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## Some adaptive pattern of behaviour in spiders of semi-arid regions

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#### Abstract

Semi-arid habitat provides the best model for adaptation of species due to the extreme living environment and for possible mitigation process for the looming climate change. Spiders have always been underestimated as model for research; however, they have provided unique behavior patterns in course of our studies in their feeding, breeding, web building process and social aspects. This paper discusses these behaviors of Salticidae, Hersillidae, Oxyopidae and Araneidae dominating families of spiders in relation to adaptation to semi-arid conditions. The study also highlights the active role of female spiders in the adaptation process.

**Keywords:** Spiders, behaviours, feeding, breeding, social, predatory, semi-arid habitat

#### 1. Introduction

Spiders are the oldest and the most diverse group of terrestrial organism, with fossils dating back to the Devonian period, Currently 48,063 species belonging to 4077 genera and 117 families were recorded from all over the world (world spider catalog 2018) <sup>[1]</sup> out of which 1686 species of spiders belonging 60 families and 438 genera were updated taxonomically from the Indian region (Keshwani *et al.*, 2012) <sup>[2]</sup>. Spiders are the organisms having four pairs of legs and the number of eyes varies from 2 to 8 in different species. Spiders have interesting facts about eye structure and their vision. The function of front eye, lateral eye and posterior eye also vary (Jackson and Pollard 1996) <sup>[3]</sup>. Many species have become highly specialized to reduce competition with other species some are nocturnal; others are diurnal some build fixed webs (sheets, orbs or tunnels); others throw webs to entangle prey, some hunt prey; other sit and wait in ambush. Researchers from different countries have recorded the interesting behaviours of spiders (Sebastian and Peter 2009) <sup>[4]</sup>, (Herberstein 2011) <sup>[5]</sup>.

Ecology of semi-arid habitat supports the spider growth and spiderlings development. Agra region falls under the semi-arid habitat and the maximum area of Agra covered by the Yamuna River (Anjali and Prakash 2012) <sup>[6]</sup>. The agricultural activities around the Yamuna flood plains and the humidity supports spiders for adaptation in that particular habitat (Anjali and Prakash 2017) <sup>[7]</sup>.

This present paper focused on the important adaptive behaviour pattern of different spiders from the semi-arid habitat of Agra region.

#### 2. Material and Methods

For observing the different behaviours of spiders visual searching sampling method was applied. The pictures and videos of spiders were captured by using a Canon camera (A3200). Focused sampling area for behaviour study was the Agra region (U.P) situated on the border of the State of Rajasthan (Fig.1). Identification of the spiders was followed by the keys and catalogs of Sebastian and Peter 2009 <sup>[4]</sup>, Tikader 1987 <sup>[8]</sup>, Pocock 1900 <sup>[9]</sup> and Platnick 2014 <sup>[10]</sup>.

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Fig 1: Sampling site [Agra-Uttar Pradesh]

### 3. Results and Discussion

Spiders displaying different behaviors, few are as follows with their interesting aspects-

**3.1 Feeding behavior:** Spiders feed for their survival like other organisms. They feed on the different variety of insects. It is important to understand that almost all spider species are not carrion feeders and they only eat living prey or perhaps very recently killed ones. The feeding strategy is also interesting as some times spider feed on the other spider too; this type of phenomenon is called cannibalism in which the individual feeds on the same type of organisms. A female spider sometimes feeds on their own young spiderlings and also on their male of the family after mating. This aspect is conditional it happens due to insufficient food and also during food unavailability. In the present work, we observed this

type of behaviour in the group of salticids spiders which feed on the same family individuals eq. *Hyllus sp.* a foliage runner was feeding on the *Plexippus paykulli* (fig.2). Our finding supports the results of Wise 2006 [11].



Fig 2: Female *Hyllus sp.* feeding on male *Plexippus paykulli*

**3.2 Predatory behavior:** As a major predatory group, spiders (Araneae), feeds on terrestrial arthropod communities and forms one of the most abundant, diversified and ubiquitous populations in both natural and agricultural habitats. Those Spiders who work as a biological controlling agent in agroecosystems have been well documented (Riechert and Lockley 1984 [12], Schmitz, 2008 [13]. Spider assemblages can offer a complementary niche to attack different pest species or subsets of the same pest species. They feed on the different agricultural pest like *Bemisia tabaci*, *Helicoverpa armigera* and other insects (Marc *et al.* 1999) [14]. In our study, we have recorded the predatory behaviour in *Menemerus semilimbatus* feeding on *Musca domestica* and ants. *Crossopriza lyoni* and *Artema atlanta* are the common household spiders feed on mosquitoes and houseflies. They work as the natural repellent of mosquitoes and controlling Malaria, Dengue and other mosquito-borne diseases.



