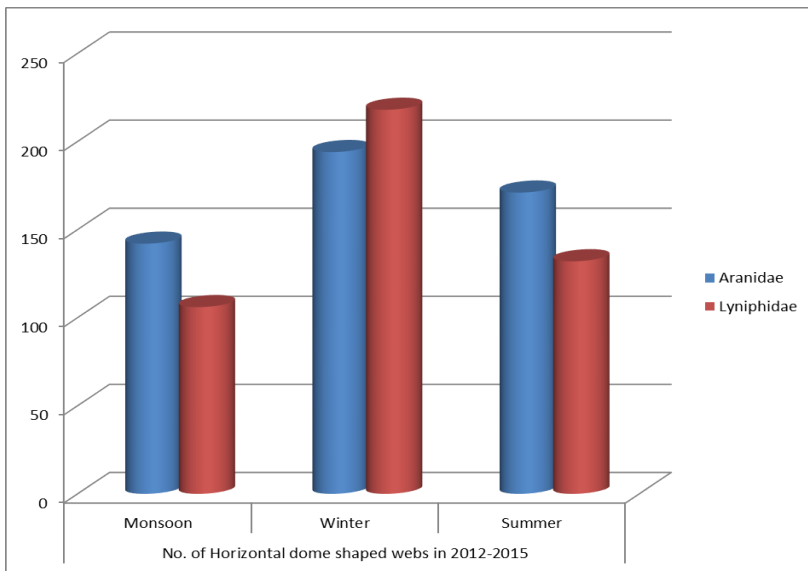Graph 2. Number and percentage of Sheet web of different families in different seasons of 2013-2016.
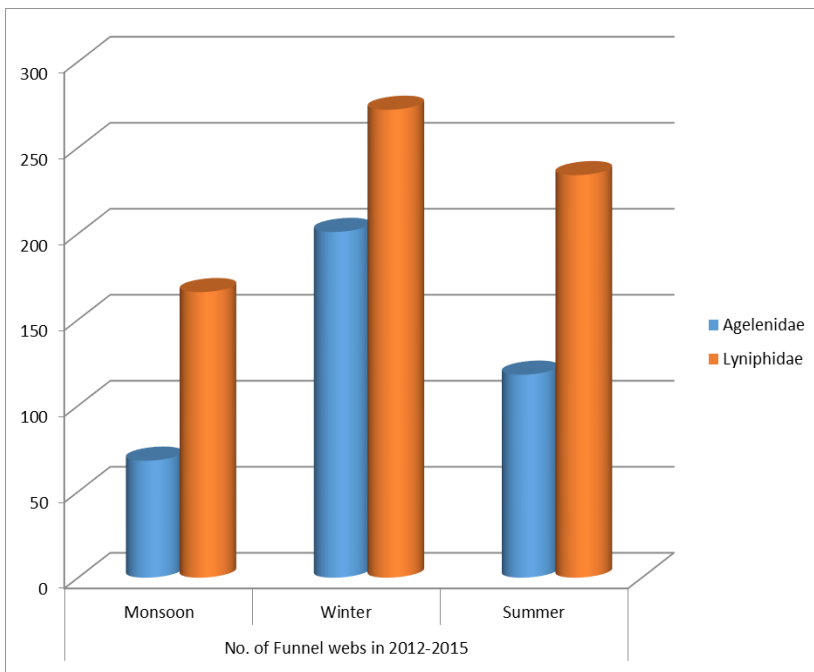
Graph 3. Number and percentage of Funnel web of different families in different seasons of 2013-2016.
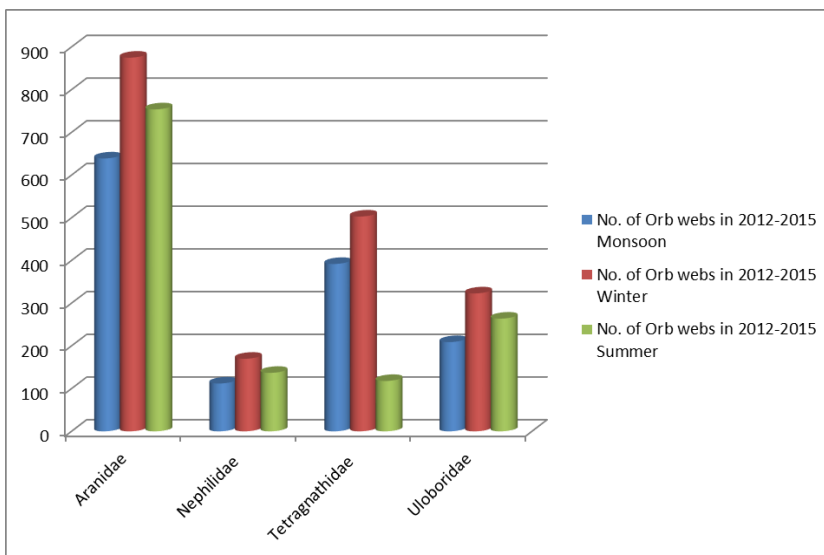
Graph 4. Number and percentage of Orb web of different families in different seasons of 2013-2016.

