POPULATION DYNAMICS OF SPIDERS IN SELECTED COTTON FIELDS OF VIRUDHUNAGAR DISTRICT, TAMIL NADU, INDIA

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ABSTRACT: The mean populations of spiders in three different places like Thayilpatti, Madathuppatti and Vembakkottai, Virudhunagar district, Tamil Nadu, India were studied. In these areas, twenty common species of spiders belonging to six families from these three selected areas were collected and identified. The collected spiders belonging to the family, Salticidae, Oxyopidae, Araneidae, Lycosidae, Gnaphosidae and Sparassidae. In this study, two species of spiders were observed, one is web weaver and another one is non – web weaver. The web weaving spiders belonging to the family Araneidae and Lycosidae. The non-web weaving spiders belonging to the family Salticidae, Oxyopidae, Gnaphosidae, Lycosidae and Sparassidae. *P. viridana*, *O. birmanicus*, *O. hindostanicus*, *P. latikae* and *A. anasuja* a dominant predator recorded in these three selected areas. The population dynamics of the individual spider species in different months showed that the population of spider species mainly *P. vridana*, *O. birmanicus*, *O. hindostanicus*, *A. anasuja*, *N. lugubris*, *P. latikae*, *C. cicatrosa* and *L. pseudoannulata* were very high throughout the study period. The increase in the spiders density suggested that the spider density is influenced by the increase in prey density.

KEY WORDS: Spider, population, oxyopidae,web.

Spiders have often been confused with insects, but in truth they belong to the class Arachnida, with major differences being that spiders have two body divisions and eight legs and insects have three body divisions and six legs. Orders within the arachnids include daddy longlegs, scorpions, mites, and ticks. About 39 000 species of spiders have been named so far (Platnick, 2005) representing what is believed to be only about one-fifth of the total spider species (Levi, 1981). Some 3,000 species have been thoroughly examined and named from Europe, and approximately 3,500 have been identified from North America (Levi, 1954). Spiders are one of the more diverse arthropod taxa, ranking seventh in global diversity (Coddington, 1986), which makes them a fascinating group to study. Biodiversity is not only an issue of curiosity but stands firm on the political agenda as a resource for humanity (Kamal et al., 1992). Spiders are predaceous arthropods which largely feed on insects, their larvae and arthropod eggs (Barnes & Barnes, 1954; Riechert & Bishop, 1990; Mansour et al., 1980; Bartos, 2005; Nyffeler et al., 1987a). Being generalist predators spiders feed on a variety of small sized prey relative to their own size (Nyffeler & Benz, 1987; Riechert & Lockley, 1984; Wise, 1993). In most of the spiders, consumption is not only limited to the adults but larvae and nymphs are preyed upon as well (Whitcomb & Eason, 1967; Sunderland, 1999). On account of these attributes spiders are rated as important biological agents for controlling insect pests in the cotton and farmlands. Before attempting to assess the role of spiders in suppressing pest populations in a given agricultural situation, there must be available sufficient information on their taxonomic diversity and abundance habitat preferences in space and time, hunting strategy, body size of species, predators and prey items and the rate of

their consumption, and reproduction. Information on these aspects is essential for the formulations of ecological concepts and conclusions (Berry, 1970; Horner & Starks, 1972).

MATERIALS AND METHODS

Study Area

Thayilpatti, Madathuppatti and Vembakkottai are located in Sivakasi taluk, Virudhunagar district, Tamil Nadu, India. Sivakasi is located at 9.5' longitude and 7.8' altitude. This city is located 157 meter above sea level. Sivakasi belongs to Virudhunagar District of Tamil Nadu State of India. This is a warm, humid region and the seasonal variation in the temperature ranges from 30°C – 38°C. Humidity is also showing seasonal fluctuation.

Study Period

The investigation was carried out for a period of three months from November 2011 to March 2012. Sampling was conducted in five months at the randomly selected 5 sites of three places.

Sampling

Sampling was done every month from quadrates. Spiders were collected from 5quadrates (1sq. m × 1sq. m) placed at four corners and one centre of 10 sq. m × 10 sq. m area by visual search method between 9.00 – 11.30 hours. A sufficient core area was left to avoid edge effects. All five quadrates were searched. Spiders were collected from the ground stratum and from the terminals of plants.