A.



B.

Fig 3: A- *Oxyopes sp.* attacking on *Argiope sp* B- *Menemerus semilimbatus* feeding on *Musca domestica*

**3.3 Breeding behaviour:** The Pedipalps, located at the anterior side of the body are work as a sensory organ which is highly modified for an intermittent function in males. At first, semen is ejected from the genital opening onto a sperm web and then picks it up from there with the help of pedipalps. Later, during the act of copulation, the sperm is again ejaculated, this time from the palp into the female. Thus the

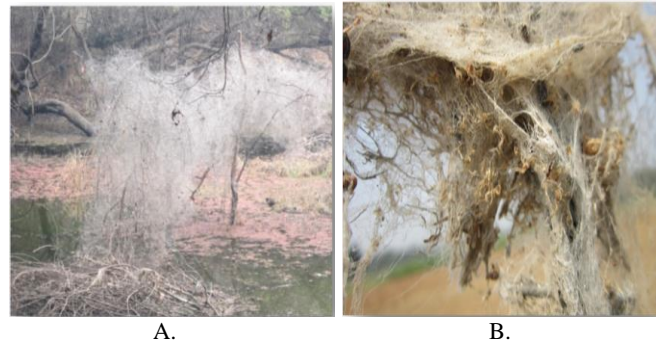
pedipalps of the male are viewed as evolving from a grasping spermatophore-transferring organ to a sperm-transfer device. Spiders show a range of courtship and copulatory behavior. The small size of the male puts them to advantage as it is easier to reach to their partner. The females are also active as they show behaviour such as dancing and changing their color pattern for attracting their males (fig.4).



