INVESTIGATION ON PREY PREFERENCE AND SWITCHING BEHAVIOR OF THE PREDATORY BUG, *ORIUS NIGER* WOLFF UNDER LABORATORY CONDITIONS (HET.:ANTHOCORIDAE)

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ABSTRACT: Prey preference and switching behavior of *Orius niger* on three preys, *Thrips tabaci*, *Aphis gosssypii* and *Tetranychus urticae* were examined. *Ephestia kuehniella* Zeller eggs, corn pollen and green bean pods were used as food and oviposition sites, respectively. Experiment was carried out under laboratory condition (25±1°C and 65±5% RH, with a 16:8 L: D photoperiod). Four to six days old females of the predatory bug was used in experiment. We monitored the prey of the preference of the predatory bug on cucumber leaf disks containing: 10 second instar larvae of *Thrips tabaci*, 10 second or third instar nymphs of *Aphis gossypii* and 10 adults of *Tetranychus urticae* for 12 h. in 6 replicates. Number of prey consumed was recorded, the preference indexes of *T. tabaci*, *A. gossypii* and *T urticae* were 0.54, 0.35 and 0.089, respectively. For each experiment, a piece of host plant, determined densities (10-40, 25-25, 40-10) of *Aphis gossypii and T. tabaci* and one predator were placed in a cage. Each experiment lasted 12h and was repeated six times. Switching behavior of predatory bug was examined. The results of host preference showed that there was no significant difference between the mean number stages of *T. tabaci* and *A. gossypii* consumed ($p>0.05$) and there was significant difference between the mean number of consumed *T. tabaci* and *A. gossypii* with *T. urticae* ($p<0.05$). In Switching behavior, number of prey consumed was recorded: In the first, with increasing of relative prey density, preference rate was decreased (negative preference), near equal density, decreasing of relative prey density, preference rate was increased (positive preference).

KEY WORDS: Host preference, switching behavior, *Orius niger, Thrips tabaci, Aphis gosssypii, Tetranychus urticae*.

In recent years, the use of different species of predatory bugs of genus, Orius as biological control agents has greatly increased in many house vegtables and ornamental crops (Van den Meiracker & Ramakers, 1991; Van de Veire & Degheele, 1992; Cocuzza et al., 1997; Baniameri et al., 2005). This genus consists of 67 species (Yasunaga, 1997). The use of different species of predatory bugs *Orius* spp. as efficient predators has been taken into consideration and they are used widely as predators of thrips (Murdoch et al., 1985), mites and Aphid (Akramovskaya, 1978) and eggs of pentatomids (Pericart, 1972) and aphids (Yasunaga, 1997) in green house cultures. *Orius laevigatus* was able to distinguish plants infested with either of the two preys and showed a switch for plant infested with spider mite over plant with thrips, plant infested with thrips contained 20-40 larvae per plant, while plants with spider mites had 800-1000 females per plant. The prediction is that inclusion of the inferior prey always depends on the density of the superior prey, and inferior prey (Venzon et al., 2000). According to Venzon (1999) predatory bug *Orius laevigatus* preffered patches with high density of inferior prey and intermediate density of superior prey. Different prey types often occure in separate patches, so that generalist

predator has to make an 'either/or' decision. This decision will not only depend on the quality per prey, but also on the quantity of prey per patch (Kindlmann & Dixon. 1999).prey preference of *Orius laevigatus* for two prey offered *Amblyseius degenerance* and *Amblyseius cucumertis* was different due to behavioral differences between preys, *Amblyseius degenerance* was more mobile than *Amblyseius cucumertis* and predator have greater success capturing the less active species (Wittmann & Leather, 1997). Both *Orius laevigatus* (Wittmann & Leather, 1997) and *Orius majusculus* (Brodsgaard & Enkegaard, 2005) show clear preference for thrips when given a choice between *F. occidentalis* larvae and *A. degenerans*. According to Chow et al (2008) prey preference of anthocorid bugs for phytoseiid mites and *Frankliniella occidentalis* has been examind among different combination of species and prey sizes (age), *Orius insidiosus* has little difficulty handling adult *A. degenerans* but adult thrips were especially difficult to capture and kill. Rogers et al. (2000) showed in *Coleomegilla maculate* the highest level of predation on small prey, the weight- consumption rate was highest for prey of intermediate sized prey, they founded that level of predation by *Orius insidiosus* was lowest on large prey, adult *Frankliniella occidentalis,* but similar for intermediate sized prey, adult *A. degenerans*. Prey switching in *Orius insidiosus* showed that this anthocorid always switches to the most abundant prey whether foraging on flowers or foliage (Chow et al., 2008).

