PARASITOID COMPLEX OF CABBAGE LARGE WHITE BUTTERFLY *PIERIS BRASSICAE* (L.) (LEPIDOPTERA, PIERIDAE) IN URMIA WITH NEW RECORDS FROM IRAN

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Abstract: Surveys for parasitoids attacking larvae and pupae of *Pieris brassicae* (L.) (Lepidoptera: Pieridae) were conducted in the *Brassica* agro-ecosystem in the Urmia region, northwest of Iran, between 2008 and 2009. Parasitized hosts were collected from infested plants placed in *Brassica* crops during the growing season (June-October), and from the natural *P. brassicae* population on the common weeds *Capparis spinosa* L. (Capparaceae), *Crambe orientalis* L. (Brassicaceae) and *Raphanus raphanistrum* L. (Brassicaceae) during the summer production break (December). Ten species of primary parasitoids – *Cotesia glomerata* (L.) (Hym., Braconidae), *Brachymeria femorata* Panzer (Hym.: Chalcididae), *Aprostocetus taxi* Graham (Hym.: Eulophidae), *Agrothereutes adustus* Grav., *Blapsidotes vicinus* Grav., *Hyposoter clauses* Brischke (Hym.: Ichneumonidae), *Pteromalus puparum* (L.) (Hym.: Pteromalidae) and *Exorista larvarum* (L.), *Exorista segregata* Rondan, *Phryxe vulgaris* Fallén (Dip.: Tachinidae) were identified. The most numerous were *P. puparum* (with 49.65% in 2008 and 46.13% in 2009) and *C. glomerata* (with 43.45% and 45.57% in 2008 and 2009, respectively). The following species: *A. adustus*, *A. taxi*, *B. vicinus*, *B. femorata*, *H. clauses* and *P. vulgaris,* were newly recorded for the Iranian fauna. With the exception of *B. femorata* and *P. vulgaris*, all of the above mentioned species were recorded for the first time as parasitoid on *P. brassicae* from Iran.

Key words *Pieris brassicae*, parasitoid, Urmia, Iran, *Brassica*

INTRODUCTION

Pieris brassicae L. and *P. rapae* (Lep.: Pieridae) are some of the most frequent pests of cabbage crops along with *Mamestra brassicae*, and *Plutella xylostella* (Patriche *et al*. 2005). *P. brassicae*, is a cosmopolitan insect, and is found wherever cruciferous plants are grown (Hill 1987). Sometimes massive outbreaks of this pest may occur and injury on cabbage cultures may be severe (Hardin *et al*. 1995). Insect parasitoids have been introduced into a variety of ecosystems as bio-regulators. There have been many successful cases of insect parasitoids being used to control harmful native arthropods (DeBach and Schlinger 1964; DeBach 1974; Quicke 1997). The role of beneficial organisms (such as parasitoids) as natural enemies of insect pests on cabbage is of great consequence (Balevski *et al*. 2007). Parasitoids play an important role in reducing the population density of *P. brassicae*. Moreover, eggs and larvae are attacked by generalist predators such as spiders, chrysopids, staphylinids and carabids (Pfiffner *et al*. 2009). This paper reports parasitoids of *P. brassicae* found during the studies on the biology and ecology of the pest in Urmia and the parasitoids' impact on the pest number in Iran. For bio-control purposes, we initiated investigations on the natural insect enemies of *P. brassicae*. Studies on the fauna of parasitic insects of different regions are of great significance for effective pest control (Aliyev 1999). In this study we attempted to introduce beneficial and effective species for biological control programs. Moreover, this study was performed in order to assess parasitism rate and parasitoid diversity of Large white butterfly (LWB) on cabbage fields, in comparison with wild hosts in Urmia.

