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Research Article

Behaviour of *Orius insidiosus* Say (Hemiptera: Anthocoridae) towards its prey, *Thrips palmi* Karny (Thysanoptera: Thripidae)

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ABSTRACT: The behaviour of 5th instar nymphs and adult males and females of anthocorid bug, *Orius insidiosus* preying on adult *Thrips palmi* was studied. Adult *O. insidiosus* males spent longest time in motion compared with 5th instar nymphs and adult females. First encounter of prey was shortest for 5th instar nymphs but not significantly different from that of adult females. The distance travelled to 1st prey by 5th instar nymphs was significantly shortest compared to both adult male and female *O. insidiosus.* However, speed of arrival to 1st prey did not significantly differ among the three stages of *O. insidiosus* examined. Mean time spent by *O. insidiosus* 5th instar nymphs and adult females on 1st, 2nd, 3rd and 4th prey encounters was not significantly different. However, adult males of *O. insidiosus* spent significantly less time on 4th prey encounter compared with 1st - 3rd prey encounters.

KEY WORDS: Feeding behaviour, *Orius insidiosus,* searching efficiency, *Thrips palmi*

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INTRODUCTION

Orius insidiosus Say (Hemiptera: Anthocoridae) has been identified as an important biological control agent for thrips and other soft-bodied insects because of its ability to successfully prey on different species of thrips at various instars in complex environments (Baez *et al.,* 2004). An insect's searching behaviour is an active movement by which it seeks resources such as food, mates, oviposition and nesting sites and refugia. For this reason, it is imperative that insects have efficient searching mechanisms, since the above mentioned resources are essential for growth, development, maintenance of the individual and for ensuring survival and reproduction (Bell, 1990).

Augmentative biological control of pests with arthropod natural enemies has become increasingly popular worldwide and is now an important facet of Integrated Pest Management systems in open fields and greenhouses (Yano *et al.,* 2005). There is a number of *Orius* spp., which is known natural enemies of soft bodied arthropods globally. In Trinidad and Tobago, *O. insidiosus* is a natural enemy of *T. palmi* on melongene (*Solanum melongena*). *Orius* spp. such as *Orius sauteri* Poppius (Heteroptera: Anthocoridae) has proven effective in management of *T. palmi* on *S. melongena* (Kawai, 1995) and has been a registered biological control agent for commercial use in greenhouses since 1998 (Yano *et al.,* 2005). Sabelis and van Rijn (1997) developed models to describe patch exploitation behaviour and discussed the implications of predation rate and biological control of spider mites with *Phytoseiulus persimilis* (Athias-Henriot) (Acarina:Phytoseiidae). If *O. insidiosus* is to be considered a potential biological control agent for *T. palmi* in *S. melongena* in Trinidad and Tobago, a control program must be established. Evaluation of foraging potential of natural enemies is the most critical phase in development of biological control programmes (van Lenteren and Manzaroli, 1999). Searching efficiency is an important parameter which must be assessed in every potential biological control agent (Yano *et al.,* 2005) as this parameter gives an indication of the predator's ability to find resources in a manner which is sustainable, thus ensuring the survival of its future generations. The present study investigates the searching efficiency and foraging and feeding behaviour of *O. insidiosus* on *T. palmi.*

MATERIALS AND METHODS

Rearing of *O. insidiosus*

The predator, *Orius insidiosus* and its preferred prey *T. palmi* were taken from a laboratory culture maintained at 27 ± 2^{0}C and 70 ± 5% relative humidity. Ten each of 1–2 day old adult males, adult females and 1-day old 5th instar nymphs were selected for the experiments. The predators were fed with *T. palmi* and placed individually in 2ml Eppendorf® centrifuge tubes, loosely covered with a moist piece of cotton, where they were starved for 6h prior to conduct of the experiments.

Predation monitoring

Four immobilized adult *T. palmi* were placed at the centre of a 9cm diameter petri-dish lined with moistened filter paper at the base. Either 1 adult male, adult female or 5th instar *O. insidiosus* was introduced into the petri-dish the top of which was covered with a glass plate. The behaviour of *O. insidiosus* was observed and recorded, while movement of *O. insidiosus* in the petri-dish was traced on the glass plate using a Sharpie® fine point marker until the prey was found. The experiment was replicated ten times for each of the three predator stages indicated. The following measurements on *O. insidiosus* were taken during the conduct of the experiment: time spent in motion, time spent stationary, arrival time to first prey, departure time from first, distance travelled to 1st prey, speed of arrival to 1st prey, time to different prey encounters and number of pricks per prey encounter (PPE) by all three stages of *O. insidiosus*.