For biological control measures, it is necessary to determine the efficacy of natural enemy against pests. Cornel (1976) proposed that switching would be most likely in mobile predators which forage among many patches where prey species occure in different proportions, Sutch conditions are well met in orius species which are good fliers, active foragers and polyphagous predators (Malais & Ravensberg. 2003). The objectives of the current study were to determine prey preference and switching behavior of the predatory bug, *Orius niger* for three prey: *Thrips tabaci*, *Aphis gosssypii* and *Tetranychus urticae*.

MATERIALS AND METHODS

Predator rearing: Predatory bugs used in the experiments were collected on marguerite flowers *Chrysanthemum frutescens* L. (Asteracea) in Tehran, Iran. *O. niger* was separated and identified (Baniameri et al., 2005). The predatory bugs were kept in plastic jars (7×10 cm) whit a hole (Ø 2.5 cm) on the top of the jar for ventilation and covered with antithrips net. They were reared on eggs of *E. kuehniella* as food at 25±1°C and 65±5% RH, with a 16:8 L: D photoperiod. Green bean pods and corn pollen were supplied as oviposition sites and supplementary food, respectively. The jars were lined with crumpled wipes papers to provide hiding place to reduce cannibalsm (Baniameri et al., 2005).

Thrips tabaci rearing: *T. tabaci* was reared on cucumber leaves of the variety of Negin at 25±1°C with a 16:8 L: D photoperiod. One or two infested cucumber leaves were placed on the green bean pods in plastic jars (7×10 cm) for infestation.

After 7-8 days second instar larvae of *T. tabaci* were available on the green bean pods and in this way, a cohort larva was maintained *Tetranychus urticae* rearing: *T. urticae* was reared on cucumber plant of variety of Negin at the same condition as above. One or two infested leaves were placed on the clean cucumber plant for infestation. After three-four days, plants were heavily infested by the mite.

Aphis gossypii rearing: *A. gossypii* were reared on cucumber plant of variety of Negin at the same condition as above. Clean cucumber leaf discs (Ø 5 cm) were placed in the center of a plastic Petri dish contaning moisten cotton wool. One or

two infested leaves were placed on leaf discs (Ø 5 cm) for infestation. After 3 days, plants were heavily infested with second and fourth nymphal instar of *A. gossypii*.

Prey preference experiment: to examin prey preference of predatory bug, *O. niger* plexi glass cages, with 25cm diameter and 10 cm height were used. To facilitate ventilation top of the cage was perforated in five places and five holes (Ø 2.5cm) were made and covered with antithrips net. A central hole (Ø 1 cm) was also made on the top of the cage and was filled with cotton. Three plastic petri dishes, (5cm in diameter) were placed in each cage and a cucumber disk leaf 5cm in diameter was placed on clean moistens filter paper. Petry dishes were designed in equal distances from each other and cage center (an incidental designment). In each petri dish 10 second instar larvae of *T. tabaci*, 10 second and fourth instar nymph of *A. gossypii* and 10 adults of *T. urticae* were placed on leaf disk of cucumber. In each cage four to six-day old females of the predatory bug were released through the central hole of the cage. Females were starved for 24h before release. Each experiment lasted 12h. and replicated 6 times. Number of prey eaten by each predator was recorded at the end of experiment. Laboratory condition was the same as before. Consumed prey was eaten not replaced, which means that in the course of the experiment the relative abundance between prey species changed due to the predation activity of *O. niger*. Prey preference was also measured using Manly´s index (Manly, 1974; Krebs, 1989; Chesson, 1983):

$$\alpha \equiv \frac{\log p_i}{\sum_{i=1}^{n} \log p_j}$$

where α = Manly´s alpha for prey type
$p_{i=}$ proportion of prey i remaining at the end of the experiment relative to the original input (i=1,2,3,4,...m); p_j = proportion of all prey types together remaining at the end of the experiment relative to the original input (j= 1,2,3,4,...m) m= number of prey type. The α indices can take values between zero and one and the values of the different prey types always sum up to one. In the case of a three prey combination the threshold value is 0.33. Thus α expresses the deviation of the predators diet from a random sample of the available prey. SAS (1998) was used to analyse data.

Switching behavior of the predator on figures were drawn

To examin the Switching behavior of predatory bug *O. niger,* on two preys were studied in a transparent cage of plastic (25cm in diameter, 10cm in hight). For proper ventilation the top of the cage 5 also small holes places were coverd with antithrips net. A central hole that is 1cm in diameter was made on the top and filled with cotton. Two Petri-dishes were placed in the cage with 7cm distance and a cucumber leaf disk was placed on the moistened paper. Different combinations of two preys (*T. tabaci* and *A. gossypii*) selected as 10-40, 25-25, and 40-10 respectively. Each prey combination was repeated to describe five times. Petri-dishes were placed equidistance from each other and cage center. The condition was as before. At each experiment 4-5 day old females and starved for 24h. Three preys species thst were released in to cages through central hole on the top, are shown in Table 1. Each experiment lasted 12h and then the number of prey eaten was recorded.