MATERIALS AND METHODS

The studies were carried out during 2008 and 2009 in *B. oleracea* agro-ecosystem and wild hosts, situated near Urmia. The parasitoids were reared out from *P. brassicae* larvae and pupae. In various localities of Urmia, 6,665 specimen including egg clusters, larvae and pupae were collected on different dates. Specimen came from 42 cabbage fields and areas with wild hosts of Large white butterfly (LWB) like *Capparis spinosa* (Capparaceae), *Crambe orientalis* L. and *Raphanus raphanistrum* (Brassicaceae). LWB eggs, larvae and pupae were kept separately in covered Petri dishes. Larvae or pupae individuals were placed in a plastic Petri dish and closed with Parafilm for parasitoid emergence. Petri dishes were kept at room temperature (23±2°C). Larvae containing dishes included a piece of fresh cabbage leaf. Fresh food was provided daily. Emergence of adults began after 1 to 2 weeks, under these conditions. Food plants did not differ during the experiment. Petri dishes were checked daily for emergence

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of *P. brassicae* adults and parasitoids. Emerged parasitoids were identified by experts and the percentage of parasitism (PP) by each parasitoid was estimated. Moreover, differences in PP between cabbage fields and wild hosts were studied.

RESULTS

Ten species were found to be parasitoids of *P. brassicae*: *Agrothereutes adustus* Grav. (Hym.: Ichneumonidae), *Aprostocetus taxi* Graham (Hym.: Eulophidae), *Blapsidotes vicinus* Grav. (Hym.: Ichneumonidae), *Brachymeria femorata* Panzer (Hym.: Chalcididae), *Cotesia glomerata* (L.) (Hym.: Braconidae), *Exorista larvarum* (L.) (Dip.: Tachinidae), *Exorista segregata* Rondan (Dip.: Tachinidae), *Hyposoter clauses* Brischke (Hym.: Ichneumonidae), *Phryxe vulgaris* Fallén (Dip.: Tachinidae) and *Pteromalus puparum* (L.) (Hym.: Pteromalidae) Results showed that in both of the studied years0.56 , 1.41, 1.97, 3.66, 44.51 and 47.89 percent of extracted parasitoids belonged to the families: Eulophidae, Ichneumonidae, Chalcididae, Tachinidae, Braconidae and Pteromalidae, respectively (Table 1). Table 1 shows the parasitoids belonging to five families within the Hymenoptera and one family from Diptera. Some species were solitary and others were gregarious parasitoids. The total mortality of *P. brassicae* from parasitoids were 15.3% and 18.56% in samples collected from farms, and 41.31% and 45.19% in samples collected from wild hosts in 2008 and 2009, respectively. *P. puparum* was the most important parasitoid in both of the studied years, reducing the pest numbers by 49.65% in 2008, and 46.13% in 2009. The second most effective parasitoid was *C. glomerata* with 43.45% and 45.57% parasitism which appeared in 2008 and 2009, respectively. Ichneumonidae and Tachinidae were the largest family represented, with three species in the parasitoid complex of *P. brassicae*, but species of these families were not as effective as *P. puparum* and *C. glomerata*. Until now, these ichneumonid species were unknown in parasitizing *P. brassicae* and we recorded this host for the first time. The *B. femorata* was the third most effective parasitic species of *P. brassicae*, which reduced pest numbers by 4.89% in 2008 and 2.43%, in 2009. The remaining parasitoids occurred in relatively low numbers and they were not important as regulating agents of *P. brassicae*.

Table 1. Parasitoids of *P. brassicae,* recorded during 2008–2009 survey in Urmia (Iran)

