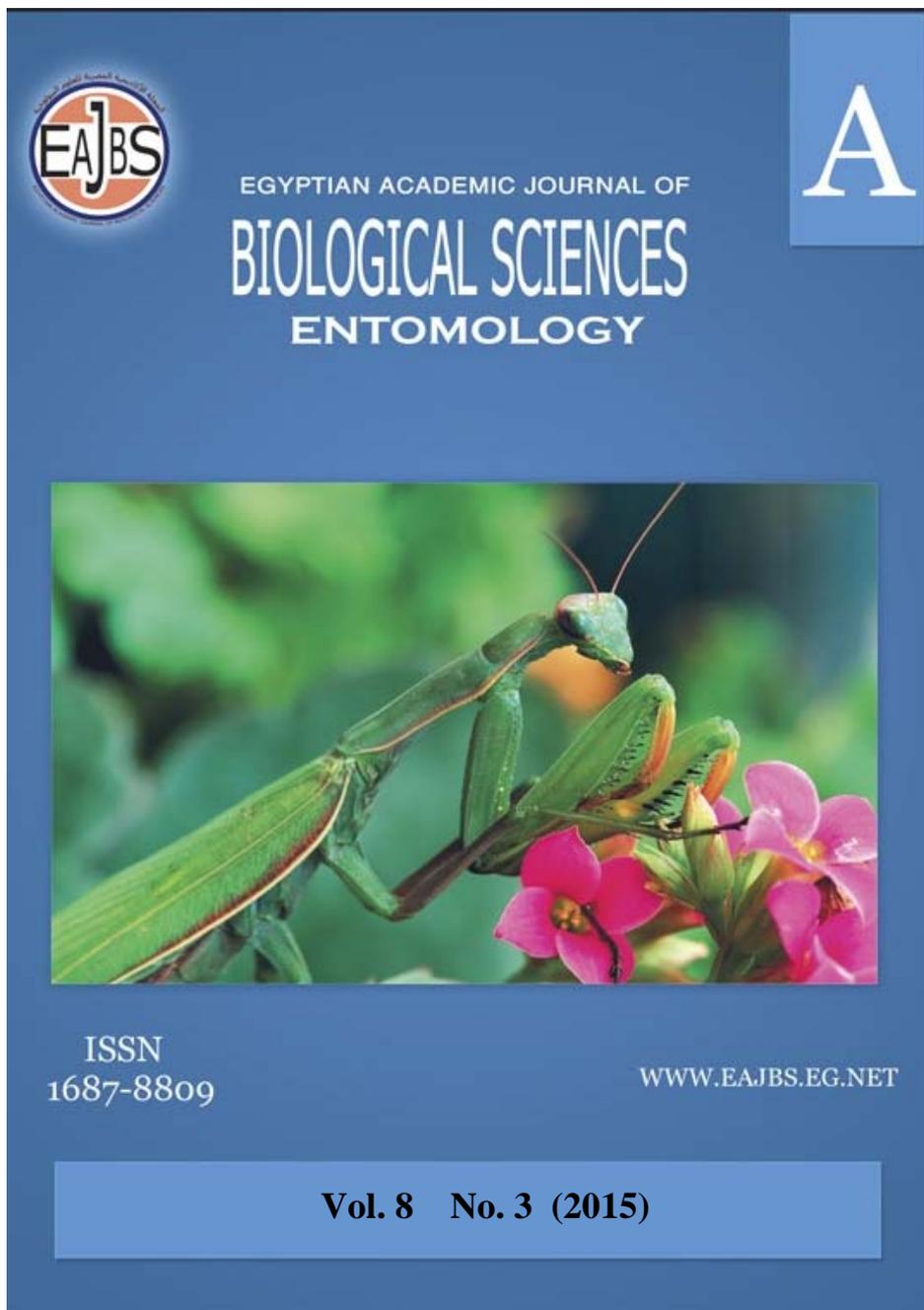


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Intraguild Predation And Cannibalism Among Mite Predators: *Stethorus gilvifrons* (Mulsant) (Coleoptera: Coccinellidae), *Orius albidipennis* (Reuter) (Hemiptera: Anthocoridae) And *Scolothrips longicornis* Priesner (Thysanoptera: Thripidae)

Nesrin A. El-Basha

Department of Biological Control, Plant Protection Research Institute, Agricultural Research Center, Giza, Egypt

E-mail:nesrinelbasha@hotmail.com

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ABSTRACT

Stethorus gilvifrons (Mulsant), *Orius albidipennis* (Reuter) and *Scolothrips longicornis* Priesner are the key predators of *Tetranychus urticae* in Egypt. In this study, the intraguild predation (IGP) and cannibalism of adult females of these predators were studied under laboratory conditions. Data revealed that in the absence of extra guild prey (*T. urticae*), the adult females of IG predator *S. gilvifrons* consumed more larvae or nymphs of IG prey species than IG predators of *O. albidipennis* or *S. longicornis*. Females of *S. gilvifrons* showed significantly a higher predation rate on heterospecific young and old nymph instars of *O. albidipennis* than on *S. longicornis*. Interactions of adults *S. gilvifrons* and larvae or nymphs of *O. albidipennis* or *S. longicornis* were highly asymmetric or unidirectional predation always being the IG predator. *S. gilvifrons* had stronger intraguild predator than *O. albidipennis* or *S. longicornis*. Intraguild predation could be considered mutual between *O. albidipennis* and *S. longicornis* but there is neither predation nor egg deposition occurred on young or old larvae of *S. gilvifrons*. The IG predator *O. albidipennis* showed higher predation rate on *S. longicornis* than on conspecific nymphs. Whereas, *S. longicornis* showed high predation rate on conspecific larvae. Females of *S. gilvifrons* provided with conspecific or heterospecific young and old larvae or nymphs were able to lay eggs when fed on *S. gilvifrons*, *O. albidipennis* and *S. longicornis*. Also, *O. albidipennis* and *S. longicornis* laid eggs when fed on conspecific or heterospecific young and old larvae or nymphs except when fed on larvae of *S. gilvifrons* as IG prey. Obviously, the presence of *T. urticae* led to significant decrease in IGP.