Murdoch no switch model (1969) was used to describe the data:

$$Y \equiv \frac{100CX}{100 - X + CX}$$

x = percent age of prey type1
C = normalization constant in equal density of prey type1and 2 as:

$$C \equiv \frac{n_1 par}{n_2 par}$$

n_1 par= average number of prey type 1 eaten.
n_2 par= average number of prey type 2 eaten.
Y = proportion of prey type1 or (type 2) eaten.

RESULTS

In preference experiments, consumed prey was not replaced due to the Manly's index was used and results were presented in table 1.

The results showed that there was no significant differences among the mean number stage consumed *T. tabaci* and *A. gossypii* (F=24.9, df =2,15,17 and p<0.0001) number of prey consumed among *T. tabaci*, *A. gossypii* and *T. urticae* (p<0.05). *O. niger* preferred *T. tabaci* over *A. gossypii* and *T. urticae* Switching behavior experiment of *O. niger* on *T. tabaci* and *A. gossypii* showed that *T. tabaci* is preferred equal densities to *A. gossypii* (Fig. 1). The feeding ratio of two preys (*T. tabaci* and *A. gossypii)* and C value in equal densities are shown in Table 3.

DISCUSSION

The results showed that there was no significant difference between the mean number prey stage consumed *T. tabaci* (α_i=0.54) and *A. gossypii* (α_i=0.35) and there was significant difference among the mean number of *T. tabaci*, *A. gossypii* and *T. urticae* (α_i=0.089) eaten (p<0.05, F=24.9). Generalist predators often attack a variety of prey which differs in energetic value and both capture and handling costs (Chow et al., 2008). Optimal foraging theory predicts that predators should utilize large prey to maximize energy gain (Stephans & Krebs, 1986) Additional information on biomass and energetic values for experimental prey of different size (age) would provide a better understanding of differential utilization of prey by *O. niger*. Manly's α index can take values between zero and one and the values of the different prey types always sum up to one (Manly, 1974). *O. niger* preference experiments with three prey combinations with equal numbers showed a great preference to *T. tabaci* and *A. gossypii* against *T. urticae*. The more phylogenic similarity between predator and prey the more prediction valuablity or prey comparative value for predator has increased. In other words, the better predator can find its need of amino acid and carbohydrates from a prey that has closed phylognetic relationship with itself (Bilde & Toft, 1994). The intrinsic growth rates were higher when predatory bugs *Orius laevigatus* fed with diets containing thrips than when they were fed spider mites (Venzon et al., 2002). Spider mites produce web that may serve as a refuge from predation (Sabelis & Bakker, 1992). The results showed that there was a positive preference to *T. tabaci* and negative one for *A. gossypii*. It was also shown that *T. tabaci* was preferred by the predator, when its desity was increased

(a Switching behavior was observed). It has been shown that predatory bugs, *Orius laevigatus* preferred plants with the inferior prey species (spider mites) when plants with moderate densities of thrips were the alternative. This preference disappeared when thrips density was increased (Venzon et al., 2002). Chow et al. (2008) showed that total and relative predation of thrips and/or mites by *O. insidiosus* depended on the types of prey available, *O. insidiosus* tended to switch to the most abundant type of prey. Predators that switch from feeding on one prey species to feeding on another species suddenly change from being harmless to dangerous for this new prey species, while becoming harmless for the old prey (Venzon et al., 2000). Results showed that when two preys are offered in equal proportions (25:25), the predator showed more preference for *T. tabaci* (C = 1.19). The curves in Fig.2 show the expected proportion of the two species with switch, there is therefore, a distinct positive switching behaviour of the predator was shown for *Thrips tabaci*. In the first by increasing the relative prey density, preference rate was decreased (negative switching), as the prey density increased a positive switching was observed.

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Table 1. The Calculated values of host preference of predatory bug, *O. niger* for three prey *Thrips tabaci*, *Aphis gosssypii* and *Tetranychus urticae* in equal numbers using Manly´s index.