Statistical analysis

Data collected were normalized using square root transformation and then subjected to Analysis of Variance (ANOVA) followed by Tukey-Kramer *post hoc* test (Gomez and Gomez, 1984).

RESULTS

Adult male *O. insidiosus* spent significantly more time (1953.11 ± 483.67s) in motion compared to 5th instar nymphs (645 ± 119.05s) ($F_{2, 23}$ = 4.749, p = 0.0188). However, there was no significant difference (P>0.05) between the time spent in motion for either 5th instar nymphs and females or males and females (Table 1). Fifth instar nymphs of *O. insidiosus* spent significantly less time stationary (1148.38 ± 288.37s) compared to males ($F_{2, 23}$ = 4.448, p = 0.0233). There was no significant difference (P>0.05) in the time spent stationary between either 5th instar nymphs and females or males and females (Table 1).

Time of arrival to 1st prey by the three stages of *O. insidiosus* examined varied considerably. Fifth instar nymphs took significantly shorter mean time (1791.63 ± 321.97s) to arrive at 1st prey compared to adult male *O. insidiosus* ($F_{2, 23}$ = 5.414, p = 0.0118). Females also arrived at 1st prey significantly (P<0.05) faster (2166.78 ± 410.29s) compared to males, however, there was no significant difference (P>0.05) between the time to 1st prey arrival by either 5th instar nymphs or females (Table 1).

Numerically, males appeared to spend more time on 1st prey (6331.11 ± 1688.20 s) compared to 5th instar nymphs (3179.50 ± 224.00 s) and females (3370.56 ± 509.96 s) however, the mean time of departure from 1st prey by all three stages of *O. insidiosus* tested did not vary significantly from each other ($F_{2, 23}$ = 2.785, p = 0.0826) (Table 1).

The mean distance travelled by *O. insidiosus* 5th instar nymphs, males and females before arriving at 1st prey given in Table 1 indicates that fifth instar nymphs travelled a significantly shorter mean distance (77.84 ± 12.99 cm) before arriving at their 1st prey compared to either male (254.86 ± 42.03 cm) or female (275.51 ± 54.23 cm) ($F_{2, 23}$ = 6.480, p = 0.0059) *O. insidiosus*. There was no significant difference (P>0.05) between the mean distance travelled by either males or females before arrival at 1st prey. Likewise, mean walking speed to arrival of all three stages of *O. insidiosus* to 1st prey was not significantly different from each other ($F_{2, 23}$ = 1.774, p = 0.1921) (Table 1).

The mean time taken by 5th instar, male and female *O. insidiosus* to encounter their 1st prey differed significantly between them ($F_{2, 23}$ = 3.662, p = 0.0416) with males taking the longest time (853.00 ± 22.27s) compared to either 5th instar nymphs (377.00 ± 70.76 s) or females (362.22 ± 81.34 s) (Table 2). Mean time to 2nd prey encounter by all three stages of *O. insidiosus* was not significantly different from each other ($F_{2, 18}$ = 0.3733, p = 0.6937). Fifth instar nymphs took an average of 270.00 ± 83.06 s to encounter their 2nd prey while females and males took an average of 307.86 ± 91.33 s and 370.43 ± 42.67 s respectively (Table 2). Females encountered their 3rd prey in significantly less time compared to males ($F_{2, 13}$ = 5.077, p = 0.0235) however there was no difference in time to encounter 3rd prey by either 5th instar nymphs and males or 5th instar nymphs and females (Table 2). There was no significant difference in time to 4th prey encounter by either 5th instar nymphs, males or females of *O. insidiosus* ($F_{2, 12}$ = 1.338, p = 0.2988). The times to 1st, 2nd, 3rd and 4th prey encounters were not significantly different (P>0.05) for that of 5th instar and female *O. insidiosus*. However, male *O. insidiosus* spent significantly more time for their 1st prey encounter compared with that of 2nd, 3rd or 4th prey encounter ($F_{3, 36}$ = 129.05, p <0.0001). Significantly least time was spent for their 4th prey encounter (Table 2). The number of pricks by *O. insidiosus* 5th instar nymphs, males and females did not vary significantly for 1st ($F_{2, 23}$ = 1.129, p = 0.3406), 2nd ($F_{2, 22}$ = 1.669, p = 0.2114), 3rd ($F_{2, 18}$ = 1.718, p = 0.2076) or 4th ($F_{2, 13}$ = 1.713, p = 0.2185) prey encounter (Table 3).