Sampling time was restricted to 15 minutes in each transect, depending on the density of under storey weeds and shrubs to be walked through, and this included time spent on field to identify unfamiliar taxa encountered. The time taken to describe web characteristics (useful in identifying the family, and in some instances, up to the genus level) was excluded from the calculation of sampling time for each transect. Attempts were made to carefully scan the leaf litter surface, tree bark, foliage (Including the under – surface of leaves when traces of webs were found) twigs, and branches of the vegetation (Up to 1.5m height) along the transect. Specimens from each quadrate were preserved in 75% alcohol in the field and counted under a microscope in the laboratory.

Spider collection methods

Following methods were used to collect the spiders.

Sweep net

This is particularly simple way to catch spiders. A sweep net is made of relatively heavy fabric like sailcloth or canvas. It was rugged enough not to be torn by the leaves and tightly woven to catch spiders of relatively small size.

Hand Picking

Slowly moving spiders, especially the soft-bodied spiders were collected by using fine camel hairbrush or fine forceps.

Aerial netting

Grasshoppers and wasps were collected by using aerial net methods described by George et al. (1986). The net has strong, light weight and easily maneuverable handle with 15-18" diameter ring and strong, durable, nylon bags with twice the diameter of the ring.

Beating method

Vegetation beating was carried out with a stick at the beginning and end of each transact by sharply tapping ten times a clump of vegetation about 1m in diameter at a height of about 1m. The spiders dislodged from the vegetation were

pooled as a single sample for analysis. The dislodged spiders were collected in a tray handheld beneath the plants and transferred in to vials for identification.

Leaf litter Method

Spiders were extracted from leaf litter using a modified Tullgren funnel (Kitching et al., 2000) consisting of ten 40cm funnels in an insect – proof box, each with a 60W bulb over it and tight fitting collection vials beneath. A 3-mm wire mesh was used in each funnel to prevent excessive amounts of litter fragments contaminating the samples of extracted spiders. About two metres away from each transect, a 25 x 25cm Metal frame was placed on the ground and the leaf litter within the frame was quickly scooped up and placed in a plastic cover, labelled, and tied tightly. In the field station, the leaf litter was placed in a tray and quickly sifted, to look for larger spiders and other arthropods too large to pass through the funnel mesh.

Identification of Spiders

The adult spiders were identified on species level and others on genus or family level using available literature (Tikader, 1987). Monthly data were prepared with detailed information on the occurrence of mature male, female and juvenile spiders. Voucher specimens were preserved in 75% alcohol and deposited in a reference collection housed with the Department of Zoology, Ayya Nadar Janaki Ammal College, Sivakasi, Virudhunagar district, Tamil Nadu, India.

RESULTS

Taxonomical Characters

The collection yielded twenty nine species belonging to twenty three genera and nine families. Among the nine sub-families, Salticidae (33.84 %) and Araneidae (21.05 %) and Oxyopidae (21.05 %) represented maximum number of species followed by Lycosidae (10.53 %). The sub-family, Gnaphosidae, Sparrasidae yielded the least number of species (05.26 % each) (Table 1).

The spiders like, *Peucetia viridana (*Stoliczka), *Oxyopes hindostanicus* (Pocock), *Oxyopes birmanicus* (Nona Yvette), *Peucetia latikae* (Tikader), *Lycosa pseudoannulata* (Bosenberg), *Hippasa olivacea* (Thorell), *Neoscona lugubris* (Doleschall), *Phidippus indicus* (Blackwall), *Marpissa decorata* (Tikader), *Marpissa thakuriensis* (Tikader), *Thalassius albosinctus* (Doleschall), *Plexippus paykulli* (Audoin), *Plexippus petersi* (Karsch), *Telemonia dimidiatta* (Simon), *Thania phamoniansis* (Tikader), *Olios millet* (pocock), *Argiope anasuja* (Thorell), *Cyrtophora cicastrosa* (Simon), *Gastracantha unquifera* (Tikader) *Gnaphosa poonaensis* (Tikader) were collected and recorded from the cotton fields of Thayilpatti, Madathuppatti and Vembakkottai, Sivakasi taluk, Virudhunagar district, Tamil Nadu, India (Figs. 1-3).

