SURVEY OF THE ICHNEUOMONOIDEA AND CHALCIDOIDEA (HYMENOPTERA) PARASITOIDS OF SATURNIIDAE (LEPIDOPTERA) IN IRAN

Hassan Ghahari[1], Ozlem Cetin Erdogan[2], Josef Šedivý[3] and Hadi Ostovan[4]

[1] Department of Agriculture, Islamic Azad University, Shahre Rey Branch, Tehran, Iran
[2] Trakya University, Faculty of Arts and Science, Department of Biology, 22030 Edirne, Turkey
[3] Research Institute for Crop Protection, 16106 Praha 6-Ruzyne, Czech Republic
[4] Department of Entomology, Islamic Azad University, Fars Science and Research Branch, Marvdasht, Iran

ABSTRACT

The present work deals with Ichneumonoidea and Chalcidoidea (Hymenoptera) as parasitoids of Saturniidae (Lepidoptera) in Iran. A total of six species of Braconidae (four genera and two subfamilies), eight species of Ichneumonidae (eight genera and four subfamilies), one species of Eupelmidae, and one species of Pteromalidae are listed in this paper. In addition to the species list, hosts and distributional data are given for all the parasitoids too.

Keywords: Ichneumonoidea, Chalcidoidea, Saturniidae, Parasitoids, Fauna, Iran

INTRODUCTION

Ichneumonoidea (Ichneumonidae and Braconidae) is considered as one of the first major parasitoid lineages in Hymenoptera (Rasnitsyn, 1980, 1988). It comprises a huge group, with probably more than 100,000 species worldwide (Gauld, 2002), of primary parasitoid insects that attack other arthropods, especially the immature stages of other insects (Gauld and Bolton, 1988; Wahl and Sharkey, 1993). Past classifications have sometimes included other groups, such as Stephanidae and Megalyridae (now transferred elsewhere) or they have recognized subfamilies of Braconidae (e.g. Aphidiinae and Apozyginae) and Ichneumonidae (Agriotypinae and Paxylommatinae) as distinct families (Sharkey and Wahl, 1992). On the other hand, members of the Chalcidoidea probably have the greater range of biological diversity than those of any other parasitoid groups. Chalcidoidea is numerically the largest and most biologically diverse in all insect groups. Recently published works indicate that chalcidoids already equal the number of Ichneumonoids in the described species, and it was believed that 60,000 to 100,000 species is not unreasonable (Gordth, 1979; Noyes, 1990). There is a great amount of confusion about the definition of families, genera and species of Chalcidoidea (Grissel and Schauff, 1997).Members of Chalcidoidea attack insect species of about 339 families representing 15 different orders, including all endopterygote orders, many exopterygotes, and also some arachnids (including pseudoscorpions, ticks, and mites) (Boucek, 1988; Noyes and Valentine, 1989). Chalcidoidea is the most important successful parasitoid group used in applied biological control, with over 800 different species have been used successfully in biocontrol programs in one way or another (Boucek, 1988; Noyes and Valentine, 1989).

Saturniidae, as hosts of those parasitoids, are among the largest and most spectacular families of Lepidoptera, with an estimated 1300-1500 described species worldwide (Grimaldi and Engel, 2005). The royal or regal moths, the giant silk moths, and the emperor moths belong to this family. In Iran, this family was poorly studied and only two species (*Neoris huttoni* Moore and *Saturnia pyri* L.) were identified so far (Modarres Awal, 1997). *Saturnia pyri* is a fruit pest in Iran, which occasionally damages the pear trees (*Pyrus communis* L.); and also observed on some other fruit and forest trees. The larva is large, voracious, and is a powerful defoliator both in gardens and forests (Esmaili, 2007). These moths are attacked by parasitoids from different families of Hymenoptera especially Ichneumonidae and Braconidae (Peigler, 1994).