Table 1: Searching behaviour parameters of three stages of *Orius insidiosus* to *Thrips palmi*

Parameter	*Orius insidiosus* (Mean ± S.E.)		
	5th instar nymph	Male	Female
Time in motion (s)	645.00 ± 119.05^{a}	1953.11 ± 483.67^{bc}	901.22 ± 109.92^{ac}
Time spent stationary (s)	1144.38 ± 288.37^{a}	3686.33 ± 159.60^{bc}	1357.56 ± 257.28^{ac}
First prey arrival time (s)	1791.63 ± 321.97^{a}	5639.44 ± 144.24^{b}	2166.78 ± 410.29^{a}
First prey departure time (s)	3179.50 ± 224.00^{a}	6331.11 ± 1688.20^{a}	3370.56 ± 509.96^{a}
Distance travelled to 1st prey (cm)	77.84 ± 12.99^{a}	254.86 ± 42.03^{b}	275.51 ± 54.23^{b}
Speed of arrival to 1st prey (cm/s)	0.19 ± 0.05^{a}	0.19 ± 0.03^{a}	0.29 ± 0.05^{a}

* Values followed by the same letter along a row are not significantly different (P>0.05) from each other based on Tukey-Kramer Multiple Comparisons Test.

Table 2: Mean time spent by *Orius insidiosus* on different prey encounters

Stage	Mean duration (s) ± S.E. spent on different prey encounters*			
	1st prey encounter	2nd prey encounter	3rd prey encounter	4th prey encounter
5th instar	377.00 ± 70.76^{aA}	270.00 ± 83.06^{aA}	320.00 ± 71.03^{aA}	310.00 ± 80.07^{aA}
Male	853.00 ± 22.27^{bA}	370.43 ± 42.67^{aB}	560.20 ± 21.98^{abC}	111.63 ± 15.12^{aD}
Female	362.22 ± 81.34^{cA}	307.86 ± 91.33^{aA}	172.50 ± 38.34^{acA}	295.20 ± 15.37^{aA}

*Values followed by the same lowercase letter along a column and the same uppercase letter along a row are not significantly different (P>0.05) from each other based on Tukey-Kramer Multiple Comparisons Test.

Table 3: Mean pricks per prey encounter by three stages of *Orius insidiosus*

Stage	Mean pricks per prey encounter ± S.E.*			
	Pricks / 1st prey encounter	Pricks / 2nd prey encounter	Pricks / 3rd prey encounter	Pricks / 4th prey encounter
5th instar	3.13 ± 0.40^{aA}	2.00 ± 0.53^{aA}	1.83 ± 0.48^{aA}	2.17 ± 0.48^{aA}
Male	4.56 ± 0.69^{aA}	3.44 ± 0.58^{aA}	3.14 ± 0.67^{aA}	4.40 ± 1.21^{aA}
Female	4.00 ± 0.80^{aA}	2.25 ± 0.70^{aA}	2.25 ± 0.31^{aA}	3.00 ± 0.89^{aA}

*Values followed by the same lowercase letter along a column or uppercase letter along a row are not significantly different (P>0.05) from each other based on Tukey-Kramer Multiple Comparisons Test.

DISCUSSION

Searching activities including probing and walking were observed for *O. insidiosus* male, female and 5th instar nymphs. Visual observations of *O. insidiosus* predation on *T. palmi* indicated that the sequence followed was: arousal-approach, capturing-probing-piercing and then sucking which was similar to that exhibited by *Sphedanolestes variabilis* Distant (Hemiptera: Reduviidae) (Ambrose *et al.,* 2009). It was observed that as *O. insidiosus* adults and 5th instar nymphs searched for *T. palmi* their proboscises were stretched forward while continuously probing with their antennae which were extended anteriorly. Cocuzza *et al.* (1997) reported a similar behaviour in both *Orius laevigatus* (Fieber) and *Orius albidipennis* (Reuter) when preying on *Frankiniella occidentalis* (Pergande) (Thysanoptera: Thripidae).