Parasitoids and Family	Order	Host Stage	Host crop(s)	Percentage of parasitism in 2008	ercentage of parasitism in 2009
Agrothereutes adustus	Hym.: Ichneumonidae	pupa	*Raphanus/Capparis/Crambe*	0.61	0.56
			Brassica oleracea	0.00	0.00
Blapsidotes vicinus	Hym.: Ichneumonidae	pupa	*Raphanus/Capparis/Crambe*	0.39	0.00
			Brassica oleracea	0.00	0.00
Hyposoter clauses	Hym.: Ichneumonidae	pupa	*Raphanus/Capparis/Crambe*	0.2	0.25
			Brassica oleracea	0.00	0.00
Brachymeria femorata	Hym.: Chalcididae	pupa	*Raphanus/Capparis/Crambe*	4.89	2.43
			Brassica oleracea	0.00	0.00
Cotesia glomerata	Hym.: Braconidae	larva	*Raphanus/Capparis/Crambe*	6.6	7.0
			Brassica oleracea	36.85	38.57
Pteromalus puparum	Hym.: Pteromalidae	pupa	*Raphanus/Capparis/Crambe*	49.65	46.13
			Brassica oleracea	0.00	0.00
Aprostocetus taxi	Hym.: Eulophidae	pupa	*Raphanus/Capparis/Crambe*	0.00	0.56
			Brassica oleracea	0.00	0.00
Exorista larvarum	Dip.: Tachinidae	larva	*Raphanus/Capparis/Crambe*	0.00	2.44
			Brassica oleracea	0.00	0.25
Exorista segregata	Dip.: Tachinidae	larva	*Raphanus/Capparis/Crambe*	0.56	0.56
			Brassica oleracea	0.00	0.5
Phryxe vulgaris	Dip.: Tachinidae	larva	*Raphanus/Capparis/Crambe*	0.25	0.00
			Brassica oleracea	0.00	0.75

Specimens reared from *Raphanus*/*Capparis* and *Brassica* in Urmia have been placed in the University of Urmia's Department of Entomology collection

DISCUSSION

Ten species of *P. brassicae* parasitoids were identified during our study. Some species were identified for the first time as *P. brassicae* parasitoids in Iran and possibly even in the world, because it is the first study of parasitoid complex of this pest in Iran.

B. vicinus is a moderately common gregarious idiobiont endoparasitoid of exposed butterfly pupae. Brood sizes of more than ten have been seen from *P. rapae*, *Vanessa atalanta*, *Polygonia c-album* and *Euphydryas desfontainii* (Shaw *et al*. 2009). *A. adustus* has been previously reported in Bulgaria (Heinrich 1936; Cankov 1968) and found as a parasitoid of

Diprion pini (L.) (Bochev and Georgiev 1996; Georgiev and Bochev 1996). However, the species is well known as a parasitoid of *Neodiprion serrifer* (Geoffr.) (Pschorn-Walcher 1982). *H. clauses* and *H. inquinatus* were reported from Finland in 1992. A few species of *Brachymeria* are solitary primary parasitoids of lepidopteran pupae, and two of them attack butterflies in grassland habitats regularly but not exclusively: *B. femorata* (Panzer) was reported from *P. brassicae*, *Melitaea didyma*, *M. deione* and *Maniola jurtina*; and *B. tibialis* (Walker) from *Euphydryas aurinia* and *E. desfontainii*. A few of the other chalcidids (including further species of *Brachymeria*) arise as pseudo hyperparasitoids ex. Ichneumonoidea cocoons (Shaw *et al*. 2009). *P. puparum* (Linnaeus) is a gregarious pupal parasitoid with a wide host range, including species of the Nympahlidae and Pieridae. This parasitoid contributes to regulation of a population of *Papilio xuthus* Linnaeus at low density in a suburban area of Fukuoka, Japan (Takagi 1985). This wasp is a predominant pupal endoparasitoid of *P. rapae* (Zhu *et al*. 2008) and considered to be an important biological control agent of this pest (Harvey *et al*. 2007).