INTRODUCTION

The two spotted spider mite (TSSM), *Tetranychus urticae* Koch (Acari: Tetranychidae), is one of the most problematic phytophagous pests not only in Egyptian fields but also around the world in various ornamental and vegetable crops (Cranham and Helle, 1985; Helle and Sabelis, 1985; Zaher, 1986; Abd-Elhady and Heikal, 2011). Biological control using natural enemies is a promising strategy for

managing TSSM mites in agricultural eco-system. The success of biological control of TSSM depends mainly on the conditions of pests and natural enemies (Rosenheim, 1998; Janssen *et al.*, 2006).

In Egypt *T. Urticae* on eggplant is usually attacked by several predators such as *Stethorus gilvifrons* (Mulsant) (Coleoptera: Coccinellidae), *Orius albidipennis* (Reuter) (Hemiptera: Anthocoridae) and *Scolothrips longicornis* Priesner (Thysanoptera: Thripidae). While some predators, such as *S.gilvifrons* and *S. longicornis* are specialized on mites (Cranham and Helle, 1985; Helle and Sabelis, 1985; Sarhan *et al.*, 1989; Rott and Ponsonby, 2000), others like *O.albidipennis* have polyphagous habits and their prey range includes spider mites, thrips, whiteflies and/or eggs and larvae of coleopteran and lepidopteran species (Tawfik and Ata,1973; Zaki,1989; Madadi *et al.*, 2008; Madadi *et al.*, 2009).

In pest management, whether introduction of multiple natural enemies is more effective than that of a single enemy has been debated for a long time (Rosenheim *et al.*,1995). The effect of predator diversity on suppression of prey is variable depending on species composition or intra- and interspecific interactions (Sih *et al.*, 1998; Griffin *et al.*, 2013). Predation among various life stages may take place between different species within a guild (intraguild predation) as well as within each species (cannibalism). Cannibalism and intraguild predation are expected to occur mainly when the population of the preferred prey is low (Polis, 1981; Polis *et al.*, 1989). Cannibalism, the consumption of conspecific individuals is a common phenomenon that occurs in the animal kingdom (Schausberger, 2003). Intraguild predation (IGP) can occur among mite predators thus reducing their effectiveness in controlling mite pests. Intraguild predation occurs when one species in a predatory guild feeds on another predatory species within the same guild. The aggressor is called the intraguild predator (IG predator), the victim is called the intraguild prey (IG prey) whereas the common resource is the extra guild prey (Polis *et al.*, 1989; Rosenheim *et al.*,1995; Janssen *et al.*,1998). Intraguild predation can be classified as: symmetric (mutual predation) when the interaction goes in both directions, the predator becoming the prey and vice versa or asymmetric (unidirectional) one of the guild's members is always the prey and the other member always the predator (Polis *et al.*,1989).

In IGP the outcome of an encounter between two guild partners depends on their general characteristics: relative body, mobility, vigour, aggressiveness, defensive strategies and degree of feeding specificity.IGP and cannibalism have been shown to directly limit predator populations (Wagner and Wise, 1996; Wissinger *et al.*,1996) and hence, the outcome of biological pest control (Colfer and Rosenheim, 2001). In greenhouses, it has become common practice to apply several biocontrol agents not only against different pest species but also against one pest species. Evaluation of the IGP potential and intensity among biocontrol agents is essential in the selection of appropriate combinations of beneficial species for biological control (Meyling *et al.*, 2004).

Therefore, the aim of the current study was to determine, under laboratory conditions, the likelihood of intraguild predation and cannibalism among adult females of *S. gilvifrons*, *O. albidipennis* and *S. Longicornis* as IG predator and young and old larval or nymphal stages of each predatory species as IG prey in the absence and presence of extra guild prey (*T. urticae*).

MATERIALS AND METHODS

Mite colony:

The stock colony of (TSSM) *Tetranychus urticae* was established from individuals collected from eggplant (*Solanum melongena* L.) at the Experimental Farm, Ismailia Agricultural Research Station, Egypt. The colony of *T. urticae* was kept on detached sweet potato branches kept with their upper part of stem in contact with water in glass vials at 25 °C, 60-80% RH. (Sarhan *et al.*, 1989; Sarhan *et al.*, 1991).

Predators rearing

Cohorts of *Stethorus gilvifrons*, *Orius albidipennis* and *Scolothrips longicornis* were collected in 2011 from eggplant infested with *T. urticae* at the Experimental Farm, Ismailia Agricultural Research Station, Egypt. Adults of *S. gilvifrons* were reared on potato leaves, heavily infested with *T. Urticae* as described earlier by (Sarhan *et al.*, 1989; Rott and Ponsonby 2000). Adults of *O. albidipennis* were reared on detached bean pods (*Phaseolus vulgaris* L.) as an ovipositional substrate infested with *T. urticae* (Sobhy *et al.*, 2010; El Basha *et al.*, 2012). Whereas, colonies of *S. longicornis* were reared in glass jars covered with muslin and provided with pieces of cabbage leaves heavily infested with *T.urticae* as oviposition site (Sarhan *et al.*, 1991). Adult predators of a specific age class were obtained by rearing neonate larvae in synchronous cohorts until they reached the desired stage. IG preys were classified as "young" (less than 24h) and "old" larvae (48h) at 25°C. Adult predators were starved for 24h prior to testing in order to increase their motivation. Rearing unites and experimental arenas were held at 25±1°C and 60-70% R. H. Preliminary tests showed that a supply of either thirty young or twenty five old larvae or nymph per day is sufficient for females of all predators to survive and reproduce.