Orius spp. are known to only partially exploit prey patches since they can only identify prey items by touch using predominantly their legs and antennae during searching (Yano *et al.,* 2005) and to short range chemical cues on prey infested leaves (Castane *et al.,* 1999; Lattin, 1999; Yano *et al.,* 2005). Stationary prey items (*T. palmi*) were used in the current study since it may have been very difficult for *O. insidiosus* to locate mobile prey in the absence of chemical cues. Mendes and Bueno (2001) and Bueno (2009) reported that *O. insidiosus* surveys an entire leaf in search of its prey by moving its head from side-to-side; when it detects a prey, its antennae move in the prey's direction and it walks toward the prey with its rostrum extended. Moreover, Loureiro and Júnior (2007) noted that *O. insidiosus* cleans its stylet and antennae after predation of the aphid *A. gossypii*. As biocontrol agents, *Orius* spp. are generalist predators which are released at high prey densities and are expected to perform efficiently even when satiated (Yano *et al.,* 2005). However, Shields (1979) observed that starved *Orius tristicolor* (White) covered 20% more distance that unstarved individuals. In the current study, *O. insidiosus* travelled longer distances to the prey patch than males or 5th instar nymphs. Shields (1979) also found that female *O. tristicolor* covered 29% more distance than males. A similar trend was found in the present study with *O. insidiosus* females covering 21% more distance to 1st prey than males.

Although there was no significant difference between mean speeds of arrival by *O. insidiosus* males, females and 5th instar nymphs to 1st prey, females had numerically the highest mean speed whilst searching for the prey patch. Yano *et al.* (2005) also concluded that the walking speed of *O. sauteri* increased as they approached the prey patch. Females of *O. insidiosus* spent less time on the 1st prey encounter than 5th instar nymphs and males. Adult females generally spent little time on all prey encounters (prey patch) and this may be advantageous because prey patches with little or no chance to encounter prey will be vacated faster in search of food by *O. insidiosus* when no prey has been encountered for some time.

Orius insidiosus fed by inserting its proboscis into the abdomen of *T. palmi*. Most stung and manoeuvred their prey into submission before quickly switching to other prey in the patch. On several occasions *O. insidiosus* females, males and 5th instar nymphs were observed puncturing (with proboscis) or stinging (with ovipositor in the case of females) usually the abdomen of *T. palmi* without actual consumption. This resulted in death of *T. palmi*, which can be regarded as beneficial in the case of a predator used for biological control and is a common behaviour by insect predators when they encounter a prey patch (Rajasekhara and Chatterji, 1970). A similar sequence of events was recorded by Yano *et al.* (2005) for *O. sauteri* including the fact that it only partially exploited each prey patch. Biocontrol agents such as *Orius* spp. are generally introduced into a field or greenhouse when pests are at high population densities. Predators can be satiated shortly after being introduced to a prey patch but are expected to continue to control pest populations. Yano *et al.* (2005) suggested that *Orius* spp. attack tendencies were not regulated by their level of starvation. At lower prey densities, the search efficiency is lower (O'Neil, 1988) due to the energy cost of locating prey. At higher densities, De Clercq and Degheele (1994) reported that the predation rate may be increased due to the ease with which predators encounter prey, causing the predator to abandon its prey before it is fully consumed.

REFERENCES

Ambrose DP, Rajan SJ, Nagarajan K, Krishnan SS. 2009. Biology, behaviour and functional response of *Sphedanolestes variabilis* Distant (Hemiptera: Reduviidae), a potential predator of lepidopteran pests. *Entomol Croatia*. **13**: 33-44.

Baez I, Reitz S, Funderburk JE. 2004. Predation by *Orius insidiosus* (Heteroptera: Anthocoridae) on life stages and species of *Frankliniella* on flower thrips (Thysanoptera:Thripidae) in pepper flowers. *Environ Entomol*. **33**: 662-670. https://doi.org/10.1603/0046-225X-33.3.662

Bell WJ. 1990. Searching behaviour patterns in insects. *Annu Rev Entomol*. **35**: 447-467. https://doi.org/10.1146/annurev.en.35.010190.002311

Bueno VHP. 2009. Desenvolvimento e criacao massal de percevejos predadores *Orius*. In: Bueno VHP (Ed.) Controle biologico de pragas: producao massal e controle de qualidade, Lavras, Brasil: UFLA Publications, pp. 33-76.

