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Prey Preference of *Orius niger* (Wolf.) and *O. minutus* (L.) from *Thrips tabaci* (Lind.) and *Tetranychus urticae* (Koch.)

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Abstract: The two-spotted spider mite (TSSM), *Tetranychus urticae* Koch and onion thrips (OT), *Thrips tabaci* Lindeman, are two serious pests of potato and *Orius niger* (Wolff) and *O. minutus* (Linnaeus) are major predators of these pests in the potato fields in Ardabil region. Therefore, we compared the predation potential and fecundity of these predator when they fed on 2nd instar larvae of thrips and female mites on potato leaves in the no-choice and choice experiments in a growth chamber that was set at 24±1°C, 50±5% RH and 16: 8 h (L:D) photoperiod. In the no-choice tests, *O. niger* showed lower nymphal mortality percentage, higher fecundity and higher killing rate (k_m) when fed on 2nd instar larvae of thrips than female mites. *O. minutus* showed lower nymphal mortality percentage, higher fecundity and higher killing rate (k_m) on female mites than 2nd instar larvae of thrips. In the choice tests, the number of 2nd instar larvae of thrips consumed by different nymphal instars and the adult pairs of *O. niger* were significantly higher than the number of female mites consumed. Different nymphal instars and the adult pairs of *O. minutus* consumed significantly more female mites compare to 2nd instar larvae of thrips. Based on these results it can be concluded that *O. niger* and *O. minutus* are effective natural enemies of OT and TSSM in the potato fields, respectively.

Key words: *Orius niger*, *Orius minutus*, prey preference, *Thrips tabaci*, *Tetranychus urticae*

INTRODUCTION

The Two-Spotted Spider Mite (TSSM), *Tetranychus urticae* Koch and Onion Thrips (OT), *Thrips tabaci* Lindeman, are important crop pests throughout the world (Lewis, 1997; Venzon *et al*., 2001; Deligeorgidis *et al*., 2006, 2007). These pests regularly cause economic damage to potato crop in Ardabil region. Potato growers in the region use insecticides heavily at high doses and short intervals to control of these pests. Continuous use of pesticides resulted in resistance to most of the available pesticides in many parts of the world (Lewis, 1997). Thus, there has been an increasing interest in using biological control agents, especially *Orius* species, against these pests (Tommasini and Nicoli, 1993; Yasunaga, 1997; Kohno and Kashio, 1998; Lattin, 1999; Zhang *et al*., 2006). Yano *et al*. (2002) mentioned that the use of indigenous species of the predators is preferred than the imported species. *Orius niger* (Wolff) and *O. minutus* (Linnaeus.) are major predators of OT and TSSM in the potato fields of Ardabil region. Also *O. niger* is a common predator in eastern Europe and northern Asia and *O. minutus* is common in Palearctic region (Pericart, 1996). The predation potential and fecundity of *Orius* species vary depending on the preys species (Kiman and Yeargan, 1985; Venzon *et al*., 2001, 2002; Deligeorgidis, 2002). If the predator species is not monophagous when tested in the no-choice situation, it is useful to assess prey preference through the choice experiments with more than one prey species present. In this study the predation potential, nymphal mortality and fecundity of *O. niger* and *O. minutus* was investigated when they fed on OT and TSSM on potato leaf in the no-choice and choice experiments.

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MATERIALS AND METHODS

Insect Colonies

Adults of *O. niger* and *O. minutus* were collected by sweep net from unsprayed potato fields (cv. Agria) in the Ardabil plain (elevation 1332 m; longitude 48°17' E; latitude 38°15' N) during July-2007. Samples were transferred to the laboratory at the University of Mohaghegh Ardabili and then adults of *O. niger* and *O. minutus* were separated under stereomicroscope by their morphological characters (Pericart, 1996). These predators were reared on alfalfa (cv. Hamadan) planted in plastic pots that were placed inside a Plexiglas cage, 10 L size and the top the cages were covered with fine mesh silk screen and kept in a growth chamber at 24±1°C, 50±5% RH and a photoperiod of 16: 8 h (L: D). Eggs of *Ephestia kuheniella* Zeller and corn pollen were provided on a piece of napkin every day and were placed on the top of the soil inside the cage as the food source for the predator. Eggs of *E. kuheniella* in conjunction with corn pollen has been used for rearing many *Orius* species as the food source by many investigators (Cocuzza *et al*., 1997; Steiner and Goodwin, 1998; Honda *et al*., 1998; Kakimoto *et al*., 2005). Newly hatched nymphs of *O. niger* and *O. minutus* were used in the no-choice and choice tests.

