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Biological Control Potential of Male and Female *Oxyopes shweta* (Araenae: Oxyopidae) against Polyphagous Insect Pest *Spodoptera litura*

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Abstract

Predator-Prey interactions are an important component for understanding the feeding potential of the predator. The present study was undertaken in laboratory microcosm arena. Two kinds of interactions (functional response and numerical response) occurring between lynx-spider and *Spodoptera litura* larvae were studied. The study shows that female lynx-spiders have more feeding potential than male spiders. Female spiders show a Type II functional response where as the males show no definite pattern of functional response. Numerical response study shows that at low densities of predators, there is cooperative feeding whereas at higher prey densities there is competition for prey. However such feeding competition doesn't culminate in cannibalism. The study shows that in natural habitat Lynx spiders can be effective in regulating the population of the gregariously occurring lepidopteran larvae, hence contributing to biological control of insect pests.

1. Introduction

Spiders being the major components of predatory arthropods in natural ecosystems including agroecosystems, they play a major role in the biological control of insect pests[1, 2]. The spiders being generalist predators have the advantage of influencing a wide array of insect pests in the agricultural fields. The diversity of the prey is so different that a simple aggregation of spiders can be effective in the biological control of insect pests. However at the same time, there is a need to develop a better understanding of dynamic interactions between predators and their prey within complex ecosystems[3]. The importance of spiders in the conservation biological control is being increasingly realized due to their abundance and ubiquitous nature[4, 5].

The success of a biocontrol agent depends partly on the rate at which they consume the prey and partly on their ability to increase in abundance and feeding in a cooperative manner. Solomon[6] described the variation in per capita rates of prey consumption and variation in predator abundance as "functional and numerical response" of a predator. The response of the spiders to the prey density is an important aspect for the incorporation of the spiders in biological control of insects. Holling[7] described three types of functional response. All the three forms represent the capacity of the predator to capture and consume a prey item once it has been located. Type I: It describes the proportional or linear increase in consumption from 0 to maximum with increasing prey availability. Type II: It describes the hyperbolic responses i.e. the proportion of the prey consumed is the highest at low levels of prey availability and a possible 100% consumption at low levels, which implies that predator have potential to eliminate the resource entirely. Type III: It represents an accelerating increase from low levels of prey availability to the proportion of the prey consumed is highest at intermediate level of prey availability. The numerical response of the predators is a function of increase in the prey density in the environment. There are two types of numerical responses which are used to elaborate the interactive dynamics of the predator and the prey population. Demographic response which links the rate of change of predator abundance to prey availability and Isocline Numerical response links the predator and the resource abundance[8, 9]. A Total response involving the functional response along with numerical response together will provide a comprehensive account of predator –prey interaction.

The Type I functional responses are more frequent among filter feeders like protozoans, sponges, web building spiders and sea cucumbers[10]. Type II responses are observed in insects like *Coccinella septumpunctata*[11], *Rhynocornis longifrons* [12,13]. Functional response studies on spiders are comparatively low as compared to the work done insects. Type II responses in spiders are observed in *Pardosa hortensis*[14]. Wolf spider *Agelenopsis aperta* shows Type III response[15]. The studies so far shows that predatory insects from coccinellidae and reduvidae families show a typical Type II functional response, where as predatory spiders, web building as well as hunting spiders usually show a Type II functional response and seldom Type III response[16]. Predator-prey interaction studies are usually relevant only when the feeding guild of the predator and the feeding niche of the prey overlap which increases the probability of predation. Microcosm studies involving the interaction among spider and prey can help us to give a better understanding on the feeding potential of the spiders on insect pests.

Oxyopes shweta (Tikader) is a dominant foliage hunting spider found in several types of agroecosystems[17-19]. It has been observed found feeding on a variety of insect prey belonging to diptera, lepidoptera, hemiptera, and orthoptera. *Spodoptera litura* is one of the dominant polyphagous lepidopteran insect pest found in a variety of agroecosystem. The larvae of *S. litura* feed in a gregarious manner on the leaves and fruits of several crops and hence are always found in high densities. Since the habitat of both the spider and the larvae overlap, an attempt was made to observe the interaction between the predator (*O. shweta*) and the prey (*S. litura* larvae). Two set of objectives were undertaken for the present study (i) Impact of increase in prey density on spider predation and (ii) Does predator density influence the prey consumption rate?