Although *C. glomerata* was found to be the most important parasitoid of *P. brassicae* in many countries, *P. puparum*, from the Petromalidae family, was recorded as the most abundant species in our study. In other countries, *P. puparum* is known as parasitoid of some lepidopteran (especially Papilionidae, Pieridae and Nymphalidae) species like *Papilio machaon*; *P. xuthus*; *Aporia crataegi*; *P. rapae*; *Pontia daplidice*; *Libythea celtis*; *Argynnis pandora*; *A. adippe*; *Vanesa atalanta*; *V. cardui*; *Aglais urticae*; *Polígona c-album*; *Araschnia levana*; *Nymphalis antiopa*; *N. polychloros*; *Euphydryas desfontainii*; *E. aurinia*; *Melitaea cinxia*; *Limenitis camilla* (Shaw *et al*. 2009; Takagi 1986).

Of the parasitoids reported in the Biologie animală by Patriche *et al*. (2005), species such as *Compsilura concinnata* Meigen, 1824 (Tachinidae), *Cotesia rubecula* Marshall, 1885 (Braconidae), *Hyposoter ebeninus* Gravenhorst, 1829 (Ichneumonidae) and *Trichogramma evanescens* Westwood, 1833 (Trichogrammatidae) were not present in our results. The results of *P. brassicae* parasitism published by Patriche *et al*. (2005) show that the pupal parasitism is low. The parasitoid complex and apparent parasitism of *P. rapae* were investigated in Europe and the Kashmir Valley in India, by Patriche *et al*. (2005) and Bhat and Bhagat (2009). *C. glomerata* Linn. (Hymenoptera: Braconidae), *H. ebeninus* (Grav.) (Hymenoptera: Ichneumonidae) and *B. femorata* Panz. (Hymenoptera*:* Chalcididae) introduced by Bhat and Bhagat (2009) as a *P. rapae* parasitoids. In conclusion, in this study the parasitoid complex of *P. brassicae* in Iran was found to be rich.

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POLISH SUMMARY

ZESPÓŁ PARAZYTOIDÓW BIELINKA KAPUSTNIKA *PIERIS BRASSICAE* (L.) (LEPIDOPTERA: PIERIDAE) W REJONIE URMIA − NOWE DONIESIENIA Z IRANU

W latach 2008–2009 prowadzono badania nad parazytoidami atakującymi larwy i poczwarki *Pieris brassicae* (L.) (Lepidoptera: Pieridae) w agro-ekosystemach roślin z rodzaju *Brassica* w rejonie Urmia – północno-zachodni Iran. Spasożytowane okazy szkodnika gromadzono z upraw roślin krzyżowych w sezonie wegetacyjnym od czerwca do października, a także z powszechne występujących gatunków chwastów: *Capparis spinosa* L. (Capparaceae), *Crambe orientalia* L. (Brassicaceae) i *Raphanus raphanistrum* (Brassicaceae), podczas letniej przerwy w uprawie roślin (grudzień). Zidentyfikowano 10 głównych gatunków parazytoidów: *Cotesia glomerata* (L.) (Hym.: Braconidae), *Brachymeria femorata* Panzer (Hym.: Ghalcididae), *Aprostocetus taxi* Graham (Hym.: Eulophidae), *Agrothereutes adustus* Grav., *Blasidotes vicinus* Grav., *Hyposoter clauses* Brischke (Hym.: Ichneumonidae), *Pteromalus puparum* (L.) (Hym.: Pteromalidae) oraz *Exorista larvarum* (L.), *E. segregata* Rondan, *Phryxe vulgaris* Fallén (Dip.: Tachninidae). Najliczniej występowały gatunki *P. puparum* (49,65% w 2008 roku i 46,13% w 2009 roku) oraz *C. glomerata* (43,45 i 45,57% odpowiednio w 2008 i 2009 roku). Wymienione wcześniej gatunki parazytoidów: *A. adustus*, *A. taxi*, *B. vicinus*, *B. femorata*, *H. clauses* i *P. vulgaris* należały do nowo zarejestrowanych w Iranie. Powyższe gatunki, z wyjątkiem *B. femorata* i *P. vulgaris,* zostały zidentyfikowane jako parazytoidy *P. brassica* w Iranie.