All the analysed spiders have hairs throughout the body. The colour of the body is varied from black to white. Moreover combination of body colour was also observed in the study. The number of eyes varied from 6 to 8. Though many ethological features present in the spiders, in my study, I recorded only the camouflaging behaviour. Diversified cocoon colour was also observed in the present study. Among the web spinners, the webs are higher spherical shape or irregular shape.

Spiders considered as biological predators in nature. Many studies have been carried out to evaluate spiders as biological control agents and present an effective method of using spiders to reduction of pest population. Most of the studies were limited to the identification of spiders, and to investigate the dominant spider species, their regional distribution and seasonal fluctuations.

Hence, the present investigation is an attempt to study the biodiversity and the relative abundance of spiders in Thayilpatti, Madathuppatti and Vembakkottai for a period of five months from November 2011 to March 2012. This study clearly indicated that the Salticidae, Oxyopidae and Araneidae fauna of this area is rich and diversified.

The major component of the spider population found in this ecosystem was the family Salticidae mainly of *P. petersi* and *P. paykullii*, Araneidae composed mainly of *A. anasuja*, *C. cicastrosa* and Oxyopidae mainly composed of *P. viridana*, *O. hindostanicus*, *O. birmanicus* and *P. latikae*. The population of *C. cicastrosa* and the Oxyopidae spiders like *P. viridana*, *O. hindostanicus*, *O. birmanicus* and *P. latikae* were higher during November and December and lowered during March. The Satlicidae spider, *P. paykullii* population was stable throughout the study period. *C. cicastrosa*, *O. birmanicus* and *A. anasuja* were the predominant species of spider followed by *P. indicus*, *G. poonaensis* and *P. latikae* during November. The population of these spiders gradually decreased from November to March. *N. lugubris*, *O. millet* and *G. unquifera* were the least number of spiders. During December, the population of *C. cicastrosa* and *O. birmanicus* were higher. The population of *T. dimidiatta* and *N. lugubris* were lowered during March. The population of Gnaphosidae spider, *G. poonaensis* and Salticidae spider, *M. thakuriensis* was stable throughout the study period. During December the population of *N. lugubris* were higher. *P. paykullii*, *H. olivacea*, *P. viridana*, *T. dimidiatta*, *P. latikae* *L. pseudoannulata*, *P. indicus* were higher during November and lowered during March. The population of *O. milleti* were absent throughout the study period. Most of the species are lowered from December to March during the study period. *G. unquifera* available during December and totally there was no population of *G. unquifera* during March. The population of *P. viridana* was higher during January than November.

P. viridana ,*O. hindostanicus*, *P. indicus*, *M. decorata*, *M. thakuriensis*, *P. paykulli* were the predominant species of spiders in Vembakkottai. These spider populations were higher during November and lowered during March. The spider *G. unquifera* was not available in the area. The population of *L. pseudoannulata* was higher from November to February and lower during March. The spider *M. thakuriensis* is available during November and absent during March. The population of *A. anasuja* was higher during January and the population of *O. millet* was higher during February and lowered during March. During March all the spider population was decreased except *H. olivacea*.

Behaviours of the spiders

The spiders belonging to the family Araneidae are orb web weaver, Gnaphosidae and Lycosidae are ground runners, Salticidae and Oxyopidae are stalkers and Sparassidae are foliage runners.

DISCUSSION

In the present study, twenty species of spiders belonging to six families in Thayilpatti, Madathuppatti and Vembakkottai were collected and identified. These spiders belonging to the family Salticidae, Oxyopidae, Araneidae, Lycosidae, Gnaphosidae, and Sparassidae. In this study two species of spiders were observed, one is web weaver and another one is non – web weaver. The web weaving spiders belonging to the family Araneidae and Lycosidae. The non web weaving spiders belonging to the family Salticidae, Oxyopidae, Thomisidae, Gnaphosidae, Tetragnathidae and Sparassidae. The reasons for the fluctuation in

different months may be due to seasonal variation and harvesting in the nearby fields to search the new niche. The reasons for the fluctuation in different months may be due to drought, flood, natural calamities, and disturbance by other animals, and manmade disturbance. The population dynamics of the individual spider species in different months showed that the population of spider species mainly *P. vridana*, *O. birmanicus*, *O. hindostanicus*, *P. latikae*, *A. anasuja*, *C. cicatrosa*, *L. pseudoannulata*, *P. petersi* and *P. paykullii* was very high throughout the study period. The increase in the spiders density suggests that spider density in influenced by the increase in prey density.

