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Predation capacity, development and reproduction of the southern African flower bugs *Orius thripoborus* and *Orius naivashae* (Hemiptera: Anthocoridae) on various prey

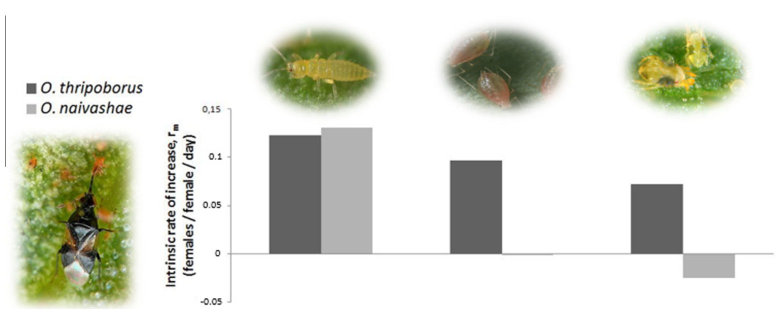
Jochem Bonte [a,*], Lien De Hauwere [a], Des Conlong [b,c], Patrick De Clercq [a]

[a] Laboratory of Agrozoology, Department of Crop Protection, Ghent University, Coupure Links 653, B-9000 Ghent, Belgium
[b] South African Sugarcane Research Institute, Private Bag X02, Mount Edgecombe 4300, South Africa
[c] School of Life Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, Pietermaritzburg 3209, KwaZulu-Natal, South Africa

HIGHLIGHTS

- High predation capacities are observed on *F. occidentalis* larvae and *T. urticae* eggs.
- Development and reproduction of both *Orius* spp. are most favorable on *F. occidentalis*.
- *Orius thripoborus* shows higher growth rates than *O. naivashae.*
- Growth rates on *M. persicae nicotianae* are higher than on *T. urticae.*
- Only *O. thripoborus* holds promise for suppression of aphids and spider mites.

GRAPHICAL ABSTRACT



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ABSTRACT

The little-studied species *Orius thripoborus* (Hesse) and *Orius naivashae* (Poppius) (Hemiptera: Anthocoridae) have potential as biological control agents of thrips pests in southern Africa, but may also hold promise for the control of other harmful arthropods. In this study, the predation capacity, development, reproduction and growth rates of both predatory species on the key pests *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae), *Tetranychus urticae* Koch (Acari: Tetranychidae) and *Myzus persicae nicotianae* Blackman (Hemiptera: Aphididae) were examined under laboratory conditions. Female adults of *O. thripoborus* and *O. naivashae* fed on 24 and 18 *F. occidentalis* 2nd instars, and 15 and 21 *T. urticae* eggs per day, respectively. Developmental and reproductive parameters of both *Orius* species were most favorable on *F. occidentalis*. Their intrinsic rates of increase (r_m) were highest when fed on *F. occidentalis*, averaging 0.123 and 0.131 females/female/day for *O. thripoborus* and *O. naivashae*, respectively. On the other prey, *O. thripoborus* showed significantly higher r_m-values than *O. naivashae*. Overall, r_m-values on *M. persicae nicotianae* were higher than on *T. urticae*, although differences were only significant for *O. thripoborus*. For *O. naivashae*, the estimated intrinsic rates of increase on the tested non-thrips prey were slightly negative. Our findings indicate the potential of both *Orius* spp. as biocontrol agents of thrips, whereas only *O. thripoborus* appears to hold promise for the suppression of aphids and spider mites as well.

* Corresponding author.
E-mail addresses: jochem.bonte@ugent.be (J. Bonte), des.conlong@sugar.org.za (D. Conlong), patrick.declercq@ugent.be (P. De Clercq).

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1. Introduction

Predatory bugs of the genus *Orius* (Hemiptera: Anthocoridae) are omnivores, feeding on a wide array of arthropod prey as well as on plant materials such as pollen and plant juices (Salas-Aguilar and Ehler, 1977; Coll, 1998; De Clercq et al., 2014). They are used worldwide for the control of different thrips (Thysanoptera: Thripidae) pests (van den Meiracker and Ramakers, 1991; Riudavets, 1995), but are also known to attack a variety of soft-bodied arthropods such as aphids (Hemiptera: Aphididae), whiteflies (Hemiptera: Aleyrodidae), mites (Arachnida: Acari), young lepidopterous larvae and small arthropod eggs (Barber, 1936; Péricart, 1972; Cranshaw et al., 1996; van Lenteren et al., 1997; Lattin, 1999).

The little-studied southern African species *Orius thripoborus* (Hesse) and *Orius naivashae* (Poppius) have been suggested as potential biological control agents of various thrips pests, which include the sugarcane thrips *Fulmekiola serrata* Kobus, the citrus thrips *Scirtothrips aurantii* Faure, the two avocado thrips pests *Heliothrips haemorrhoidalis* (Bouché) and *Selenothrips rubrocinctus* (Giard), and the western flower thrips *Frankliniella occidentalis* (Pergande) (Hesse, 1940; Dennil, 1992; Way et al., 2006; EPPO, 2014). However, little is known on the prey range of *O. thripoborus* and *O. naivashae*. Given their good performance when reared on factitious or even artificial diets (Bonte et al., 2012b), it is likely that their natural prey range reaches beyond the Thysanoptera. Therefore, it is warranted to investigate whether these *Orius* species may also contribute to the suppression of non-thrips arthropod pests in southern Africa.