Onion thrips and two-spotted spider mite were collected from the same potato fields and reared on bean, *Phaseolus vulgaris* Linnaeus, planted in pots that were placed inside a Plexiglas cage, 10*l* size and the top of the cages were covered with fine mesh silk screen and kept in a growth chamber at 24±1°C, 50±5% RH and a photoperiod of 16: 08 h (L:D). Newly emerged 2nd instar larvae of thrips and female mites were collected from the colony and used in the experiments as preys.

Preference Tests

The no-choice tests were conducted to demonstrate the suitability of 2nd instar larvae of thrips and female mites to the *O. niger* and *O. minutus*. In the no-choice tests thirty 2nd instar larvae of thrips and thirty female mites were transferred separately with a fine hair brush on the lower surface of potato leaf (with 5 leaflets). These potato leaves were placed, from petiole, on a piece of moist cotton wool inside the transparent cylindrical plastic cage (10 cm diameter and 25 cm high). Then one newly hatched nymph of *O. niger* and *O. minutus* were separately transferred on potato leaf with one type of prey (thirty 2nd instar larvae of thrips or thirty female mites) inside a transparent cylindrical plastic cage. The transparent cylindrical plastic cages with a meshed lid were kept in a growth chamber at 24±1°C, 50±5% RH and a photoperiod of 16:08 h (L:D). Potato leaves were renewed every 24 h for all treatments and the number of remained prey on these leaves was counted under stereomicroscope to determine the number of prey consumed by one nymph/day. The predation potential of five different nymphal instars of two predators were determined every 24 h until the adult emergence. The status of the predator's nymphs (the death or completion of their development to the adult stage and gender) was recorded in all cages. Twenty-four hour after the adult emerged, one adult pair of *O. niger* and *O. minutus* separately were presented with thirty 2nd instar larvae of thrips and thirty female mites inside the transparent cylindrical plastic cages using similar protocol that was mentioned above. Potato leaves were renewed every 24 h for all treatments. Survival of *Orius* females, the number of prey consumed and the number of eggs laid were counted under stereomicroscope every 24 h until the death of the predator's females. If the male of *O. niger* and *O. minutus* died before the mated females began to oviposit, another newly emerged male from the same treatment would be introduced into the transparent cylindrical plastic cage. Non-ovipositing females were also included in calculations of longevity, fecundity and predation potential of each predator species. Each adult pair of *O. niger* and *O. minutus* feeding on one of the two prey species was considered as an experimental unit. Each treatment was replicated 40 times.

The choice test was used to delineate the preferred prey for each predator. In these tests fifteen 2nd instar larvae of thrips+fifteen female mites were presented to one newly hatched nymph and the adult pair of *O. niger* and *O. minutus*. These tests were assessed using similar protocols to the no-choice test experiment.

Data Analysis

The coefficients of variation of data in the no-choice and choice tests were high (>30). Therefore, the data was log transformed to meet the assumptions of normality and homogeneity of variances. In the no-choice tests, the differences of the number of prey consumed by five different nymphal instars and the adult pairs of predators were compared by ANOVA and Tukey's HSD test (PROC ANOVA, SAS Institute 1999). The performance of the same predator species when fed on different prey was compared by using the Mann-White U test (SAS Institute 1999). Also in these experiments the killing rate (k_m = ln (K_0)/T_k), the net predation rate ($K_0 = \Sigma_x l_x K_x$) and predation period ($T_k = \Sigma_x l_x Kx_x/K_0$), were calculated for two *Orius* species when they fed on 2nd instar larvae of thrips and female mites. In these formulas, x is day age (including the nymphal and the adult stages), l is the age-specific survival (including the nymphal and the adult stages) and K_x is the age-specific predation (both during the nymphal and the adult stages) (extraction from formula of the intrinsic rate of natural increase explained by Birch (1948) and Laughlin (1965)). In the choice tests the differences of the number of prey consumed by five different nymphal instars and the adult pairs of predators were compared by ANOVA and Tukey's HSD test and the performance of the same predator species when fed on combination of 2 prey species was compared by using the TTEST (SAS Institute, 1999).

