Entomofauna

ZEITSCHRIFT FÜR ENTOMOLOGIE

Band 33, Heft 18: 281-288 ISSN 0250-4413 Ansfelden, 2. Januar 2012

Braconid and ichneumonid wasps (Hymenoptera, Ichneumonoidea) as the parasitoids of *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) in Iran

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Abstract

This paper deals with the braconids and ichneumonids (Hymenoptera, Ichneumonoidea) as the parasitoids of diamond back moth, *Plutella xylostella* (L.) (Lepidoptera, Plutellidae) in Iran. A total 2 braconid species in one genus (*Cotesia* CAMERON) and 5 ichneumonid species in 3 genera (*Diadromus* WESMAEL, *Herpestomus* WESMAEL, *Diadegma* FOERSTER) were reported from different regions of Iran so far. Of these, one braconid, *Cotesia vestalis* (HALIDAY) and two ichneumonid species *Herpestomus brunnicornis* GRAVENHORST and *Diadegma fenestrale* (HOLMGREN) are newly recorded from Iran.

Key words: Hymenoptera, Braconidae, Ichneumonidae, Parasitoid, *Plutella xylostella*, Iran.

Zusammenfassung

Braconiden- und Ichneumonidenwespen (Hymenoptera, Ichneumonoidea) gezogen im Iran als Parasitoide aus *Plutella xylostella* (L.) (Lepidoptera, Plutellidae). Bis jetzt wurden 2 Braconiden-Arten des Genus *Cotesia* CAMERON und 3 Ichneumoniden-Arten der Gattungen *Diadromus* WESMAEL, *Herpestomus* WESMAEL und *Diadegma* FOERSTER in verschiedenen Regionen des Iran aus *Plutella xylostella* (L.) gezogen. Die Braconide *Cotesia vestalis* (HALIDAY) und die Ichneumoniden, *Herpestomus brunnicornis* GRAVENHORST und *Diadegma fenestrale* (HOLMGREN) sind neu für die Fauna des Iran.

Introduction

The diamondback moth, *Plutella xylostella* (L.), is the most important pest of cabbage and other cruciferous crops worldwide (MUCKENFUSS et al. 1990; TALEKAR & SHELTON 1993). Because the larvae attack crops from seedling to harvest stage, virtually all cabbage crops are treated with insecticides during the growing season. Diamondback moth attacks only plants in the family Cruciferae. Virtually all cruciferous vegetable crops are eaten, including broccoli, Brussels sprouts, cabbage, Chinese cabbage, cauliflower, collard, kale, kohlrabi, mustard, radish, turnip, and watercress. Not all are equally preferred, however, and collard will usually be chosen by ovipositing moths relative to cabbage. Several cruciferous weeds are important hosts, especially early in the season before cultivated crops are available (HARPCOURT 1960; TALEKAR et al. 1985; TALEKAR & GRIGGS 1986). Large larvae, prepupae, and pupae are often killed by the parasitoids *Microplitis plutellae* (MUESBECK) (Hymenoptera: Braconidae), *Diadegma insulare* (CRESSON) (Hymenoptera: Ichneumonidae), and *Diadromus subtilicornis* (GRAVENHORST) (Hymenoptera: Ichneumonidae). All are specific on *P. xylostella*. Nectar produced by wildflowers is important in determining parasitism rates by *D. insulare*. Egg parasites are unknown. Fungi, granulosis virus, and nuclear polyhedrosis virus sometimes occur in high density diamondback moth larval populations (GOODWIN 1979; HIRASHIMA et al. 1989; TALEKAR 1996; CAPINERA 2001). Larval control with chemical pesticides started failing in the 1980s and insecticide resistance has since spread to *Bacillus thuringiensis* spp. *kurstaki* BERLINER (TABASHNIK et al. 1990; SHELTON & WYMAN 1992). Coupled with resistance, the increasing cost of pesticides and environmental awareness has encouraged the search for alternative management strategies (OOI & SUDDERUDDIN 1978).