Experimental set up

We characterized the level of IGP among larval or nymphal stages of each of the three predator species as IG prey in the absence and presence of extra guild prey (*T. urticae*). A couple (7days old) of each species (10 replicates/treatment per species) was added to 4 cm diameter bean leaf discs with an excess of mites and placed on a layer of filter paper sheet on water-saturated cotton pad in 8 cm diameter Petri dishes, which used as the experimental arena. After 24h, each female was transferred to a fresh arena without the prey *T. urticae* and with bean pod (*Phaseolus vulgaris*) as the oviposition site for *O. albidipennis* and *S. longicornis*. Adult predators starved for 24h prior to testing in order to increase their motivation for predation and only females that laid at least one egg during starvation were used for the experiments. During the starvation period only tap water on a cotton ball was provided to the predator. Three experimental sets up were conducted with three sub sets in each set.

In the first set of the experiment of each IG predator, one adult female was confined with thirty young larvae or nymphs of each tested con-or heterospecific prey (IG preys), ten replicates were used 10 times for each species (experiment 1). In the second set of the experiment twenty five old larvae or nymphs of the IG preys were used in each replicates with ten replicates for each predatory species (experiment 2). In the third set of the experiment twenty five old larvae or nymphs in each IG preys were offered for the tested IG predators with the presence or absence of extra guild prey of *T. urticae* (experiment 3). In the presence of extra guild prey of *T. urticae*, three hundred individuals of deuto nymphs were provided in each replicate. Predation (number of prey individuals consumed) and oviposition rate (number of laid eggs) were recorded daily among the three predators. Shriveled corpses of the dead

immatures were taken as evidence of predation. Every 24h, all immature stages were renewed and the eggs laid by females were removed. The experimental period lasted a maximum of 10 days. The mortality of IG prey (young or old larvae) in the absence of predators was measured as a control, all individuals of three species of the predators survived throughout the 10 days experiment regardless of TSSM present or not except *O.albidipennis* and *S.longicornis* when feeding on *S.gilvifrons* in the absence of TSSM.

Statistical analysis

All experiments were subjected to analysis of variance (ANOVA), using Co Stat 6311 Windows Computer Program. The mean predation and oviposition rates of predators provided with either con-or heterospecific prey were compared using Duncan's Multiple Range Tests (DMRT). Data of the predation and oviposition rates were calculated as a daily mean for each female and used for interspecies comparison. Data were fitted with the assumptions of normality, not transformed, and the differences were compared for each predator species between all prey species.

RESULTS

Experiment 1: In case of feeding on con- or heterospecific young larval or nymph instars

The first IG predator *S. gilvifrons* showed significantly a higher predation rate on heterospecific young nymphal instar of *O. albidipennis* and it showed a low rate on conspecific young larval instar and heterospecific young larval instar of *S. longicornis* (Table 1).

Table 1: Daily mean predation and oviposition (\pm SE) for *S. gilvifrons*, *O. albidipennis* and *S. longicornis* females provided with con- or heterospecific young larval or nymphal instars for 10 consecutive days under laboratory conditions of $25\pm 1^\circ\text{C}$ and 60-70% R.H.

| IG predator | IG prey | Predation* | Oviposition** |
|------------------------|------------------------|---------------------------------|---------------------------------|
| <i>S. gilvifrons</i> | <i>S. gilvifrons</i> | 7.98 \pm 0.21 b ^B | 0.26 \pm 0.06 b ^{CD} |
| | <i>O. albidipennis</i> | 21.71 \pm 0.46 a ^A | 0.65 \pm 0.07 a ^A |
| | <i>S. longicornis</i> | 6.26 \pm 0.21 c ^C | 0.18 \pm 0.03 b ^D |
| F value | | 758.375 | 15.157 |
| P value | | 0.000 | 0.000 |
| <i>O. albidipennis</i> | <i>O. albidipennis</i> | 5.99 \pm 0.26 b ^C | 0.36 \pm 0.08 b ^{BC} |
| | <i>S. gilvifrons</i> | 0.00 \pm 0.00 c ^F | 0.00 \pm 0.00 c ^E |
| | <i>S. longicornis</i> | 8.40 \pm 0.16 a ^B | 0.52 \pm 0.07 a ^A |
| F value | | 813.523 | 27.009 |
| P value | | 0.000 | 0.000 |
| <i>S. longicornis</i> | <i>S. longicornis</i> | 5.13 \pm 0.16 a ^D | 0.42 \pm 0.07 a ^{AB} |
| | <i>S. gilvifrons</i> | 0.00 \pm 0.00 c ^F | 0.00 \pm 0.00 b ^E |
| | <i>O. albidipennis</i> | 3.31 \pm 0.16 b ^E | 0.33 \pm 0.04 a ^{BC} |
| F value | | 550.996 | 22.527 |
| P value | | 0.000 | 0.000 |
| F value | | 968.810 | 16.640 |
| P value | | 0.000 | 0.000 |

*Mean number of larvae or nymphs eaten /female /day

**Mean number of eggs deposited /female /day

Means in a block for each predator species followed with the same SMALL letters are not significantly different. Means in a whole column followed with the same CAPITAL letters are not significantly different at 5% level probability. In each predator (differences within each prey species) df=2.97; In a whole column (differences among all IG preys) df=8.9.