Prey species			
	Tetranychus urticae	***Aphis gosssypii***	***Thrips tabaci***
		α_i (Manly's index)	
	0.06	0.24	0.7
	0.14	0.28	0.51
	0.07	0.32	0.6
	0.06	0.21	0.71
	0.08	0.37	0.47
	0.12	0.39	0.22
Mean±SE	0.089±0.01 **B**	0.35±0.01 **A**	0.54±0.01 **A**

Table 2. Number of *T. tabaci* and *A. gossypii* fed upon by *Orius niger*.
-N2 fed = number of consumped *T. tabaci*
-N1 fed =number of consumped *A. gossypii*

N2 /N1	N2 fed / N1 fed					mean	SE
10/ 40	2/ 9	9/ 2	8 / 1	7 / 3	8 / 2	8.2 / 2	0.6/ 0.2
25/ 25	8/ 6	7 / 8	7 /8	8 /10	8 / 9	7.2 / 8.6	0.4/ 0.3
40/ 10	16/ 1	1 / 13	2 / 17	2 / 16	1 / 15	1.6 / 15.4	0.3 / 0.3

Table 3. *Orius niger* feeding ratio of *Thrips tabaci* to *Aphis gossypii*.

ratio N2 /N1	N2 fed /N1 fed means ±SE	ratio N2 fed /N1 fed
0.25	8.2±0.3/ 2±0.3	0.24
1	7.2±0.3 / 8.6±0.4	1.19 =C
4	1.6±0.2/15.4 ±0.6	9.62

Table 4. Proportion of *Thrips tabaci* and *Aphis gossypii* combination in different proportion. N_1 and N_2 = number of *T. tabaci* and *A. gossypii,* respectively.
N_1fed = number of *A. gossypii* fed upon by the predator, *Orius niger.*
N_2 fed= number of *T. tabaci* fed upon by the predator, *Orius niger.*

N_2/N_1+N_2	Observed mean N_2fed / N_1fed+N_2 fed	Calculated mean by Murdoch model(1969)
0.2	0.09	0.135
0.5	0.4	0.337
0.8	0.8	0.54

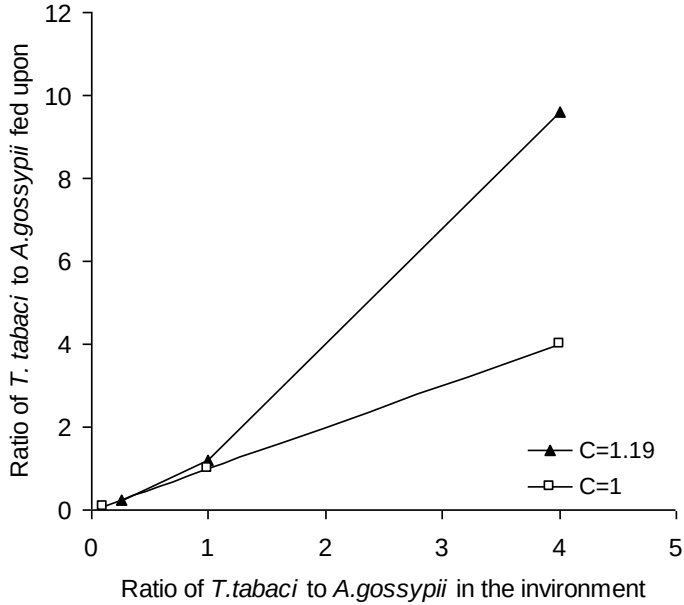

Figure 1. Predation of *Orius niger* females when *Thrips tabaci* and *Aphis gossypii* were offered in.

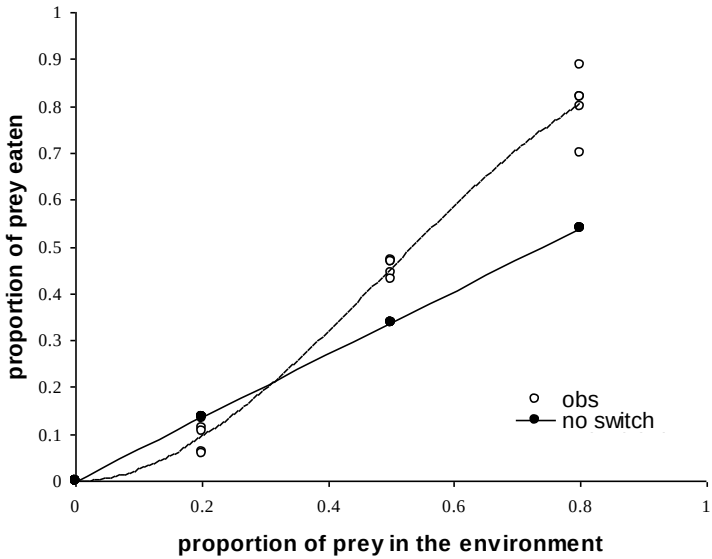

Figure 2. proportion of *Thrips tabaci* and *Aphis gossypii* fed upon when offered in combination in different proportions to female predator, *Orius niger* The expected No Switch curve was fitted by The Murdochs (1969) equatin.