RESULTS

In the no choice tests, the number of 2nd instar larvae of thrips consumed by different nymphal instars and the adult pairs of *O. niger* were not significantly different compare to the number of female mites consumed, but different nymphal instars and the adult pairs of *O. minutus* consumed significantly more female mites than the 2nd instar larvae of thrips (Table 1).

Also the number of 2nd instar larvae of thrips consumed by different nymphal instars and the adult pairs of *O. niger* were significantly higher than *O. minutus* and the number of female mites consumed by different nymphal instars and the adult pairs of *O. minutus* were significantly higher than *O. niger* (Table 1).

Nymphal development time of *O. niger* was not significantly different when fed on 2nd instar larvae of thrips and female mites. Also nymphal development time of *O. minutus* was not significantly different when fed on 2nd instar larvae of thrips and female mites (Table 2). *O. niger* showed lower nymphal mortality percentage, higher fecundity and sex ratio and longer female and male longevity

Table 1: The number of prey consumed by different nymphal instars and the adult pairs of two *Orius* species when they fed on two prey species in the no-choice tests

Predator	*O. minutus*		*O. niger*	
Prey	TSSM	OT	TSSM	OT
N	40	40	40	40
1st instar	8.60±1.23a	3.70±1.19c	5.70±1.27b	6.10±1.10b
2nd instar	21.70±4.98a	4.60±1.02c	11.10±4.35b	10.10±0.99b
3rd instar	21.90±4.99a	7.20±0.83c	15.60±0.84b	14.50±4.40b
4th instar	29.70±5.84a	10.20±1.10c	16.40±4.10b	15.30±4.03b
5th instar	35.30±6.23a	15.50±4.19c	21.60±4.10b	19.80±3.47b
a pair of adult	554.03±30.58a	191.46±29.13c	290.49±30.69b	282.38±29.63b

Different letters in the same column show significant differences at p 0.05

when fed on 2nd instar larvae of thrips than female mites and *O. minutus* showed lower nymphal mortality percentage, higher fecundity and sex ratio and longer female and male longevity on female mites than 2nd instar larvae of thrips (Table 2).

The nymphal mortality percentage of *O. niger* was significantly lower in comparison with *O. minutus* when they fed on 2nd instar larvae of thrips (Table 2). Also fecundity, sex ratio, female and male longevity of *O. niger* was significantly higher than fecundity, female and male longevity of *O. minutus* when they fed on 2nd instar larvae of thrips (Table 2). On the other hand *O. minutus* showed significantly lower nymphal mortality percentage, higher fecundity and sex ratio and longer female and male longevity than *O. niger* when they fed on female mites (Table 2).

In these tests, the killing rate and the net predation rate of *O. minutus* were higher when fed on female mites compare to the 2nd instar larvae of thrips and the killing rate (k_m) and the net predation rate (K_0) of *O. niger* were higher when fed on 2nd instar larvae of thrips than female mites (Table 3). Also the killing rate and the net predation rate of *O. niger* were higher than *O. minutus* when they fed on 2nd instar larvae of thrips and the killing rate and the net predation rate of *O. minutus* were higher than *O. niger* when they fed on female mites (Table 3). Predation period (T_k) of *O. niger* and *O. minutus* was shorter on 2nd instar larvae of thrips and female mites respectively (Table 3).

Table 2: Comparison of means (±SE) of nymphal development time, nymphal mortality percentage, female and male longevity, fecundity and sex ratio of two *Orius* species when fed on two prey species in the no-choice tests

Predator	*O. minutus*		*O. niger*	
Prey	TSSM	OT	TSSM	OT
N	40	40	40	40
Nymphal development time (days)	15.70±1.92ab	16.40±2.05a	14.60±2.03ab	13.70±1.97b
Nymphal mortality percentage	47.60±12.6b	67.40±14.0a	61.20±15.7a	45.30±12.3b
Longevity of females (days)	19.60±8.18a	12.40±6.67b	11.17±6.2b	17.15±7.90a
Longevity of males (days)	17.98±8.12a	11.65±7.53b	10.95±6.33b	15.75±7.60a
Total fecundity (eggs/female)	58.05±11.31a	16.00±6.09c	15.95±6.20c	33.30±14.36b
Sex ratio (% of females)	49.23±4.10a	40.18±3.50b	38.27±5.10b	47.80±3.90a