2. Material and Methods

Experiment 1: Impact of increase in prey density on spider predation.

The spiders of both the sexes were fed ad-libitum and were later fasted for one week prior to the experiment. Microcosm Studies involving cotton plant twigs of 7-9 leaves kept in plastic vials containing water which id then enclosed by a plastic cylinder test arena[20] .The larvae were transferred to the leaves and allowed to acclimatize for one hour. The experiment started with the introduction of the spider into the test arena. The test ended after 24 hours.

Experiment 2: Does predator density influence the prey consumption rate?

The spiders of both the sexes were fed ad-libitum and were later fasted for one week prior to the experiment. Microcosm involving cotton plant twigs of 7-9 leaves were kept in plastic vials containing water. 10 larvae per test arena were released on the leaves and were allowed to acclimatize for one hour and later on the spiders at varying densities viz.1,2,3,5 and 7 were introduced in respective test arena and the whole setup was enclosed by a plastic cylinder test arena. The test was conducted for 12 hours starting at 0600 hrs and terminating it at 1800 hrs. The photoperiod was maintained at 12:12 light: dark

3. Results

Functional response: The female spider shows a gradual increase in prey consumption rates till intermediate prey density and then there is a slight decrease. In the male spiders the prey consumption shows a hyperbolic shape, showing a decline in prey consumption rates after reaching a maximum density. The female spider shows a typical Type II functional response while the male spiders show a mixed type of response comprising of Type I and Type II.

Numerical response: *O. shweta* females and Males do not show any cannibalism, though the number of prey consumed in both the cases remain the almost constant at varying predator densities. The spiders show a cooperative feeding at low predator densities while at the higher predator densities there is a competition among the predators for the resource which is in short supply. Showing that competition among the spiders is prevalent.

The Total response involving the male and female spider shows that the female spiders show more feeding rates as compared to males; it may be due to the increased requirement of food required for production of more number of eggs. The numerical response shows that there is a certain degree of cooperative feeding but at higher predator densities the competition results in comparatively less feeding. The total response in males shows that the feeding rates increases with an increase on the prey density to a certain extent and later on show a decrease. The Numerical response studies shows there is only some amount of competition, however further studies needs to be done pertaining to the conspecific behaviour of the spider with respect to larval predation. The functional and numerical response studies show that the feeding rates of the females are higher than that of the male spiders. Both the sexes are equally potent in reducing the population of *S. litura.*

4. Discussion

The Predator – Prey interaction is an important aspect of studying the efficiency of biological control of the predators to the insect prey. For a predator to be effective in the field, the feeding rate has to increase with the increase in the prey density. The foraging studies have two components functional response and the numerical response. A combination of the two responses gives an idea of the potential of the biocontrol agent.

In the present study male and female *O.shweta* were chosen for the experiments. Two set of experiments were kept one for understanding the foraging efficiency of the predator to the increase in prey density and the other to test whether the cooperative feeding by the spider was present or absent? Another objective was to see whether there is any difference in the foraging rates of the male and female spiders. The results show that the foraging efficiency of the male spider is comparatively less as compared to the female spider. The Male Spiders show a Type II functional response (Figure 1) and in the case of female a type III response (Figure 2) which is weak at the prey density of 1-15 individuals might increase with the increasing prey density.

Figure 1. Average feeding rates of male and female *Oxyopes shweta* at to varying density of third instar *Spodoptera litura* (prey)

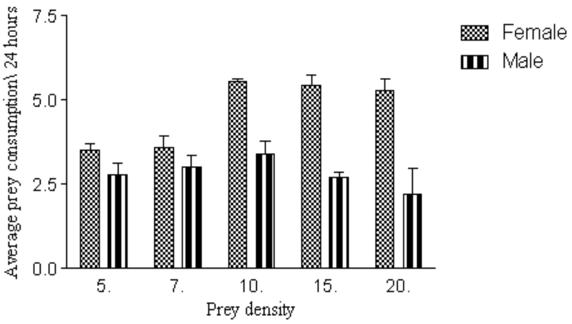
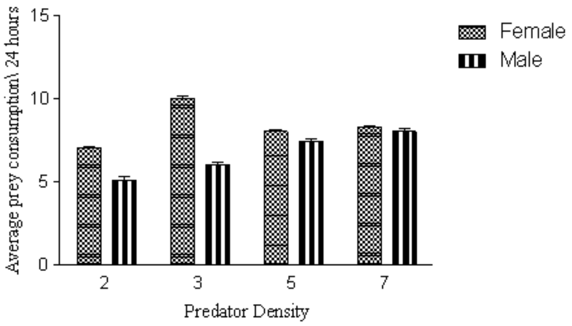


