A survey of natural parasitism of mirid bugs by parasitoids on apples and pears in Norway

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Abstract

Mirid bugs are important pests in both integrated and organic fruit production. In a survey in 2006 the proportion of mirids parasitized by parasitoids was investigated in 18 Norwegian orchards. More than 50 beating samples were collected from apple and pear orchards under integrated and organic management in different areas of Norway. About 30% of nymphs of the most abundant mirid bug species, Lygocoris pabulinus, Ortholylus marginalis and Psallus ambiguus, were parasitized. Important factors for enhancing biological control in organic fruit production are discussed.

Keywords: Biological control, fruit, Miridae, Norway, parasitoids

Introduction

Biological control is defined as 'the use of living organisms to suppress the population density or impact of a specific pest organism, making it less abundant or less damaging than it would otherwise be' (Eilenberg, 2001). Parasitoids are used as control organisms against insect pests in both classical, inoculation and inundation biological control, and they are also important regulators in nature.

Mirids are important pests in apple and pear production in both Europe and the United States (Wheeler, 2001; Alford, 2007), causing fruit damage of 40% or even more in organic production systems (Røen *et al.*, 2003). Mirid bugs feed on fruit sap in shoot tips, flower buds and fruitlets, resulting in deformation and stony pits in the fruit (Wheeler, 2001). Controlling mirid pests is difficult both in integrated and organic fruit production. Naturally occurring parasitoids are important natural enemies of many mirid species (Udayagiri *et al.*, 2000; Wheeler, 2001; Tilmon & Hoffmann, 2003), and parasitoids have also been tried as biological control agents for several mirid species. Udayagiri et al. (2000) evaluated the potential for biological control of *Lygus hesperus* Knight by the native egg parasitoid *Anaphes iole*. A suppression of 64 % was achieved when 15.000 *A. iole* individuals were released in acre-sized plots (0.405 ha) every week throughout the growing season.

A management practice suitable for organic fruit production is conservation biological control. By enhancing the efficiency and local abundance of natural enemies, the pest might be reduced to a level acceptable for economic production. Several studies have shown that management practice, composition of the ground cover, and distance from adjacent native habitat might affect the number of beneficial arthropods in a horticultural crop (Milliczky & Horton, 2005; Thomson & Hoffmann, 2007). In order to evaluate the potential for controlling mirid pests by parasitoids with conservation biological control methods the degree of natural parasitisation must be known. The objective of this study was to investigate the parasitisation of different species of mirids in different locations, fruit crops and production systems.

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Material and Methods

Investigations were carried out in May and June 2006. Samples were taken from three organic and 15 integrated fruit orchards in South-Eastern and Western Norway, two of them apple orchards and 16 pear orchards. Samples were collected in connection with various trials of factors affecting the Heteropteran fauna of orchards. Thus, in 4 of the orchards, situated in Lier, Njøs, Ulvik and Hauso, several samples were taken during May and June. In Hardanger, 14 orchards were sampled once or twice during the same period. Mirids were collected by beating random branches with a stiff rubber hose. Each branch received three quick beats, and dislodged insects were collected by a beating tray. All mirids, adults and nymphs, were identified and counted. A total of 54 samples were collected, but both the number of samples and the size of each sample (no of branches beaten) varied between orchards. Only the most numerous mirid species are presented here. Most mirids sampled were in their third to fifth instar.

Mirids were stored in 70 % alcohol and later dissected under a stereo microscope. Only nymphs of mirid bugs were examined for parasitoid larvae. Parasitoid species were not identified.

Data are presented as the number of parasitized mirid nymphs. An analysis of variance was performed on parasitism, with mirid species and location as explanatory variables (SAS Institute, 2003). Degree of parasitism was arcsin-transformed prior to analysis.

Results

The three most numerous mirid species collected were *Lygocoris pabulinus* (L.) *Orthotylus marginalis* Reuter and *Psallus ambiguus* (Fallén) (Table 1). No significant differences in parasitism between the three species was found on the basis of arcsin-transformed data ($F = 0.49$, $df = 2, 108$, $p = 0.62$).

Table 1: Total number of individuals collected, number parasitized and percentage of parasitism of *L. pabulinus*, *O. marginalis* and *P. ambiguus* in this survey. N = number of samples where the given species was found. All orchards are included. Different letters indicate significantly different means.

Species	N	Total collected	Number parasitized	% parasitized
L. pabulinus	35	142	41	29a
O. marginalis	31	85	24	28a
P. ambiguous	43	297	94	32a

On average, the percentage of mirids parasitized was higher in pear than in apple orchards (Table 2), and higher in integrated fields than in organic fields (Table 3). However, as both apple fields were organic and only one of 15 pear orchards was organic, it is difficult to distinguish between the effect of host plant and growing system.

When location and species were analysed for their effect on degree of parasitism, location explained a significant part of the variation ($F=4.79$, $df=4,102$, $p=0.0014$) while species did not ($F=0.80$, $df=2,102$, $p=0.45$) (arcsin-transformed data). In four of the locations only one field was sampled and in the fifth area 14 orchards were sampled, however a significant difference in parasitism was found between the four locations with one orchard only (Table 4).

Table 2: Total number of individuals collected, number parasitized and percentage of parasitism for *P. ambiguus*, *O. marginalis* and *L. pabulinus* collected from apple and pear. N = number of samples were the given species was found. Organic and integrated orchards are combined.