The Braconidae constitute one of the most species-rich families of insects which most taxonomists would agree that a rough, probably highly conservative, estimate of 40-50,000 species worldwide is reasonable as an extrapolation from the current described number of roughly 12,000 species (SHARKEY & WAHL 1992; QUICKE et al. 1999). The Ichneumonidae is one of the most species rich families of all organisms with an estimated 60.000 species in the world (TOWNES 1969). Ichneumonids utilize a diverse array of insects and arachnids as their hosts and play an essential role in the normal functioning of most ecosystems, underlining the need to inventory their diversity. Ichneumonids have been used successfully as biocontrol agents and given the largely undocumented fauna there is a huge potential for their utilization in managed biocontrol programs (GUPTA 1991). Ichneumonoids parasitize mainly the larvae and pupae of holometabolous insects, excluding the Megaloptera and Siphonaptera. Whereas ichneumonids are almost completely restricted to the immature stages of the Holometabola (a few groups use egg nests of Pseudoscorpionida, egg cocoons or adult Araneae). Unlike microhymenoptera, ichneumonoids rarely parasitize individual eggs, and a few are egg-larval parasitoids, laying an egg in the host egg but consuming the host in its larval stage (GAULD 1988; WAHL & SHARKEY 1993).

Materials and Methods

The Braconidae and Ichneumonidae specimens were collected by the rearing of larvae of diamond back moth in optimum condition (26±2 ºC, 65±5 % RH, 14: 10 L: D) in

incubator. Additionally, the data adapted from the prior papers on Iranian Braconidae (GOLIZADEH et al. 2007) and Ichneumonidae (KOLAROV & GHAHARI 2005, 2008) were used in this paper too. Also the collected materials were put in ethanol 75% and determined by J. Šedivý of Czech Republic and V.I. Tobias of Russia. Classification, nomenclature and distributional data of Braconidae suggested by YU et al. (2006), and Ichneumonidae suggested by KASPARYAN (1981) and YU & HORSTMANN (1997) have been followed.

Results

So far in a total two braconid and five ichneumonid species were collected from different regions of Iran as the parasitoids of *P. xylostella*. The list of species is given below with distribution data.

Family B r a c o n i d a e

Subfamily M i c r o g a s t r i n a e FOERSTER 1862

Genus *Cotesia* CAMERON 1891

***Cotesia plutellae* (KURDJUMOV 1912)**

I r a n i a n r e c o r d : GOLIZADEH et al. (2007).

D i s t r i b u t i o n i n I r a n : Alborz province.

D i s t r i b u t i o n o u t s i d e I r a n : Holarctic.

C o m m e n t : *C. plutellae* is the most efficient parasitoid of diamondback moth in almost regions of the world (HIRASHIMA et al. 1989; OKINE et al. 1998; MANYANGIRWA et al. 2009). The effect of host plant resistance on foraging behaviour and parasitism success of *C. plutellae* was studied by KARIMZADEH et al. (2004).

***Cotesia vestalis* (HALIDAY 1834)**

M a t e r i a l e x a m i n e d : East Azarbayjan province: Arasbaran, 2♀, April 2007, det. V.I. Tobias. **New country record.**

D i s t r i b u t i o n o u t s i d e I r a n : Palaearctic and Oriental.

C o m m e n t : *C. plutellae* is used as a biological control agent for *P. xylostella*, in many countries and has been evaluated as a candidate for release in some countries.

Family I c h n e u m o n i d a e

Subfamily I c h n e u m o n i n a e LATREILLE 1802

Genus *Diadromus* WESMAEL 1845

***Diadromus subtilicornis* GRAVENHORST 1858**

I r a n i a n r e c o r d : KOLAROV & GHAHARI (2008).

D i s t r i b u t i o n i n I r a n : Kermanshah province.

Distribution outside Iran: The whole of the European part of the former USSR, Southwest Siberia, Western Europe, North America.

***Diadromus varicolor* WESMAEL 1844**

Iranian record: KOLAROV & GHAHARI (2008).

Distribution in Iran: West Azarbayjan province.

Distribution outside Iran: Caucasus, Northern and Central Europe, England, Romania.

Genus *Herpestomus* WESMAEL 1845

***Herpestomus brunnicornis* GRAVENHORST 1891**

Material examined: East Azarbayjan province: Arasbaran, 2♀♀, September 2005, det. J. Šedivý. **New country record**.