Iran is predominantly an arid and semi-arid country, but the northern slopes of Alburz ranges and the Caspian lowland receive 800-2000mm annual rainfall and are the most humid parts of the country. On the other hand, Dasht-e Kavir and Dasht-e Lut deserts are the driest parts with less than 150mm annual precipitation (Zehzad *et al.*, 2002). The highlands receive between 250 and 800mm. From the bioclimatic point of view, the country is divided

Revised by: Sime, K. R. - Berkeley, California, USA (ksime@nature.berkeley.edu)
Laurenne, N. - University of Helsinki, Finland (laurenne@cc.helsinki.fi)

into 14 bioclimatic types. There is no clear cut picture of zoogeographic affinities of the degree of endemism of the Iranian fauna (Zehzad *et al.*, 2002). The aim of the present work is to identify some saturniid's ichneumonoid and chalcidoid parasitoids in Iran.

MATERIALS AND METHODS

The fauna of ichneumonoid and chalcidoid parasitoids of Iranian Saturniidae was studied in different forests of many provinces through 2004-2006. For collecting the parasitoid specimens, saturniid larvae (totally 43 larvae) were collected from the forests and were reared in optimum condition (26±2 ºC, 65±5 %RH, 14: 10 L: D) in an incubator for emergence of harboured parasitoids. In addition to the mentioned main method, some specimens were collected by malaise traps (totally 4 traps) which were set out only in forests of Mazandaran province (northern Iran). The collected parasitoids by malaise traps were considered as parasitoids of saturniids according to Peigler (1994). Classification, nomenclature, and distributional data of parasitoids suggested by Yu and Horstmann (1997), Yu *et al.* (2005), and Noyes (1998) have been followed.

During the present work, a total of 14 ichneumonoid and 2 chalcidoid parasitoids of Saturniidae were collected from different regions so far. A list of the collected species is presented with hosts and distributional data in Iran provinces (Fig.1) and outside Iran.

Checklist of the collected species

Superfamily Ichneumonoidea

Family Braconidae

Subfamily Euphorinae

1- *Meteorus luridus* Ruthe

Distribution in Iran: Kermanshah province: Paveh (1567 m), 2 materials, August 2006.

Host: *Saturnia pavonia* (Rougeot, 1971).

Distribution outside Iran: Palaearctic region.

Subfamily Microgastrinae

2- *Cotesia glomerata* (Linnaeus)

Distribution in Iran: Guilan province: Lahijan (18 m), 5 materials, July 2004.

Host: *Antheraeopsis assama* (Yu et al., 2005).

Distribution outside Iran: Palaearctic region.

3- *Cotesia juniperatae* (Bouché)

Distribution in Iran: Mazandaran province: Ghaemshahr (18 m), Joibar (14 m), Kiakola (23 m), Savadkooh (550 m), 7 materials, September 2006.

Host: *Saturnia pavonia* (Mason, 1981; Papp, 1990).

Distribution outside Iran: Central Europe and Middle Asia.

4- *Cotesia melanoscela* (Ratzeburg)

Distribution in Iran: East Azarbayjan province: Arasbaran (778 m), 1 material, September 2005.

Host: *Hemileuca maia* (Thompson, 1944; Mason, 1981).

Distribution outside Iran: Palaearctic region.

5- *Dolichogenidea aethiopica* (Wilkinson)

Distribution in Iran: Guilan province: Fooman (39 m), Rasht (39 m), 3 materials, October 2005.

Hosts: *Holocerina angulata*, *Imbrasia tyrrhea*, and several other Lepidoptera in Arctiidae, Lasiocampidae, Noctuidae, Nymphalidae, Pyralidae, Zygaenidae (Walker, 1994).

Distribution outside Iran: Palaearctic region.

6- *Protapanteles immunis* (Haliday)

Distribution in Iran: West Azarbayjan province: Ourmieh (1416 m), Piranshahr (1376 m), 2 materials, June 2005.