Mean predation rate of *S. gilvifrons* was 21.71 young nymphal instar of *O. albidipennis*, while it was 7.98 on feeding conspecific young larva and it was 6.26

larvae of *S. longicornis*. Daily fecundity of *S. gilvifrons* provided with con- or heterospecific young larvae or nymphs were 0.26, 0.65 and 0.18 eggs/day when feeding on *S. gilvifrons*, *O. albidipennis* and *S. longicornis*, respectively. In case of *O. albidipennis*, it showed predation rate of 8.40 larvae of *S. longicornis*, while on conspecific nymph it was 5.99. On *S. gilvifrons* neither predation nor laying eggs was observed. *O. albidipennis* females provided with con- or heterospecific young larvae or nymphs laid 0.52 and 0.36 eggs/day/female when fed on *S. longicornis* and *O. albidipennis*, respectively. Regarding the IG predator *S. longicornis*, it showed predation rate on conspecific young larvae by 5.13 and 3.31 on *O. albidipennis* but failed to feed on *S. gilvifrons*. Females of *S. longicornis* laid on average 0.42 eggs/day on conspecific young larvae and 0.33 eggs on heterospecific nymphs of *O. albidipennis*, but no eggs were deposited when fed on *S. gilvifrons* (Table 1).

Experiment 2: In case of feeding on con- or heterospecific old larval or nymphal instars

Females of *S. gilvifrons* consumed more larvae of the tested IG preys than females of *O. albidipennis* and *S. longicornis*. Mean predation rates of *S. gilvifrons* were significantly higher when feeding on heterospecific old nymphs of *O. albidipennis* (12.73) with subsequent higher daily fecundity as compared to *S. longicornis* (3.15) larvae and cannibalized 4.94 larvae per day (Table 2).

Table 2: Daily mean of predation and oviposition (\pm SE) for *S. gilvifrons*, *O. albidipennis* and *S. longicornis* females provided with con- or heterospecific old larval or nymphal instars for 10 consecutive days under laboratory conditions of $25\pm 1^\circ\text{C}$ and 60-70% R.H.

| G predator | IG prey | Predation | Oviposition |
|------------------------|------------------------|----------------------------------|----------------------------------|
| <i>S. gilvifrons</i> | <i>S. gilvifrons</i> | 4.94 \pm 0.124 b ^B | 0.49 \pm 0.067 a ^A |
| | <i>O. albidipennis</i> | 12.73 \pm 0.415 a ^A | 0.57 \pm 0.049 a ^A |
| | <i>S. longicornis</i> | 3.15 \pm 0.160 c ^D | 0.19 \pm 0.037 b ^{BC} |
| F value | | 526.681 | 13.114 |
| P value | | 0.000 | 0.000 |
| <i>O. albidipennis</i> | <i>O. albidipennis</i> | 2.77 \pm 0.187 b ^{DE} | 0.18 \pm 0.055 a ^{BC} |
| | <i>S. gilvifrons</i> | 0.00 \pm 0.000 c ^F | 0.00 \pm 0.000 b ^D |
| | <i>S. longicornis</i> | 3.92 \pm 0.172 a ^C | 0.27 \pm 0.131 a ^B |
| F value | | 264.186 | 14.591 |
| P value | | 0.000 | 0.000 |
| <i>S. longicornis</i> | <i>S. longicornis</i> | 3.59 \pm 0.120 a ^C | 0.24 \pm 0.061 a ^B |
| | <i>S. gilvifrons</i> | 0.00 \pm 0.000 c ^F | 0.00 \pm 0.000 c ^D |
| | <i>O. albidipennis</i> | 2.47 \pm 0.110 b ^E | 0.10 \pm 0.039 b ^{CD} |
| F value | | 339.562 | 12.985 |
| P value | | 0.000 | 0.000 |
| F value | | 570.768 | 21.343 |
| P value | | 0.000 | 0.000 |

Means in a block for each predator species followed with the same SMALL letters are not significantly different at 5% level of probability.

Means in a whole column followed with the same CAPITAL letters are not significantly different at 5% level of probability.

In each predator (differences within each prey species) df = 2.97; In a whole column (Differences among IG preys) df = 8.91.

Daily fecundity of *S. gilvifrons* provided with con- or heterospecific old larvae or nymphs were 0.49, 0.57 and 0.19 eggs/day when feeding on *S. gilvifrons*, *O. albidipennis* and *S. longicornis*, respectively. Intraguild predation was 3.92 larvae in IG predator of *O. albidipennis* when fed on *S. Longicornis* and cannibalize 2.77 nymphs. *O. albidipennis* females provided with con- or heterospecific old larvae or

nymphs laid 0.27 and 0.18 eggs/day/female when fed on *S. longicornis* and *O. albidipennis*; respectively. Mean predation rate of IG predator *S. Longicornis* on conspecific were 3.59 larvae. While, when fed on *O. albidipennis* were 2.47. Females of *S. longicornis* laid on average 0.24 eggs/day on conspecific young larvae and 0.10 eggs on heterospecific nymphs of *O.albidipennis*. Both IG predators of *O. albidipennis* and *S. longicornis* failed to feed or oviposit eggs on *S. gilvifrons* (Table 2).

Experiment 3: In case of feeding on con- or heterospecific old larval or nymphal instar in presence and absence of extraguild prey *T. urticae*.