The webbing sites of web builders are easily affected by environmental factors in addition, when the web spaces over lap, there is competition with and between species of web builders. Therefore, hunters probably are more effective predators than web builders. In particular, the interaction of prey and predator shows a constant numerical interaction about these relationships which is fundamental to biological control. Spiders are considered as the favorable biological control agents in the forest eco system. The spiders are abundant throughout and all parts of country. They are an integrated part of all ecosystems and contribute to the balanced ecosystem evidently due to their predatory potential. They are found from hedges, shrubs, bushes and trees. They have also been found in fields of paddy, wheat, rice, and other crops etc. (Perfecto et al., 1996) Apart from this, spiders are observed in other ecologically different places *viz*., forest floors, under stone and logs, in dead leaves and detritus.

The present work includes the taxonomic position, morphological characters, and list of diversified species. The seasonal variation of spider population from this sites have also been observed in the cotton field, maximum web – weaving individual had been found in November while less number of individual, were recorded during summer season (March). The study was resulted to identification of twenty species belonging to twenty three genera and nine families. The major families were Salticidae, Araneidae, oxyopidae and Lycosidae. Spiders are ubiquitous predators that are abundant and diverse in agricultural ecosystems. Spider assemblages have the ability to limit population growth of arthropod pests alone or in combination with other natural enemies (Mansour et al., 1980; Oraze & Grigarick, 1989; Riechert & Bishop, 1990; Carter & Rypstra, 1995). Different studies have shown that spiders' influence on prey populations depends on spider density or biomass. Therefore, relatively high spider abundance has been considered a requirement for pest control in agricultural systems (Greenstone, 1999; Riechert, 1999; Sunderland & Samu, 2000), but the role of spider diversity in prey regulation is less understood. The same result observed in my study also. A diverse assemblage of spiders may occupy a variety of biotopes in agroecosystems and, as a whole, are likely to be active throughout the day. Therefore, a diverse spider assemblage will leave fewer refuges for potential prey in time and space. Due to variation in spider size and/or prey capture strategies, spiders should be able to capture prey that varies in size and/or developmental stages (Sunderland, 1999; Henaut et al., 2001; Riechert et al., 1999) found that there seemed to be no single spider species that regulates pests or maintains temporal consistency, as well as a diverse assemblage of spider species. The complexity of vegetation structure has been suggested to be an important habitat component that affects spider density and diversity in both natural ecosystems (Lowrie, 1948; Barnes ,1953; Barnes & Barnes, 1955; Greenstone, 1984) and agroecosystems (Hatley & MacMahon, 1980; Alderweireldt, 1994; Rypstra & Carter, 1995; Downie et al., 1999). Vegetation structure could influence spiders through a variety of biotic and abiotic factors, namely structures for webs,

temperature, humidity, level of shade cover, abundance and type of prey, refuges from natural enemies and intraguild predation (Wise, 1993; Samu et al., 1999; Rypstra et al., 1999).