Hosts: *Saturnia pavonia*, *Orgyia antiqua* (Linnaeus) (Lymantriidae), and many other Lepidoptera including mostly Geometridae but also Lycaenidae, Noctuidae, Tortricidae, Plutellidae, Coleophoridae (Thompson, 1944; Rougeot, 1971; Papp, 1990; Mason, 1981).

Distribution outside Iran: Palaearctic region.

Family Ichneumonidae

Subfamily Anomaloninae

7- *Anomalon signatum* Gravenhorst

Distribution in Iran: Mazandaran province: Amol (198 m), Mahmood-Abad (65 m), 2 materials, July 2003. Kerman province: Jiroft (1196 m), 1 material, July 2004.

Host: *Saturnia pavonia* (Packard, 1914).

Distribution outside Iran: Palaearctic region.

Subfamily Campopleginae

8- *Campoplex quadrimaculatus* Ratzeburg

Distribution in Iran: Isfahan province: Najaf-Abad (1588 m), 1 material, August 2004.

Host: *Aglia tau* (Packard, 1914).

Distribution outside Iran: Palaearctic region.

Subfamily Ichneumoninae

9- *Amblyteles erythronotus* Rondani

Distribution in Iran: Ardabil province: Pars-Abad (96 m), 3 materials, September 2004. Guilan province: Astara (-19 m), 2 materials, October 2006.

Hosts: *Saturnia caecigena* (Lederer, 1951-1952; Rougeot, 1971).

Distribution outside Iran: Southeastern Europe.

Subfamily Pimplinae

10- *Agrothereutes fumipennis* (Gravenhorst)

Distribution in Iran: East Azarbayjan province: Arasbaran (805 m), 4 materials, September 2005. Khuzestan province: Ahwaz (15 m), 2 materials, October 2006.

Hosts: *Saturnia pavonia* (Nordström, 1916; Thompson, 1944; Kugler, 1961; Rougeot, 1971; Carlson, 1979; Ebert, 1994).

Distribution outside Iran: Northern Europe including Britain, and Middle Asia.

11- *Coccygomimus indra* (Cameron)

Distribution in Iran: Golestan province: Minoodasht (151 m), 1 material, September 2004. Mazandaran province: Behshahr (57 m), 2 materials, April 2005.

Hosts: *Saturnia pyri*, other Lepidoptera including butterflies, Lymantriidae, Lasiocampidae (Townes et al., 1965).

Distribution outside Iran: China, India, westward into European Russia.

12- *Gelis insolens* (Gravenhorst)

Distribution in Iran: East Azarbayjan province: Arasbaran (805 m), 4 materials, July 2005.

Host: *Saturnia pavonia* (Rougeot, 1971; Carlson, 1979).

Distribution outside Iran: Palaearctic region.

13- *Itoplectis viduata* (Gravenhorst)

Distribution in Iran: Kerman province: Jiroft (1196 m), 3 materials, July 2004. Mazandaran province: Ghaemshahr (18 m), 1 material, Savadkooh (550 m), 3 materials, June 2006.

Hosts: *Hemileuca oliviae*, Noctuidae, Lasiocampidae, Lymantriidae, Nymphalidae, Pieridae, Tortricidae, with mostly one species recorded per family (Carlson, 1979).

Distribution outside Iran: Palaearctic region; Northwest Territories and British Columbia to California and New Mexico.

14- *Pimpla robusta* Rondani

Distribution in Iran: Guilan province: Chaboksar (2 m), 1 material, October 2005. Mazandaran province: Ramsar (9 m), 3 materials, September 2006.

Host: *Actias isabellae* (Testout, 1947; Rougeot, 1971; Gómez & Fernández, 1976; Ylla, 1992).

Distribution outside Iran: Palaearctic region.

Superfamily Chalcidoidea

Family Eupelmidae

15- *Anastatus bifasciatus* Fourcroy

Distribution in Iran: East Azarbayjan province: Arasbaran (805 m), 1 material, October 2005.