The presence of the extraguild prey *T. urticae* had significant effect on the IGP level. The mean number of *O. albidipennis* old nymphs consumed by *S. gilvifrons* female significantly decreased from 12.73 in the absence of *T. urticae* to 3.12 in presence of *T. urticae*. In case of the IG prey *S. gilvifrons* and *S. longicornis*, the mean number of old larvae consumed were 4.94 and 3.15 in absence of *T. urticae* and 1.97 and 0.94 in presence of *T. urticae* respectively. The mean number of Larvae *S. longicornis* consumed by adults *O. albidipennis* decreased from 3.92 to 1.12 larvae in absence and presence of *T. urticae*. While, cannibalizing old nymphs of *O. albidipennis* were 2.77 and 0.77 in absence and presence *T. urticae*. The cannibalizing rate of IG predator, *S. longicornis* decreased from 3.59 to 0.60 old larvae in absence and presence of *T. urticae*. The mean predation of *S. longicornis* on heterosecific nymph of *O. albidipennis* decreased from 2.47 to 0.28. The IG predators *S. longicornis* and *O. albidipennis* failed to feed on *S. gilvifrons* but oviposit eggs as a result of feeding on *T. urticae*. The oviposition rates increased significantly in presence than in absence of *T. urticae*. The highest oviposition of *S. gilvifrons* fed on *O. albidipennis* was 1.28 eggs, while the highest oviposition of *O. albidipennis* fed on *S.longicornis* was 1.07 eggs. Whereas, the highest oviposition of *S. longicornis* was 0.93 eggs when, cannibalized its larvae (Figs.1, 2).

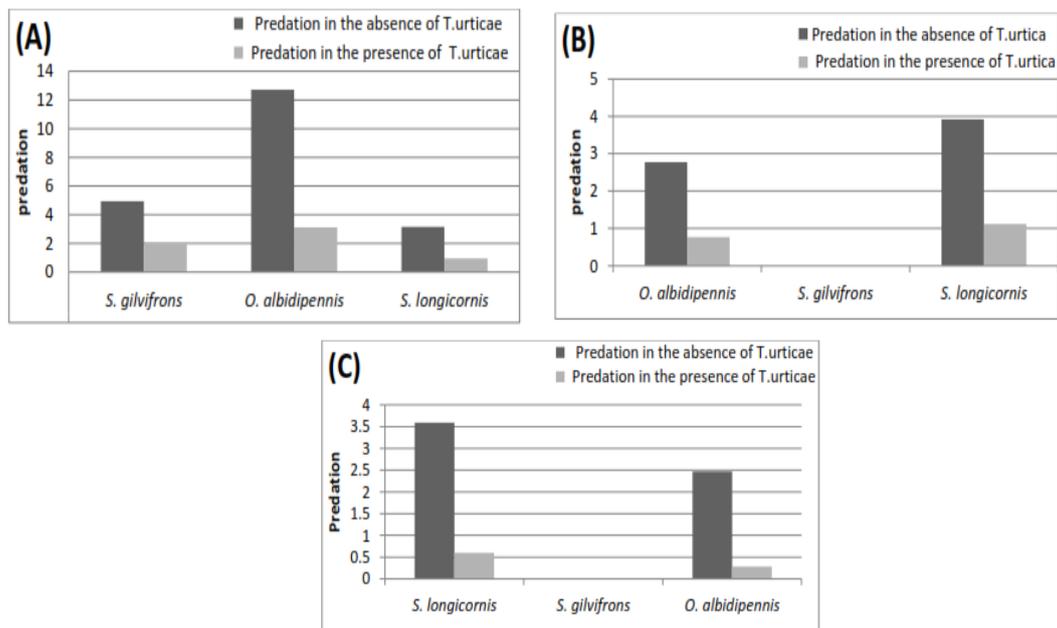


Fig. 1: Mean predation rate for adult females of *S. gilvifrons* (A), *O. albidipennis* (B) and *S. longicornis* (C) provided with conspecific or heterospecific old larval or nymphal instars in the absence and presence of the extraguild prey *T. urticae*.

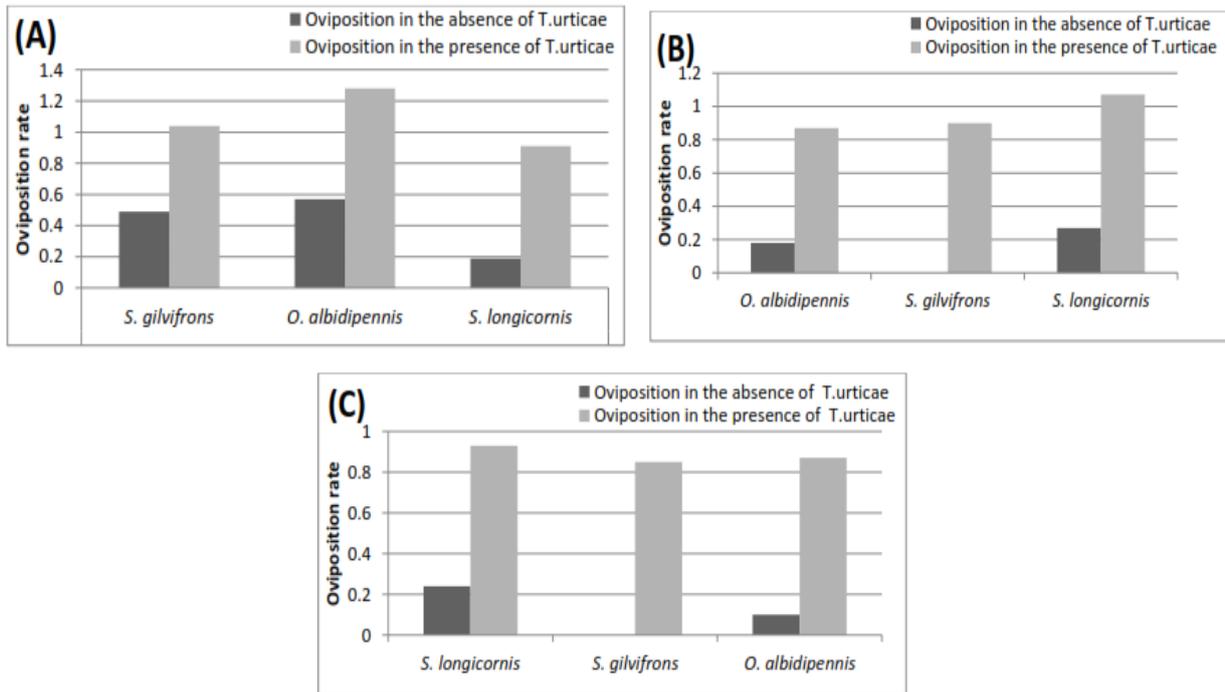


Fig. 2: Mean oviposition rate for adult *S. gilvifrons* (A), *O. Albidipennis* (B) and *S. longicornis* (C) females provided with conspecific or heterospecific old larval or nymphal instars in the absence and presence of the extraguild prey *T. urticae*.