Species	Host plant	N	Total collected	Number parasitized	% parasitized
P. ambiguous	Apple	23	120	25	20.8
	Pear	20	177	69	38.9
O. marginalis	Apple	15	49	9	18.4
	Pear	16	36	15	41.7
L. pabulinus	Apple	27	109	27	24.8
	Pear	8	33	14	42.4

Table 3: Total number of individuals collected, number parasitized and percentage of parasitism for *P. ambiguus*, *O. marginalis* and *L. pabulinus* collected from organic and integrated orchards. N = number of samples where the given species was found. Apple and pear orchards are combined.

Species	Production system	N	Total collected	Number parasitized	% parasitized
P. ambiguus	Organic	23	120	25	20.8
	Integrated	20	177	69	38.9
O. marginalis	Organic	23	61	13	21.3
	Integrated	8	24	11	45.8
L. pabulinus	Organic	29	112	27	24.1
	Integrated	6	30	14	46.7

Table 4: Total number of individuals collected, number parasitized and percentage of parasitism for *P. ambiguus*, *O. marginalis* and *L. pabulinus* collected from different locations, host plants and production systems. N = number of samples where the given species was found. Different letters indicate significantly different degrees of parasitism between locations (all three species combined).

Location	Host plant	Production system	Species	N	Total	No. para.	% para.
Hardanger[a] (14 fields)	Pear	Integrated	*P. ambiguus*	12	134	50	37.3
			O. marginalis	4	16	8	50.0
			L. pabulinus	4	25	12	48.0
Hauso[a] (1 field)	Pear	Integrated	*P. ambiguus*	8	43	19	44.2
			O. marginalis	4	8	3	37.5
			L. pabulinus	2	5	2	40.0
Lier[b] (1 field)	Apple	Organic	*P. ambiguus*	7	22	3	13.6
			O. marginalis	5	24	3	12.5
			L. pabulinus	14	80	18	22.5
Njøs[ab] (1 field)	Apple	Organic	*P. ambiguus*	16	98	22	22.4
			O. marginalis	10	25	6	24.0
			L. pabulinus	13	29	9	31.0
Ulvik[ab] (1 field)	Pear	Organic	*P. ambiguus*	-	-	-	-
			O. marginalis	8	12	4	33.3
			L. pabulinus	2	3	0	0

Discussion

To our knowledge parasitism of mirid bugs in Norway, and the parasitism of *L. pabulinus*, *O. marginalis* and *P. ambiguus* in general, has not been investigated previously. Blommers *et al*. (1997) reported that some fifth instar nymphs of *L. pabulinus* were parasitized by *Peristenus laeviventris* in field collected individuals in The Netherlands, although the degree of parasitism was not given.

L. pabulinus, *O. marginalis* and *P. ambiguus* were the most abundant species sampled in this survey. In Norway, *L. pabulinus* is regarded as the most important mirid pest in fruit orchards (Edland, 2004). Both *P. ambiguus* and *O. marginalis* are mainly regarded as predators, but might also cause damage because they are able to feed on plants (Taksdal, 1983; Wheeler, 2001; Edland, 2004). Earlier studies from Norway have shown that both species can also cause stony pits in the fruit (Taksdal, 1983).

Compared to other studies a relatively high degree of parasitism was found in all three species, in both apples and pears, in organic and integrated orchards and in all locations in this study. An overall parasitism of 19.7 and 12.3 % by *Peristenus* spp. was found for *Lygus lineolaris* in eastern New York State and western New York State, respectively (Tilmon & Hoffmann, 2003). Further, Demirel *et al*. (2005) found an average parasitism of 5.54 and 7.62 % on *Lygus* spp. in Colorado in 2001 and 2002, respectively.

The parasitoids were not identified in this study. However according to Wheeler (2001) members of the braconid genera *Leiophron* and *Peristenus* are specialized parasitoids of mirids. Further, Rämert *et al*. (2005) found that *Lygus rugulipennis* was parasitized by both *Phasia obesia* and *Peristenus* spp., and Blommers *et a*l. (1997) found that *Peristenus laeviventris* parasitized *L. pabulinus*.

It is likely that degree of parasitism varies between location and orchards. We found a higher parasitism in Hauso (which belongs to the Hardanger area, Western Norway) compared to Lier (South-Eastern Norway) in this study. For all species combined, the average degree of parasitism in Hauso was 43 %, while the average parasitism in Lier was 19 %. Similar differences between areas have also been found in other surveys (Tilmon & Hoffmann, 2003; Rämert *et al*., 2005).

Whether host plant or production system affects parasitism of the mirids found in this study cannot be evaluated based on our data as there was an interaction between the two factors, and as more integrated than organic orchards were sampled. However, differences in mirid parasitism on different host plants have been found in other studies. Rämert *et al*. (2005) found that parasitism in *Lygus* spp. on spring oil seed rape was much higher than in *Lygus* spp. on alfalfa.

Factors likely to be important in conservation biological control were not evaluated in this study. Habitat type, surrounding vegetation, ground cover and mowing frequency have been shown earlier to affect the number of parasitoids in orchards (Landis *et al*., 2000; Horton *et al*., 2003; Kruess, 2003; Thomson & Hoffmann, 2007). Whether this is true for Norway and for species of parasitoids important for *L. pabulinus*, *O. marginalis* and *P. ambiguus* must be further investigated.

In conclusion, conservation biological control of mirid pests by parasitoids might be possible as the degree of parasitism found in this study was relatively high. However, to increase the amount of parasitoids in fruit orchards we need to identify the species involved and how habitat management can promote them.

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