The western flower thrips, *F. occidentalis*, the two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) and the green peach aphid *Myzus persicae* Sulzer, including its subspecies *M. persicae nicotianae* Blackman, are economically important pests on a wide range of agricultural and ornamental plants worldwide. In South Africa, *F. occidentalis* and *T. urticae* are key pests in vineyards (Schwartz, 1990; De Villiers and Pringle, 2007, 2011; Allsopp, 2010), tomatoes and other fruit and vegetable crops, while *M. persicae* is a known vector of two potato viruses in the area (van der Waals et al., 2013). Their propensity to develop resistance to chemical pesticides greatly complicates the control of the above pests, necessitating the development of alternative control strategies.

In the present study, laboratory experiments were conducted to assess the development, reproduction, intrinsic growth rates and predation capacities of *O. thripoborus* and *O. naivashae* on different life-stages of *F. occidentalis*, *T. urticae* and *M. persicae nicotianae*. These are aimed to allow a better insight into the potential of the anthocorids as biological control agents of a range of agricultural pests in southern Africa.

2. Materials and methods

2.1. Stock cultures

2.1.1. O. thripoborus and O. naivashae

Cultures of *O. thripoborus* and *O. naivashae* were started with about 15 to 20 females for each species collected in and around sugarcane (*Saccharum officinarum* L.) fields in South Africa and were thereafter not infused with wild individuals. Stock colonies of the anthocorids were established at Ghent University (Ghent, Belgium) and maintained in climatic cabinets at 25 ± 1 °C, 65 ± 5% RH, and a photoperiod of 16:8 (L:D) h. The predators were reared in Plexiglas containers (9 cm diameter, 4 cm high) containing a 4- to 5-week-old sharp pepper plant (*Capsicum annuum* L. 'Cayenne Long Slim') as a water source and oviposition substrate. The food of nymphs and adults consisted of a mixture of frozen *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae) eggs (Koppert B.V., Berkel en Rodenrijs, The Netherlands); adults were also given dry honey bee pollen (N.V. Weyn's Honingbedrijf, Ghent, Belgium). To reduce cannibalism, a lightly crushed piece of wax paper was placed in each container (Bonte and De Clercq, 2011).

2.1.2. F. occidentalis

A laboratory population of *F. occidentalis* was established in 2011 using insects collected on rose plants (*Rosa* spp.) in Belgian greenhouses. The thrips were reared on green bean pods (*Phaseolus vulgaris* L.), serving as an oviposition substrate and food source, placed on a layer of vermiculite in vented plastic boxes. The diet of adult *F. occidentalis* was supplemented with dry honeybee pollen to enhance reproduction. Rearing containers were kept in an incubator set at 23 ± 1 °C, 65 ± 5% RH and a 16:8 (L:D) h photoperiod.

2.1.3. M. persicae subsp. nicotianae

A colony of *M. persicae nicotianae* was started in 2012 with individuals provided by Koppert B.V. and maintained at ambient laboratory conditions on sharp pepper plants.

2.1.4. T. urticae

Two-spotted spider mites were collected from castor bean (*Ricinus communis* L.) at the Faculty of Bioscience Engineering of Ghent University and a laboratory colony was set up using broad bean (*Vicia faba* L.) plants. The infested plants were kept in ventilated Plexiglas containers (60 × 60 × 60 cm) at ambient laboratory conditions.

2.2. Experiments

All experiments were performed at Ghent University in climatic cabinets set at 25 ± 1 °C, 65 ± 5% RH and a 16:8 (L:D) h photoperiod. For each experiment, similar plastic containers were used (4.5 cm diameter, 2 cm high), the lids of which had a ventilation hole covered with fine-mesh gauze.

2.2.1. Predation capacity

Predation capacities of the 2nd and 4th instars, and female adults of *O. thripoborus* and *O. naivashae* were assessed on different stages and species of prey: 2nd instars and adults of *F. occidentalis*, 2nd–3rd instars of *M. persicae nicotianae*, and eggs and deutonymphs of *T. urticae*. The predator/prey combination between 2nd instar *Orius* nymphs and *F. occidentalis* adults was not examined, as preliminary experiments indicated that the thrips adults were too agile to serve as prey for the small predator nymphs.

Newly moulted (<24 h) second and fourth instars, and 3- to 5-day-old female adults (i.e., reproductively active) of *O. thripoborus* and *O. naivashae* were collected randomly from stock cultures. Fourth instars and adults were individually starved for 24 h, during which time water was provided by way of a moist piece of cotton wadding fitted into a 1.5 cm plastic dish. Second instars of the predators were only starved for 16 h. After starvation, each predator was transferred to an individual plastic cup containing an excess of prey and a plant substrate serving as food for the prey and a moisture source for the predator. The number of prey presented in each predator/prey combination was determined based on preliminary experiments and is given in Table 1. In all treatments, more prey was provided than could be consumed.

When *F. occidentalis* were used as prey, a piece of bean pod was added to the container. The pod was cut between two seeds and fixed on a small pile of Pritt Buddies (N.V. Henkel, Brussel, Belgium), in order to limit hiding places for the prey. For *M. persicae nicotianae*, a reversed *C. annuum* leaf was placed on water-soaked cotton. *T. urticae* eggs and nymphs were offered on a