DISCUSSION

Intraguild predation IGP is particularly common in generalist predators as they will often consume other natural enemies as well as the target pest (Polis *et al.*, 1989; Momen and Abdel-Khalek, 2009). In this study and with the absence of the extra guild prey *T. urticae*, females of IG predator *S. gilvifrons* consumed more larvae of IG prey species than the IG predators, *O. albidipennis* or *S. longicornis*. Females of *S. gilvifrons* showed significantly higher predation rate on heterospecific young and old nymphal instars of *O. albidipennis*. Interactions of the IG predator *S. gilvifrons* and IG prey young and old larvae or nymphs of *O. albidipennis* or *S. longicornis* were highly asymmetric or unidirectional predation always being the IG predator due to the effectiveness of the defensive alkaloids that coccinellid are synthesized in fat bodies, and secreted as defensive fluids (reflex bleeding) in larvae and adults (Laurent *et al.*, 2002). *S. gilvifrons* was more aggressive and stronger intraguild predator than *O. albidipennis* or *S. longicornis*. Aggressiveness among species has previously been shown to be an important factor in interactions of the three mite predators. There is neither predation nor egg deposition occurred on young or old larvae of *S. gilvifrons* by adults of *O. albidipennis* or *S. longicornis*. IGP could be considered mutual between *O. albidipennis* and *S. longicornis*. The heterospecific individual proved to be more attractive prey for females of *S. gilvifrons* and *O. albidipennis* but in case of IG predator *S. longicornis*, the conspecific individuals were more acceptable as preys. Predators can discriminate heterospecific preys from conspecifics and feed preferentially on the prey. Cannibalism or IGP could supply the predator with the required energy to molt to the subsequent stage till reach adulthood (Schausberger, 2003).

Data showed that adults *S. longicornis* cannibalized their own larvae in presence and absence of TSSM, but a significant reduction took place in presence of *T. urticae*.

These findings are in line with those recorded by Farazmand *et al.* (2014) for *S. longicornis*, which showed a cannibalistic behavior on its own first and second instar larvae, however when TSSM was added, females of *S. longicornis* fed only on TSSM. Therefore, cannibalizing larval stages of thrips would help to sustain its population in lack or absence of TSSM. This is an adaptive mechanism to environmental factors such as limitations in the quality or quantity of food (Richardson *et al.*, 2010). *S. longicornis* revealed predation rate on heterospecific young or old nymph of *O. albidipennis*. However, in contrast to the earlier study, which showed that *S. longicornis* is monophagous and was not able to feed on larval stages of two phytoseiid predators, *Neoseiulus californicus* and *Typhlodromus bagdasarjani* (Farazmand *et al.*, 2013).

IG predator *O. albidipennis* showed higher predation rate on *S. longicornis* than on conspecific nymphs. As a polyphagous predator, *Orius* may not discriminate between predatory and phytophagous insects and mites (Madadi *et al.*, 2008). This has led to some concerns about interference with other biological control agents. Indeed, laboratory experiments generally showed that predatory bugs readily preyed on several natural enemies, but field observations never justified this concern (Brødsgaard and Enkegaard, 1997) For example, *O. insidiosus* was reported preying on *Scolothrips sexmaculatus* and *Leptothrips mali* (McCaffrey and Horsburgh, 1986). Cannibalism has been observed in several *Orius* species, both in the laboratory (Askari and Stern, 1972; Mituda and Calilung, 1989) and in the field (Nakata, 1994). Brødsgaard and Enkegaard, (1997) reported that the combined use of *Orius majusculus* and *Phytoseiulus persimilis* delayed the control of *Tetranychus urticae* due to the intraguild predation of *O. majusculus* on *P. persimilis*.

Although IG predator *S. gilvifrons* is acarophagous and specialist on mites, it showed higher predation rate when feeding on heterospecific nymphs of *O. albidipennis* and consumed fewer larvae of *S. longicornis* and conspecific larvae. These results are in agreement with studies of other species of *Stethorus* that attack other predators. Lucas (2005) reported that small acarophagous ladybirds *Stethorus pusillus* attacked young stages of the mired bug *Campylomma verbasci*. Also, Putman (1955) observed predation of *Stethorus* sp. upon phytoseiids.

Females of *S. gilvifrons* provided with conspecific or heterospecific young and old larvae or nymphs were able to lay eggs when feeding on *S. gilvifrons*, *O. albidipennis* and *S. longicornis*. Also, *O. albidipennis* and *S. longicornis* laid eggs when feeding on conspecific or heterospecific young and old larvae or nymphs except when feeding on larvae of *S. gilvifron* as IG prey.

The presence of spider mites did not prevent IGP or cannibalism. These findings partially confirm that IGP decreases if extraguild prey *T. urticae* is present. Adding *T. urticae* modified the IGP levels. A significant reduction in IGP was observed during the present experiment than in absence of *T. urticae*. The presence of extraguild prey usually decreases the intensity of IGP (Lucas *et al.*, 1998; Hindayana *et al.*, 2001). The oviposition rates of IG predators significantly increase in presence of mite prey than in its absence. The IGP and cannibalism events were inversely correlated with abundance of food (Lucas *et al.*, 1998; Hindayana *et al.*, 2001), hypothesized that interactions among individuals would be expressed most strongly at low food availability.