Castañé C, Riudavets J, Yano E. 1999. Biological control of thrips. In: Albajes R, Gullino MA, van Lenteren JC and Elad Y (Eds.) Integrated Pest and Disease Management in Greenhouse Crops, Dordrecht, the Netherlands: Kluwer Academic Publishers, pp. 244-253. https://doi.org/10.1007/0-306-47585-5_17

Cocuzza GE, De Clerq P, Lizzo S, Van De Veire M, Tirry L, Degheele D, Vacante V. 1997. Life tables and predation activity of *Orius laevigatus* and *O. albidipennis* at three constant temperatures. *Entomol Exp Applic*. **85**: 189-198. https://doi.org/10.1046/j.1570-7458.1997.00249.x

De Clerq P, Degheele D. 1994. Laboratory measurement of predation by *Podisus maculiventris* and *P. sagitta* (Hemiptera: Pentatomidae) on beet armyworm (Lepidoptera: Noctuidae). *J Econ Entomol*. **87**: 76-83. https://doi.org/10.1093/jee/87.1.76

Gomez KA, Gomez AA. 1984. Statistical Procedures in Agricultural Research, New Jersey: Wiley-Interscience, 704p.

Kawai A. 1995. Control of *Thrips palmi* Karny (Thysanoptera: Thripidae) by *Orius* spp. (Heteroptera: Anthocoridae) on greenhouse eggplant. *Appl Entomol Zool*. **30**: 1-7. https://doi.org/10.1303/aez.30.1

Lattin JD. 1999. Bionomics of the Anthocoridae. *Annu Rev Entomol*. **44**: 207-231. https://doi.org/10.1146/annurev.ento.44.1.207 PMid:15012372

Loureiro ES, Júnior AM. 2007. Patogenicidade de fungos entomopatogênicos a *Orius insidiosus* (Say) (Hemiptera: Anthocoridae). *BioAssay*. **2**: 1-8. https://doi.org/10.14295/BA.v2.0.15

Mendes SM, Bueno VHP. 2001. Biologia de *Orius insidiosus* (Say) (Hemiptera: Anthocoridae) alimentado com *Caliothrips phaseoli* (Hood) (Thysanoptera: Thripidae). *Neotrop Entomol*. **30**: 423-428 https://doi.org/10.1590/S1519-566X2001000300014

O'Neil RJ. 1988. Predation by *Podisus maculiventris* Say on Mexican bean beetle *Epilachna varvestris* Mulsant in Indian soyabeans. *Can Entomol*. **120**: 161-166. https://doi.org/10.4039/Ent120161-2

Rajasekhara K, Chatterji S. 1970. Biology of *Orius indicus* (Hemiptera: Anthocoridae), a predator of *Taeniothrips nigricornis* (Thysanoptera). *Ann Entomol Soc Amer*. **63**: 364-367. https://doi.org/10.1093/aesa/63.2.364

Sabelis MW, van Rijn PCJ. 1997. Predation by insects and mites. In: Lewis T (Ed.) Thrips as Crop Pests, New York, NY, USA: Oxford University Press/CAB International, pp. 259-354.

Shields EJ. 1979. Searching behaviour of *Orius tristicolor* (White) on cotton. Master of Science thesis University of Arizona, USA. 72pp.

van Lenteren JC, Manzaroli G. 1999. Evaluation and use of predators and parasitoids for biological control of pests in greenhouses. In: Albajes R, Gullino ML, van Lenteren JC and Elad Y (Eds.). Integrated Pest and Disease Management in Greenhouse Crops, Dordrecht, the Netherlands: Kluwer Academic Publishers, pp. 183-201. https://doi.org/10.1007/0-306-47585-5_13

Yano E, Jiang N, Hemerik L, Mochizuki M, Mitsunaga T, Shimoda T. 2005. Time allocation of *Orius sauteri* in attacking *Thrips palmi* on an eggplant leaf. *Entomol Exp Applic*. **117**: 177-184. https://doi.org/10.1111/j.1570-7458.2005.00347.x