Most studies regarding the role of shade tree density and diversity in coffee plantations have found a higher species diversity in more diverse coffee agroecosystems (Perfecto et al., 1996; Greenberg et al., 1997). Perfecto and Snelling (1995) found that species diversity of ground-foraging ants decreased with shade reduction whereas coffee-foliage-foraging ant diversity did not change along the same shade gradient. In our study, there was no apparent trend between management and spider diversity. Most cases (11 out of 18), according to species richness, Shannon and Simpson indices, showed no relation between management and spider diversity. In only two cases did we find that spider diversity decreased with management intensification. Surprisingly, in five cases, we found an increase in spider diversity as land management increased. These results are contrary to what has previously been reported (Perfecto et al., 1996; Greenberg et al., 1997), and there are several possible explanations. An uncontrolled factor that could affect spider diversity was the presence and density of insectivorous birds, which are known to predate spiders intensely (Gunnarsson, 1998). The different predation level could affect spiders' abundance and composition, by selectively reducing numbers of those spiders species more exposed to bird predation. Another explanation is the possibility that relative diversity levels change between years, as we only made a one-year study, and therefore results should be interpreted with caution. The organic management site had the lowest species richness and diversity, and the highest dominance in the dry season (according to all alpha indices used) with the exception of hunting spiders. In both seasons, web-building spiders were more abundant and had higher species richness than hunting spiders. Among the web-building spiders, *Leucauge argyra* and *Leucauge* sp. were found disproportionately abundant in all sites, but most notably in organic management. The extreme dominance of the *Leucauge* spp. in organic management was the cause for the high values estimated by Simpson index (which is more sensitive to dominant species). The Shannon index values are most affected by species richness and secondarily by evenness. The organic management with low species richness and extreme dominance (reduced evenness) therefore had low Shannon index values. Several authors consider that dominant species tend to exploit resources more efficiently than non-dominant species (Agnew & Smith, 1989; Mason et al., 1997). Extreme dominance of *Leucauge* spp. in organic management compared to control and conventional management in the dry season may be because the optimum, in shade and humidity conditions, for these species are those of the organic management (intermediate between the control and the conventional sites). *Leucauge mariana* has been reported as a very abundant species in disturbed habitats in Central America (Eberhard, 1988; Eberhard & Hube, 1998). For these reasons, these species could be more abundant in the coffee systems than in the control site, but the dominance of this species should be subject of a particular study. Spider diversity under the organic management significantly increased in the rainy season due to an increase in species richness and a decrease in the dominant species abundance. In contrast, in conventional management and control, there were no significant differences between the seasons. Theoretically, when populations of competitive dominant species decrease or disappear, species diversity might increase (Putman, 1994). In the study period, the population of *O. milleti* and *G. unquifera* were less common. These results support the existence of a gradient in species composition, from control site to conventional management,

with organic as intermediate, although in the rainy season the difference between organic and conventional management was reduced. This might be explained because in the rainy season the interference of clouds and rain with solar irradiation reduces the differences in temperature and humidity, making the coffee farms more similar in these variables. Additionally, the exclusive presence of a spider species at one site may be related to the existence of a favourable microclimate and/or an adequate web support for these species. For example, *T. albosinctus* were high during November and lowered February and no population was observed during March in Madathuppatti. *Spintharus flavidus*, had been poorly studied taxonomically and is common under the leaves of bushes (Levi, 1954), so it is possible that it could prefer the non disturbed control site, in opposition to the periodically perturbed coffee plantations. On the other hand, *E. brevipes* was found only on control habitat, and is known that the spiders of this family live almost exclusively in wet or humid, shaded forest habitats (Coddington, 1986). Some species collected were singletons, as in the case of *Dolichognatha* sp. and *Tetragnatha* sp., and could reflect a demographic rarity (Halfter & Ezcurra, 1992). In the summer season, a few species like *P. viridana* and *A. anasuja* of Oxyopidae and Araneidae were among the dominant and subdominant species at all sites, showing that they were not affected by the management gradient. However, with a seasonal change from dry to rainy season, *G. anguifera* became considerably less abundant in all sites. In contrast the population of Salticidae were higher throughout the study period.

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Table 1. Taxonomical diversity of spiders collected from the selected areas of Virudhunagar district.