**Fig 4:** Breeding Behaviour in *Hersilia savingnyi* also showing the cryptive coloration on the bark of *Eucalyptus*

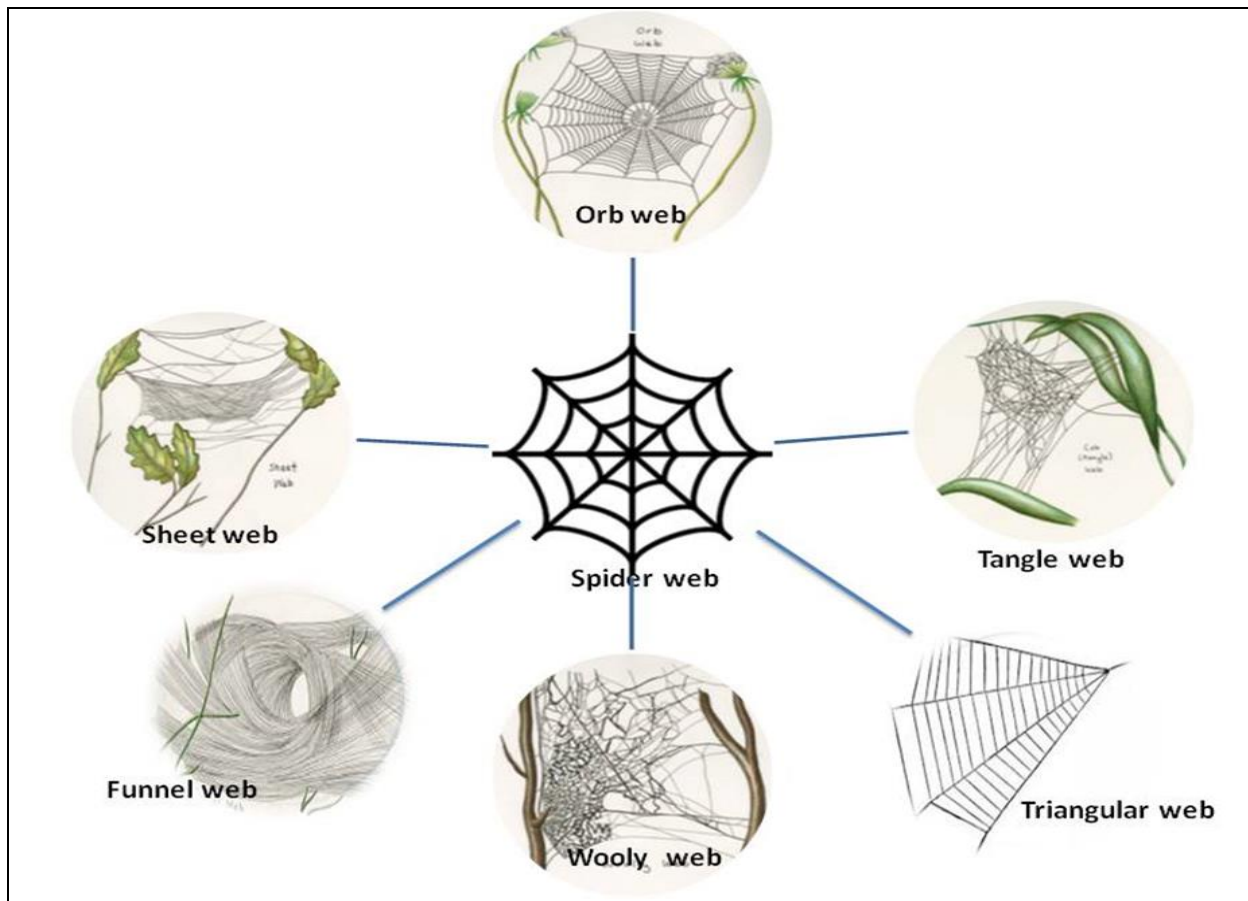
**3.4 Social behaviour:** For building a larger communal web multiple spiders work together to make it bigger to capture the variety of insects at the same time. These preys were captured tightly in the tight junction of the web and then these insects were taken by different groups of spiders. Some species like *Stegodyphus sp.* and *Cyrtophora sp.* (fig.5) working on a large scale to make their tight junction of the web. These webs are huge in size, covering the whole tree or the whole wall. In the observation, it was recorded that a huge number of insects were captured and are taken by different species of spiders. This community web building behavior which is shown by various groups is a unique phenomenon of spiders (Bradoo 1972 [15], (Karus and Karus 1988) [16]). It has been observed in the case of *Stegodyphus sp.* and *Cyrtophora sp.* Initially while spinning the web, the web fibers are almost transparent, as it comes on the end the web turns into the brown or grey largely due to the trapping of insects and dust. The species *Cyrtophora* has particularly preferred the community-based

pattern. Such web making occurs in the Agra region in particular places where Spiny plants are scattered (Berry and Date palm trees) is at least in a distance of 200 meters especially in drylands. Such a phenomenon was also observed in trees growing in Marshy lands. The areas with dense bushes do not show a community web building pattern therefore, it is assumed that over a year spiders have adapted an intelligent and social behavior pattern for trapping the prey and for the survival of adoptees.



**Fig 5:** A- Community web -*Cyrtophora sp.* B- *Stegodyphus sp.* (A Social behaviour)

**3.5 Web building behaviour:** A best known behavior of spiders is the web building as they exhibit efficient and geometric patterns of web spinning process. They have silk producing glands and spinnerets through which they release silk. There are different types of web pattern in spiders (fig.6 and fig.8) but two commonly prevalent are orb web and sheet web. Making an orb web is a characteristic of Araneidae and Tetragnathidae family (fig.7).