Different letter(s) in the same column show significant differences at p 0.05

Table 3: Net predation rate (K0), predation period (Tk) and killing rate (km) of two *Orius* species when fed on two prey species in the no-choice tests

Predators	*O. minutus*		*O. niger*	
Preys	TSSM	OT	TSSM	OT
K0	72.90	53.060	64.520	62.800
Tk	17.10	20.180	20.380	17.180
km	0.249	0.196	0.204	0.241

Table 4: The number of prey eaten by different nymphal instars and the adult pairs of two *Orius* species when fed on two prey species in the choice tests

Predator	*O. minutus*		*O. niger*	
Prey	TSSM	OT	TSSM	OT
N	40	40	40	40
1st instar	6.4±1.33a	0.9±0.47d	2.3±1.10c	4.10±1.18b
2nd instar	21.2±4.65a	1.1±0.47d	2.8±1.06c	5.20±0.96b
3rd instar	22.4±4.70a	1.9±0.45d	4.6±0.78c	7.10±0.96b
4th instar	31.5±6.12a	2.2±1.07d	5.9±1.23c	8.20±1.19b
5th instar	41.7±5.53a	4.1±1.22d	9.5±1.28c	13.40±3.84b
A pair of adult	359.8±26.29a	48.3±23.32d	116.2±23.27c	190.19±27.24b

Different letter(s) in the same column show significant differences at p 0.05

Table 5: Comparison of means (±SE) of nymphal development time, nymphal mortality percentage, female and male longevity, fecundity and sex ratio in two Orius species when they fed on two prey species in the choice tests

Predators	*O. minutus*	*O. niger*
N	40	40
Nymphal development time (days)	15.20±1.88a	14.75±1.78a
Nymphal mortality percentage	60.40±16.49a	57.30±14.48a
Longevity of females (days)	17.80±7.63a	13.72±7.64b
Longevity of males (days)	16.54±7.25a	12.22±6.10b
Total fecundity (eggs/females)	46.10±15.80a	23.23±6.27b
Sex ratio	46.50±3.90a	43.33±3.90ab

Different letter(s) in the same column show significant differences at p 0.05

In the choice tests, the number of 2nd instar larvae of thrips consumed by different nymphal instars and the adult pairs of *O. niger* was significantly higher than the number of female mites consumed and the number of female mites consumed by different nymphal instars and the adult pairs of *O. minutus* was significantly higher than the number of 2nd instar larvae of thrips consumed (Table 4).

Also in the choice tests, *O. niger* showed significantly shorter female and male longevity and lower fecundity compare to *O. minutus* when they fed on the combination of 2nd instar larvae of thrips and female mites . But, nymphal development time, nymphal mortality percentage and sex ratio of *O. niger* and *O. minutus* were not significantly different when they fed on the combination of 2nd instar larvae of thrips and female mites (Table 5).

DISCUSSION

Prey preference in the no-choice and choice tests under controlled conditions is an important intermediate step in the risk assessment of biological control agents. The killing rate, k_m, is the important characteristic of a predator to obtain an indication for its capability in biological control.

This study showed that the type of prey could strongly influence the predation potential, fecundity and mortality of *Orius* species. In the no-choice and choice tests, *O. niger* preferred feeding on 2nd instar larvae of thrips, km = 0.241, than female mites, km = 0.204, while *O. minutus* preferred feeding on female mites, km = 0.249, than 2nd instar larvae of thrips, km = 0.196. Also analysis of the nymphal development time, nymphal mortality percentage and fecundity indicated that the population growth of *O. niger* was restricted mostly by high nymphal mortality and low fecundity when fed on females of TSSM and the population growth of *O. minutus* was restricted mostly by high nymphal mortality and low fecundity when fed on 2nd instar larvae of OT.