CONCLUSION

This study presents experimental evidence that intraguild predation and

cannibalism exist among the studied mite predators. In the absence of extra guild prey TSSM, studying IGP among mite predators revealed that *S. gilvifrons* acts as a strong predator on young and old stages of *O.albidipennis*, *S.longicornis*; but *O. albidipennis* was prone strongly to IGP. *S. gilvifrons* demonstrated asymmetric or unidirectional predation always being the IG predator and seems to be a more voracious intraguild predator than others and may play an important role in population dynamics of mite predators. IGP could be considered mutual between *O. albidipennis* and *S. longicornis* our findings partially confirm that IGP decreases if extra guild prey present, the significant reduction in IGP was observed following the addition of *T. urticae*.

The laboratory results may give indications as to interactions among the three species in the field. However, ecologists are interested in knowing whether multiple predators lead to lower prey densities than the most effective single predator, especially in the context of biological control (Cardinale *et al.*,2003). In case of no IGP, releasing multiple control agents will provide better suppression of the pest population than a single control agent. However, if either unidirectional or mutual IGP may occur, single control agent will be more effective in suppressing the prey population than multiple control agents combined.

Further research need to be conducted under field conditions on biological and ecological aspects of the *S.gilvifrons*, *O.albidipennis* and *S.longicornis* to complement information on their successful application against mites before any ultimate conclusion could be drawn.

REFERENCES

- Abd-Elhady, H.K. and Heikal, H.M. (2011): Selective toxicity of three acaricides to the two spotted spider mite *Tetranychus urticae* and predatory mite *Phytoseiulus persimilis* in apple orchards. *J. Entomol.*, 8:574-580.
- Askari, A. and Stern, V. (1972): Biology and feeding habits of *Orius tristicolor* (Hemiptera: Anthocoridae). *Ann. Entomol. Soc. Am.*, 65: 96-100.
- Brødsgaard, H. and Enkegaard, A. (1997): Interactions among polyphagous anthocorid bugs used for thrips control and other beneficial in multispecies biological pest management systems. *Recent Res. Dev. Entomol.*, 1: 153–160.
- Cardinale, B.J., Harvey, C.T., Gross, K. and Ives, A.R. (2003): Biodiversity and biocontrol emergent impacts of a multi enemy assemblage on pest suppression and crop yield in an agro ecosystem. *Ecology Letters*, 6:857–865.
- Colfer, R.G. and Rosenheim, J.N. (2001): Predation on immature parasitoids and its impact on aphid suppression. *Oecologia*, 126: 292–304.
- Cranham, J.E. and Helle, W.(1985): Pesticide resistance in Tetranychidae. In: Spider mites, their biology, natural enemies and control. Elsevier.,1(B):405-422.
- El-Basha, N.A., Salman, M.S. and Osman, M.A. (2012): Functional Response of *Orius albidipennis* (Reuter) (Hemiptera: Anthocoridae) to the Tow-spotted Spider Mite *Tetranychus urticae* (Acari: Tetranychidae). *J. Entomol.*, 9(5):248-256.
- Farazmand, A., Fathipour, Y.and Kamali, K.(2013): Intraguild predation among *Scolothrips longicornis* (Thysanoptera: Thripidae), *Neoseiulus californicus* and *Typhlodromus bagdasarjani* (Acari: Phytoseiidae) under laboratory conditions. *Insect Sci.*, 2013 Jun 11. doi: 10.1111/1744-7917.12047
- Farazmand, A., Fathipour, Y. And Kamali, K. (2014): Cannibalism in *Scolothrips longicornis* (Thysanoptera: Thripidae), *Neoseiulus californicus* and *Typhlodromus bagdasarjani* (Acari: Phytoseiidae) *Systematic & Applied*