Figure 2.Average feeding rates of male and female *Oxyopes shweta* (Predator) at varying predator densities to third instar *Spodoptera litura* (prey)



Spiders usually show a Type II response, as they eat fewer insects when the insects become abundant[21, 22]. Type III functional responses are also seen in the spiders, but these are very rare, these responses of the spiders are considered to be an important component for stabilizing the insect populations and hence are of potential interest in biological control. Usually the Type III functional responses are exhibited by the vertebrates. However the recent studies have shown that certain spiders do infact show a Type III response. Mansour[23] have shown that *Chieracanthium meildei* feeding on *Spodoptera litoralis, Philodromus rufus* feeding on drosophila and lycosid spiders feeding on rice leaf hoppers exhibit such responses. Type III responses are achieved by the ability of the predator to learn from the previous experiences to prefer some prey and avoid others.

In study *Oxyopes shweta* populations were obtained from the field were maintained in insectary on diet composed of *Tribolium* larvae. Prey preference tests done in the laboratory showed that they preferred *spodoptera litura* to *Tribolium* larvae. Similar results were observed in *Oxyopes salticus* preferring grasshopper to mealworm[24]. This shows that *Oxyopes* spiders generally prefer insects present in field as against stored grain pests.

The females of *Oxyopes shweta* kill and consume more prey than do the males; indicating that the energy needs of both males and females for reproduction are different[25,26]. According to Wise[16] foraging success dictates the number of eggs a female can lay and thus could strongly influence the female fitness. As a result a Type III functional response can be expected from the female spider. The recent studies have shown that learning in spiders leading to a strong prey dependent switching has been observed in several studies [27, 28]. Nyffeler et al., [29] have shown that *Oxyopes salticus* switches the dietary intake composition in response to prey availability.

The Numerical response of the predator can compensate for a weak functional response. A predator showing a Type I or Type II response can be effective if it shows a strong numerical response. Numerical responses are easily studied in the web building spiders in rice fields, as it is seen that with the growth of crops the spiders migrate from field margins to the interior in high numbers. They abandon their earlier patches to colonize patches with high prey densities. Since the predation pressure is high, thus the population is regulated[4, 30]. Web relocation in therridids and immigration to foraging patches having high prey densities have been observed in funnel web spider (*Agelenopsis aperata)* showing that numerical response by immigration is well pronounced in spiders. However there are certain drawbacks of the numerical response, these are competition, Intraguild predation and predator interference, cannibalism.

Intraguild predation is very common among hunting spiders which show a strong arenophagic behaviour[31], whereas Oxyopids have been observed to feed on the araneidae when prey density is very low (personal observation). The numerical response study pertaining to *Oxyopes shweta* found that no cannibalism occurred in any prey density kept at 20 cu cm. testing arenas. The above result shows that the territorial behaviour and competition were very low when the prey availability is high. A preliminary study conducted to observe the preference of *O. shweta* to lady bird beetle grubs versus *Spodoptera litura* and *Clavigralla horrens* showed that the spider tended to avoid the grubs showing that *O. shweta* and ladybird grubs can utilize the common resource in a cooperative manner. The increased predator density of *O. shweta* also showed a positive feeding and showed complete elimination of *Spodoptera litura* larvae as a predator density of four (4) and above in the test arena.

The total response of *O. shweta* male and female shows that the male represents a Type II and female represents a Type III response. Both the sexes show a cooperative feeding on larvae of *Spodoptera litura*. From the above study it is seen that the *O. shweta* is an effective in regulating the population of *Spodoptera litura* larvae by showing a Type II and Type III functional response which was accompanied by a strong numerical response. The relative abundance to the prey ladybird grubs shows that these spiders show a very less intraguild predation in the field when the prey is less abundant. Studies on the interspecific competition among spiders might further substantiate the potential of the lynx spiders in the biological control of the lepidopteran larvae.

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