Graph 5. Number and percentage of ISingle line snare web of different families in different seasons of 2013-2016.
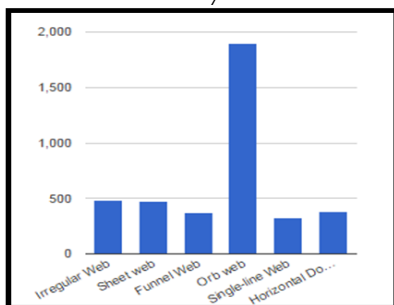


Graph 6. Number and percentage of Dome shape horizontal web of different families in different seasons of 2013-2016.
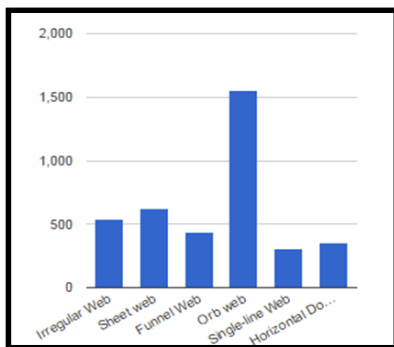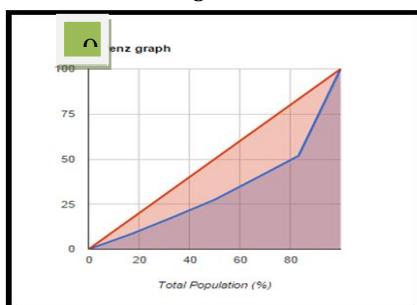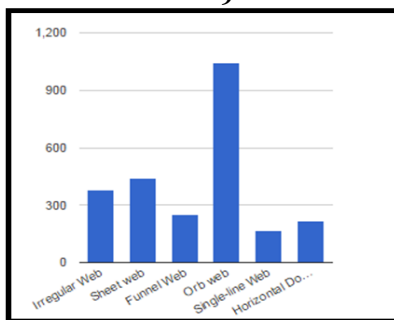
**7**
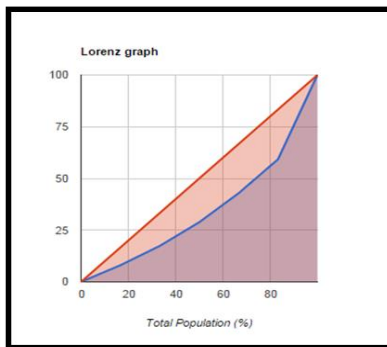


**8**



**9**



**10**



**11**



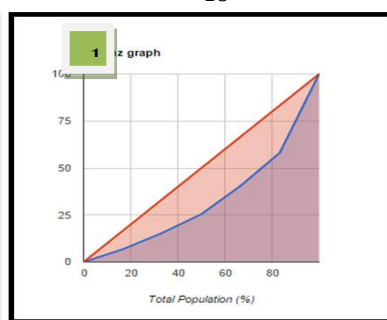**12**

Graphs 7-12. (7 & 8). Web Count and Larenz Graph for spider web population in the year 2013-14. (9 & 10). Web Count and Larenz Graph for spider web population in the year 2014-15. (11 & 12). Web Count and Larenz Graph for spider web population in the year 2015-16. (Note- Lorenz graph representing cumulative % population of Spider's web).