Few data are available about the predatory rate and fecundity of *O. niger* and *O. minutus* when fed on OT and TSSM. Deligeogidis (2002) demonstrated that *O. niger* strongly preferred 2nd instar larvae of OT compare to 2nd instar larvae of *Frankliniella occidentalis* (Pergande) and recorded that *O. niger* is suitable predator in control of OT. Atakan and Gencer (2008) concluded that populations of *O. niger* were more abundant and also significantly correlated with *F. occidentalis* population in normal-planted cotton fields. With regard to predator-thrips interactions, they suggested that *O. niger* may be an efficient biological control agent regulating *Frankliniella* flower thrips especially in normal-planted cotton. Baniameri *et al.* (2005) estimated high r_m (0.113) for *O. niger* at 26°C on a diet of *E. kuehniella* eggs and suggested that the population growth rate of *O. niger* was restricted mostly by juvenile mortality. Toyoshima (2006) reported that *O. minutus* had the potential to control of TSSM population.

The killing rate of *O. niger* and *O. minutus* on adults of thrips can be varied by the different species of prey offered and the greater difficulty for *Orius* species to catch adults than nymphs of thrips (Salas-Aguilar and Ehler, 1977; Teeriling *et al.*, 1993). For example, Teeriling *et al.* (1993)

showed that *Orius tristicolor* (White) responds to specific semiochemical cues from western flower thrips and preferred feeding on it in comparison with other thrips species. Lichtenauer and Sell (1993) concluded that in the no-choice tests, *O. insidiosus* (Say) and *O. minutus* consumed more thrips larvae than adults.

It has been reported that dietary differences of various prey species affects the longevity and fecundity of *Orius* species (Kiman and Yeargan, 1985; Chyzik *et al*., 1995). Fecundity of *O. insidiosus* varied when it consumed from thrips, mites and the eggs of moths (Kiman and Yeargan, 1985). Venzon *et al*. (2001, 2002) reported that *O. laevigatus* (Fieber) was attracted more to the two-spotted spider mite infected cucumber than western flower thrips infected plants. Fritsche and Tamo (2000) found that the efficiency of *O. albidipennis* (Reuter) in control of *Megalurothrips sjostedti* Trybom was lower than the *Ceratothripoides cameroni* (Priesner) and *F. schultzei* Trybom.

Present results indicated that *O. niger* and *O. minutus*, that are common in Ardabil potato fields, can be useful in the biological control of onion thrips and two-spotted spider mite respectively.

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REFERENCES

Atakan, E. and O. Gencer, 2008. Influence of planting date on the relationship between populations of *Frankliniella* flower thrips and predatory bug *Orius niger* in cotton. J. Pest Sci., 81: 123-133.

Baniameri, V., E. Soleiman-Nejadian and J. Mohaghegh, 2005. Life table and age-dependent reproduction of the predatory bug *Orius niger* Wolff (Heteroptera: Anthocoridae) at three constant temperatures: a demographic analysis. Applied Entomol. Zool., 40: 545-550.

Birch, L.C., 1948. The intrinsic rate of natural increase of insect population. J. Anim. Ecol., 17: 15-26.

Chyzik, R., M. Klein and Y. Ben-Dov, 1995. Reproduction and survival of the predatory bug *Orius albidipennis* on various arthropod prey. Entomol. Exp. Appl., 75: 27-31.

Cocuzza, G.E., P. De Clercq, M. Van De Veire, A. De Cock, D. Degheele and V. Vacante, 1997. Reproduction of *Orius laevigatus* and *Orius albidipennis* on pollen and *Ephestia kuehniella* eggs. Entomol. Exp. Appl., 82: 101-104.

Deligeorgidis, P.N., 2002. Predatory effect of *Orius niger* (Wolff) (Hem., Anthocoridae) on *Frankliniella occidentalis* (Pergande) and *Thrips tabaci* Lindeman (Thysan., Thripidae). J. Applied Entomol., 126: 82-85.

Deligeorgidis, P.N., L. Giakalis, G. Sidiropoulos, M. Vaiopoulou, G. Kaltsoudas and C.G. Ipsilandis, 2006. Longevity and reproduction of *Frankliniella occidentalis* and *Thrips tabaci* on cucumber under controlled conditions. J. Entomol., 3: 61-69.

Deligeorgidis, P.N., C.G. Ipsilandis, G. Kaltsoudas, G. Sidiropoulos and N.P. Deligeorgidis *et al*., 2007. Chemical control of *Thrips tabaci*, *Epitrix hirtipennis* and *Myzus* persicae in tobacco fields in Northern Greece. J. Entomol., 4: 463-468.