- Acarology, 19(4): 471–480.
- Griffin, J., Byrnes, J. and Cardinale, B. (2013): Effects of predator richness on prey suppression a meta-analysis. *Ecology*, 94:2180–2187.
- Helle, W. and Sabelis, M. (1985). Spider mites and their Biology, Natural Enemies and Control. Elsevier, Amsterdam, the Netherlands, 1(B): 367-370.
- Hindayana, D., Meyhofer, R., Scholz, D. and Poehling, H. (2001): Intraguild predation among hoverfly, *Episyrphus balteatus* de Geer (Diptera: Syrphidae) and other aphidophagous predators. *Bio Control*, 20:236–246.
- Janssen, A., Pallini, A., Venzon, M. and Sabelis, M. (1998): Behaviour and indirect interaction in food webs of plant-inhabiting arthropods. *Experimental and Applied Acarology*, 22: 497–521.
- Janssen, A., Montserrat, M., Ris Lambers, R., Roos, A., Pallini, A. and Sabelis, W. (2006): Intraguild predation usually does not disrupt biological control. Springer, Dordrecht, pp. 21–44.
- Laurent, P., Braekman, J.C., Daloz, D. and Pasteels, J. M. (2002): In vitro production of Adaline and coccinelline, two defensive alkaloids from ladybird beetle (Coleoptera: Coccinellidae). *Insect Biochem. Mol. Biol.*, 32:1017–1023.
- Lucas, E. (2005): Intraguild predation among aphidophagous predators. *Eur J. Entomol.*, 102: 351–364.
- Lucas, E., Coderre, D. and Brodeur, J. (1998): Intraguild predation among aphid predators, characterization and influence of extraguild prey density. *Ecology*, 79:1084-1092.
- Madadi, H., Enkegaard, A., Brødsgaard, H., Pakdel, A., Ashouri, A. and Neishabouri, J. (2008): Intraguild predation of *Orius albidipennis* (Heteroptera: Anthocoridae) and prey preference for *Neoseiulus cucumeris* (Acari: Phytoseiidae) on different host plants. *Entomol. Fennica*, 19: 32–40.
- Madadi, H., Enkegaard, A., Brødsgaard, H., Pakdel, A., Ashouri, A. and Neishabouri, J. (2009): Interactions between *Orius albidipennis* (Heteroptera: Anthocoridae) and *Neoseiulus cucumeris* (Acari: Phytoseiidae): Effects of host plants under microcosm condition. *Bio. Control*, 50:137–142.
- McCaffrey, J. and Horsburgh, R. (1986): Biology of *Orius insidiosus* (Heteroptera: Anthocoridae) a predator in Virginia apple orchards. *Environ. Entomol.*, 15: 984-988.
- Meyling, N., Enkegaard, A. and Brødsgaard H. (2004): Intraguild predation by *Anthocoris nemorum* (Heteroptera: Anthocoridae) on aphid parasitoid *Aphidius colemani* (Hymenoptera: Braconidae). *Bio. Sci. Techn.*, 14: 627–630.
- Mituda, E. and Calilung, V. (1989): Biology of *Orius antillus* (Hemiptera: Anthocoridae) and its predatory capacity against *Thrips palmi* (Thysanoptera: Thripidae) on watermelon. *Philipp. Agric.*, 72(2):165-184.
- Momen, F. and Abdel-Khalek, A. (2009): Cannibalism and intraguild predation in the phytoseiid mites *Typhlodromus swirskii*, *Euseius scutalis* and *Typhlodromus athiasae* (Acari: Phytoseiidae). *Acarina*, 17: 223–229.
- Nakata, T. (1994): Prey species of *Orius sauteri* (Poppius) (Heteroptera: Anthocoridae) in a potato field in Hokkaido, Japan. *Appl. Entomol. Zool.*, 29: 614-616.
- Polis, C. A. (1981): The evolution and dynamics of intraspecific predation. *Annual Review of Ecology and Systematic*, 12: 225–251.
- Polis, G.A., Myers, C.A. and Holt, R.D. (1989): The ecology and evolution of intraguild predation, potential competitors that eat each other. *Annual Review of Ecology and Systematic*, 20: 297–330.

- Putman, W.L. (1955): Bionomics of *Stethorus punctillum* (Coleoptera: Coccinellidae) in Ontario. *Can. Entomol.*, 87: 9-33.
- Rhicardson, M. L., Mitchell, R. F., Reigel, P. F., Hanks, L. M.(2010): Causes and consequences of cannibalism in non carnivorous insects. *Annual Review of Entomology*, 55: 39–53.
- Rosenheim, J. (1998): Higher-order predators and the regulation of insect herbivore populations. *Annu. Rev. Entomol.*, 43:421–447.
- Rosenheim, J. A., Kaya, H. K., Ehler, L. E., Marois, J. J. and Jaffee, B. A.(1995): Intraguild predation among biological control agents: theory and evidence. *Bio Control*, 5: 303–335.
- Rott, A. S. and Ponsomby, D. J. (2000): The effect of temperature, relative humidity and host plant on the behavior of *Stethorus punctillum* as a predator of the two-spotted spider mite, *Tetranychus urticae*. *Bio Control*, 45:155-164.
- Sarhan, A. A., Shoukry, A. and Ahmed, S. A. (1989): Feeding capacity of the predator, *Stethorus gilvifrons* and effect of its prey, *Tetranychus urticae* on its post embryonic stages. *Proceed. 3rd Nat. conf. Pest & Plant dis. Veg. & Fru. In Egypt and Arab Countr., Ismailia*, 1:140-148.
- Sarhan, A.A., Shoukry, A. and El-Basha, N. A. (1991): Biological studies on *Scolothrips longicornis* a predator of *Tetranychus urticae* in Egypt. *5th Nat. conf. of pests and Dis. of Veg. & Fruits in Egypt Ismailia*, (1): 297-310.
- Schausberger, P. (2003): Cannibalism among phytoseiid mites: a review. *Experimental and Applied Acarology*, 29: 173–191.
- Sih, A., Englund, G. and Wooster, D. (1998): Emergent impacts of multiple predators on prey. *Trends Ecol. Evol.*, 13: 350–355.
- Sobhy, I., Sarhan, A., Shoukry, A., El-Kady, G., Mandour, N. and Reitz S. (2010): Development, consumption rates and reproductive biology of *Orius albidipennis* reared on various prey. *Bio Control*, 55:753–765.
- Tawfik, M. S. and Ata, A. M. (1973): The life history of *Orius albidipennis* (Reut.) (Hemiptera: Anthocoridae). *Bull. Entomol. Soc Egypt*, 57: 117-126.
- Wagner, J. and Wise, D. (1996): Cannibalism regulates densities of young wolf spiders: evidence from field and laboratory experiments. *Ecology*, 77: 639–652.
- Wissinger, S., Sparks, G., Rouse, G., Brown W. and Steltzer, H. (1996): Intraguild predation and cannibalism among larvae of detritivorous caddisflies in subalpine wetlands. *Ecology*, 77: 2421–2430.
- Zaher, M. (1986): Predaceous and non phytophagous mites in Egypt. Project No. EG-ARS-30, pl.480 Program USA., Grant No. Fg-EG-139.
- Zaki, F.N. (1989): Rearing of two predators, *Orius albidipennis* (Reut.) and *Orius laevigatus* (Fieber) (Hem: Anthocaridae) on some insect larvae. *J. Appl. Entomol.*, 107:107-109.