Sub-family	No. of genera	No. of species	% of species
Oxyopidae	2	4	21.05
Lycosidae	2	2	10.53
Araneidae	4	4	21.05
Salticidae	5	7	36.84
Gnaphosidae	1	1	5.26
Sparassidae	1	1	5.26
Total	15	19	

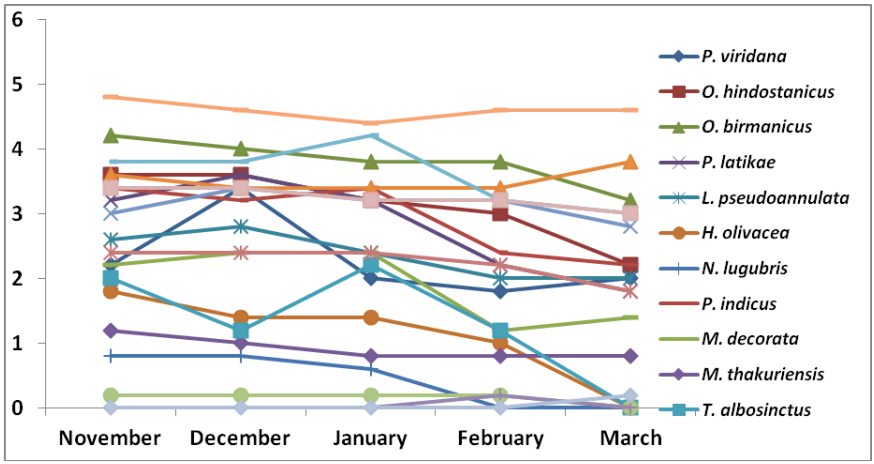

Figure 1. Population dynamics of spiders from the cotton field of Thayilpatti.

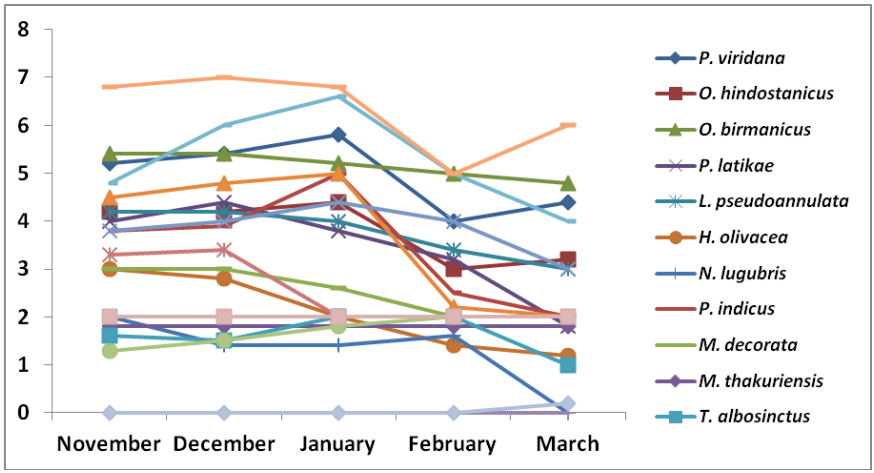

Figure 2. Population dynamics of spiders from the cotton field of Madathuppatti.

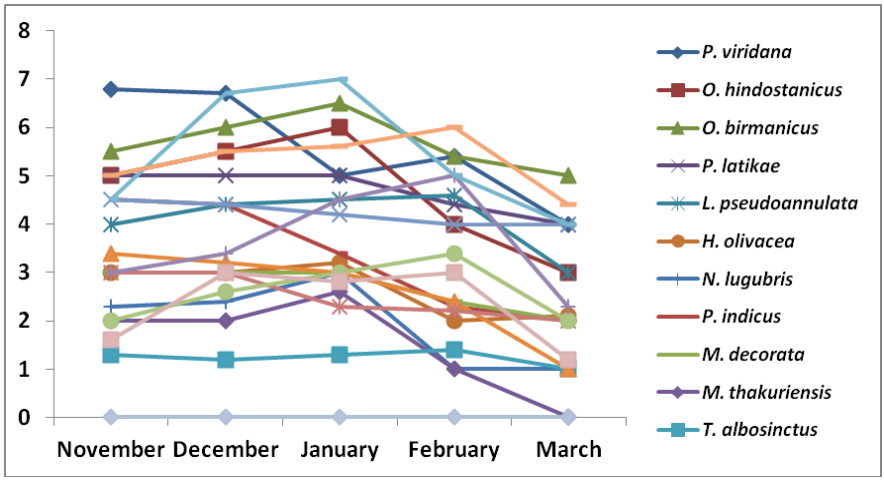

Figure 3. Population dynamics of spiders from the cotton field of Vembakkottai.