Fritsche, M.E. and M. Tamo, 2000. Influence of thrips prey species on the life history and behavior of *Orius albidipennis*. Entomol. Exp. Appl., 96: 111-118.

Honda, J.Y., Y. Nakashima and Y. Hirose, 1998. Development, reproduction and longevity of *Orius minutus* and *Orius sauteri* (Heteroptera: Anthocoridae) when reared on *Ephestia kuehniella* eggs. Applied Entomol. Zool., 33: 449-453.

Kakimoto, K., S. Urano, T. Noda, K. Matuo, Y. Sakamaki, K. Tsuda and K. Kusigemati, 2005. Comparison of the reproductive potential of three *Orius* species, *O. strigicollis*, *O. sauteri* and *O. minutus* (Heteroptera: Anthocoridae), using eggs of the Mediterranean flour moth as a food source. Applied Entomol. Zool., 40: 247-255.

Kiman, Z.B. and K.V. Yeargan, 1985. Development and reproduction of the predator *Orius insidiosus* (Hemiptera: Anthocoridae) reared on diets of selected plant material and arthropod prey. Ann. Entomol. Soc. Am., 78: 464-467.

Kohno, K. and T. Kashio, 1998. Development and prey consumption of *Orius sauteri* (Poppius) and *O. minutus* (L.) (Heteroptera: Anthocoridae) fed on *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae). Applied Entomol. Zool., 33: 227-230.

Lattin, J.D., 1999. Bionomics of the Anthocoridae. Ann. Rev. Entomol., 44: 207-231.

Laughlin, R., 1965. Capacity for increase: A useful population statistic. J. Anim. Ecol., 34: 77-91.

Lewis, T., 1997. Thrips as Crop Pests. 1st Edn., CAB International, Oxon.

Lichtenauer, A. and P. Sell, 1993. Biological control of insects: Predation of different developmental stages of the western flower Thrips by adults of *Orius minutus* (Heteroptera: Anthocoridae). Meded. Fac. Landbouw. Univ. Gent., 58: 397-407.

Pericart, J., 1996. Family Anthocoridae (Fiber). In: Catalogue of the Heteroptera of the Palearctic Region, Aukema, B. and C. Rieger (Eds.). The Netherlands Entomological Society, Wageningen.

Salas-Aguilar, J. and L.E. Ehler, 1977. Feeding habits of *Orius triticolor*. Ann. Entomol. Soc. Am., 70: 60-62.

Steiner, M.Y. and S. Goodwin, 1998. Method for collecting and rearing thrips (Thysanoptera) and their natural enemies. Aust. J. Entomol., 37: 101-106.

Teeriling, C.R., D.R. Gillespie and J.H. Borden, 1993. Utilization of western flower thrips alarm pheromone as a prey-finding kairomone by predators. Can. Entomol., 125: 431-437.

Tommasini, M.G. and G. Nicoli, 1993. Adult activity of four *Orius* species reared on two preys. Integrated control in glasshouses. IOBC/WPRS Bull., 16: 181-184.

Toyoshima, S., 2006. Development, prey consumption and fecundity of *Orius minutus* (Heteroptera: Anthocoridae) when fed on *Tetranychus urticae* (Acari: Tetranychidae). J. Acarol. Soc. Jap., 15: 151-156.

Venzon, M., A. Janssen and M.V. Sabelis, 2001. Prey preference, intraguild predation and population dynamics of an arthropod food web on plant. Exp. Appl. Acarol., 25: 785-808.

Venzon, M., A. Janssen and M.W. Sabelis, 2002. Prey preference and reproductive success of the generalist predator Orius laevigatus. OIKOS, 97: 116-124.

Yano, E., K. Watanabe and K. Yara, 2002. Life history parameters of *Orius sauteri* (Poppius) (Het., Anthocoridae) reared on *Ephestia kuehniella* eggs and the minimum amount of the diet for rearing individuals. J. Applied Entomol., 126: 389-394.

Yasunaga, T., 1997. The flower bug genus *Orius* Wolff (Heteroptera: Anthocoridae) from Japan and Taiwan, part II. Applied Entomol. Zool., 32: 379-386.

Zhang, S., L. Wu, X. Xu and B. Hua, 2006. Predation of *Orius minutus* on *Odontothrips loti*. Ying Yong Sheng Tai Xue Bao, 17: 1259-1263.