**Fig 6:** Types of spider webs

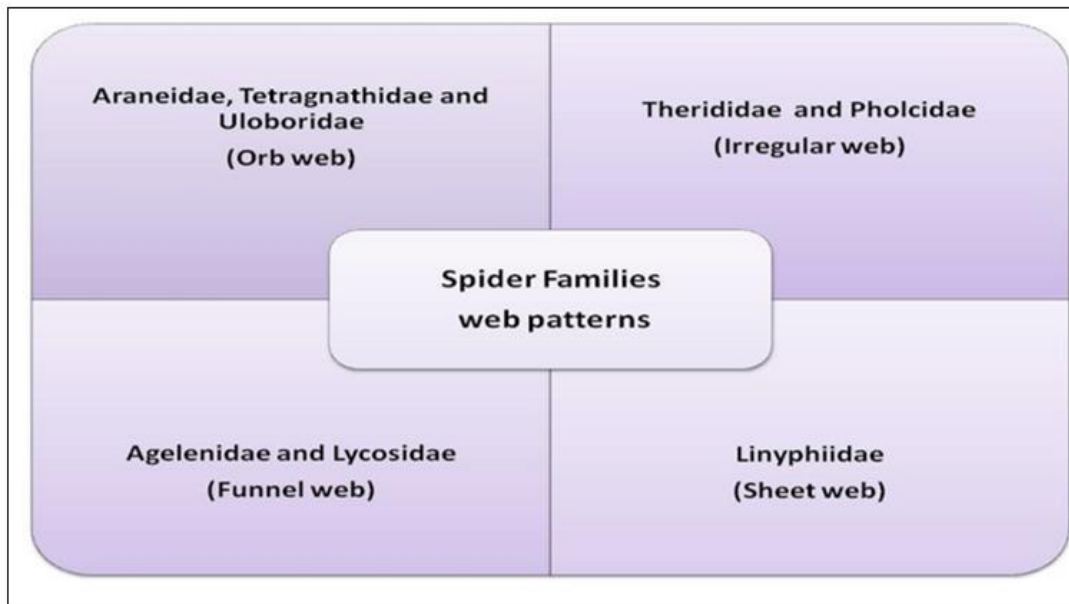


Fig 7: Major spider families and their web pattern in the semi-arid habitats



Orb web

Funnel web

Fig 8: Orb and funnel web

**3.6 Mimic behaviour:** Spiders show interesting mimicry behavior like the ant, they look exactly like ants and on keen observation, only one can see the presence of eight legs. Even during any threat, they raise their front two legs as the real ants do. This observation was recorded in *Myrmarachne sp.*(fig.9)



Fig 9: *Myrmarachne sp.* ant mimic spider

**3.7 Parental care:** Spiders exhibit the finest example of female parental care, especially in our observation *Oxyopes sp.* (Oxyopidae) and *Plexippus sp.* (Salticidae). They spin a cocoon and attach it with plant leaves or barks and guard their

eggs till it hatches. While in the case of Pholcids and Lycosids, females carry their eggs on their body till the spiderlings come out (fig. 10)

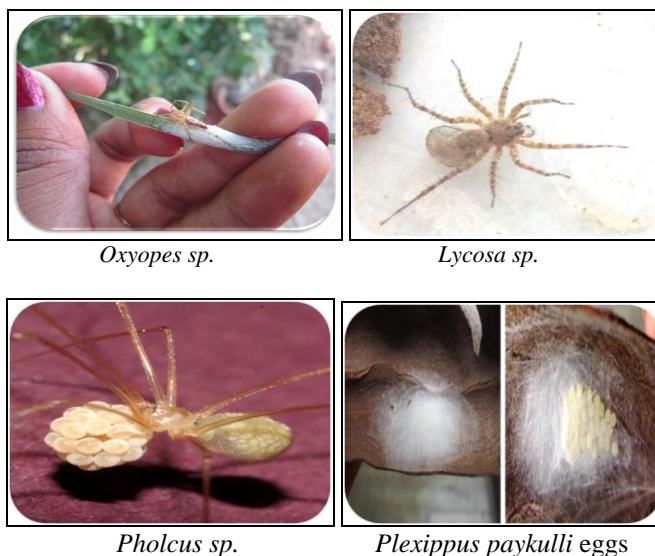


Fig 10: Parental care in spiders

**3.8 Silk production:** Silk is used to build webs and egg sacs, wrap up prey and help dispersal of young ones and act as safety lines while escaping predators. Water spiders also use silk to hold an underwater air supply. Spiderlings disperse using silk. They travel to a high point, raise their abdomens and let out one or more strands (Zschokke 2003) <sup>[17]</sup>. Now a day's spider silk is highlighted as important for the biotechnological application it is recorded that spider silk is used to make bulletproof jackets and also help to heal a wound as it is having other medicinal importance too.

#### 4. Conclusion

In the present study different behaviours like feeding, breeding, predatory, web building, parental care, and mimicry was recorded in the spiders *Oxyopes sp.*, *Menemerus sp.*, *Hersillia sp.* and *Lycosa sp.* with their adaptation strategies. The Semi-arid regions of India are characterized by extreme temperature, alluvial soil and minimum rainfall, hot sand laden wind and thin green cover, therefore requires various adaptive features for the spiders to indulge in order to survive. All these features are reflected in their unique pattern of behaviorism response to their habitat. During the study, it is recorded that the females were relatively more active to participate in all behavioral activities as compared to the males especially in the case of Salticidae and Araneidae family.

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