Distribution outside Iran: The whole of the European part of the former USSR, Khabarovsk, Western Europe.

Subfamily Campopleginae FÖRSTER 1869

Genus *Diadegma* FÖRSTER 1869

***Diadegma semiclausum* HELLÉN 1949**

Iranian record: BAGHERI et al. (2004); KOLAROV & GHAHARI (2005).

Distribution in Iran: Isfahan province.

Distribution outside Iran: Palaearctic.

Comment: This species is cosmopolitan (all regions of Palearctic) and powerful parasitoid on *P. xylostella*. Several materials of this species were collected from different regions of Iran. *D. semiclausum*, a solitary parasitoid of *P. xylostella* larvae, is thought to have originated in Eurasia (FITTON & WALKER 1992) and be an effective biological control agent of *P. xylostella*. In the Papua New Guinea highlands, the release and successful establishment of *D. semiclausum* since 1995 has substantially reduced crop losses by *P. xylostella* (SAUCKE et al. 2000). The wasp has also been introduced into the Philippines (AMEND & BASEDOW 1997) and Taiwan (TALEKAR 1996).

***Diadegma fenestrale* (HOLMGREN 1860)**

Material examined: Isfahan province: Isfahan, 1♀, 1♂, August 2006, det. J. Šedivý. **New country record**.

Distribution: Palaearctic and Oriental.

Discussion

Although only two braconid and five ichneumonid species as the parasitoids of *P. xylostella* were collected from Iran so far, but Iran is a large country incorporating various geographical regions and climates and we expect that further species of braconid and ichneumonid parasitoids of *P. xylostella* remain to be discovered. Therefore it is expected that other species will be discovered as the parasitoids of *P. xylostella* in different regions of Iran especially in the areas which were not sampled so far. The diamondback moth is rather important pest on cabbage in some regions of Iran and using the efficient control methods is usually essential for control. The main applied strategy in Iran is chemical control which surely with destructive effects on the nature and human health. Regarding to the powerful parasitoids of *P. xylostella* in Iran, conservation of these natural enemies will be resulted to successful control of the pest. Integrated pest management provides the most viable alternative to the heavy reliance on pesticides. An integrated approach to control lepidopterous pests in cabbage using multiple tactics is described by BIEVER et al. (1994). For diamondback moth control, this involves scouting, limiting the use of conventional pesticides, more reliance on *B. thuringiensis* -based insecticides, and parasitoids. Of the parasitoids attacking the diamondback moth, *C. plutellae* KURDJUMOV, *Diadegma insulare* (CRESSON) and *D. semiclausum* (HELLÉN) show the most promise (OOI & LIM 1989; OOI 1990; TABASHNIK et al. 1990; WAKISAKA et al. 1992). Proposed integrated pest management (IPM) strategies for diamondback moth include biological, chemical, and cultural control methods (LIM 1986; WATERHOUSE & NORRIS 1987; BIEVER et al. 1994). *Cotesia plutellae* (KURDJUMOV) and *Diadegma insulare* (CRESS) are 2 parasitoids used in diamondback moth control, with *C. plutellae* considered less effective than *D. insulare* (PARKER 1971; RU & WORKMAN 1979; HORN 1987; MUCKENFUSS et al. 1992; MITCHELL et al. 1997). Despite this, *C. plutellae* is a good candidate for augmentative control of diamondback moth because a mass-rearing technology has been developed for it; whereas, *D. insulare* is presently more difficult to mass rear (OKINE et al. 1998).

Acknowledgements

The authors are indebted to V.I. Tobias (Russian Academy of Sciences, he died July 2011), Dr. J. Šedivý (Research Institute for Crop Protection, Praha, Czech Republic) and Dr. J. Kolarov (University of Plovdiv, Bulgaria) for identification of specimens and sending the necessary papers. The research was supported by Shahre Rey Islamic Azad University, Naturhistorisches Museum and Zoological Museum of Turku University.

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Druck, Eigentümer, Herausgeber, Verleger und für den Inhalt verantwortlich:
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