Hosts: *Samia cynthia*, *Malacosoma neustria* L. (Lasiocampidae), *Dendrolimus pini* L. (Lasiocampidae), *Dendrolimus spectabilis* Butler, *Gonometa fasciata* (Lasiocampidae), three species of *Thaumetopoea* (Notodontidae), Hemiptera (Coreidae and Pentatomidae) (Arzone, 1971).

Distribution outside Iran: Palaearctic region.

Family Pteromalidae

16- *Dibrachys cavus* (Walker)

Distribution in Iran: East Azarbayjan province: Arasbaran (805 m), 3 materials, October 2005.

Hosts: *Hyalophora cecropia*, *Hyalophora columbia gloveri*, *Actias luna*, numerous other Lepidoptera, Hymenoptera, Diptera (Peck, 1963; Peigler, 1994).

Distribution outside Iran: Palaearctic region.

Comment: *D. cavus* is extremely polyphagous and can be a primary, secondary, or tertiary parasitoid.

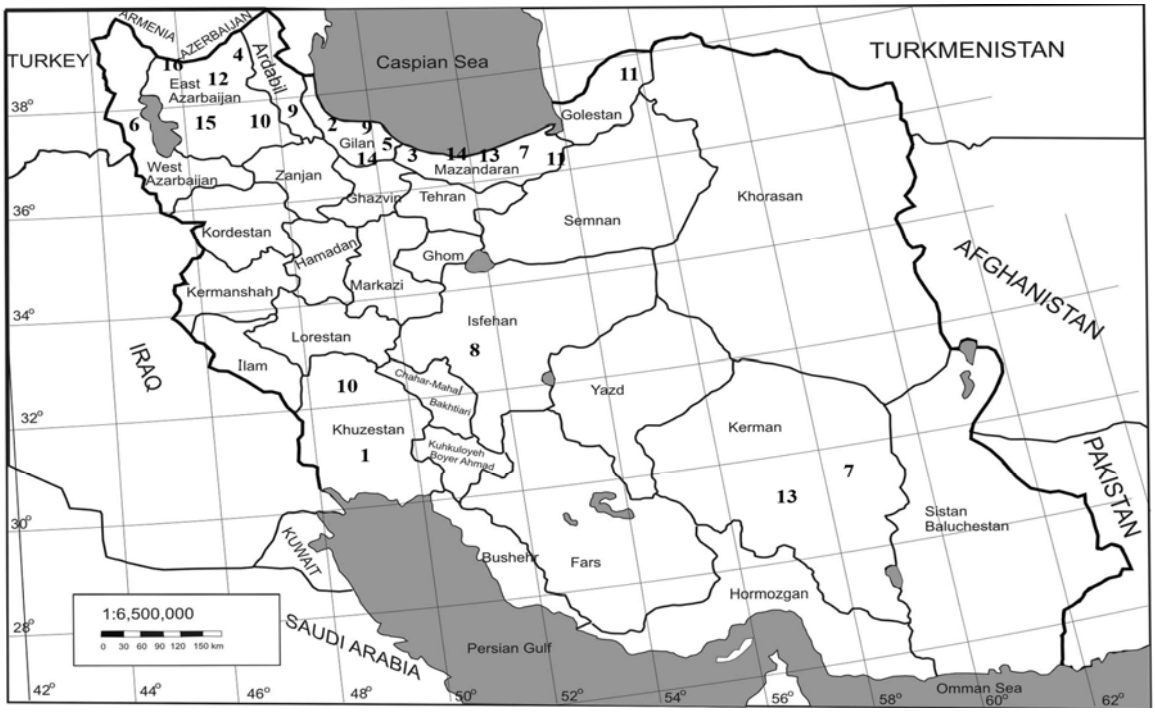

Fig.1. Map of Iran with boundaries of provinces showing the distribution of the collected ichneumonoid and chalcidoid parasitoids of saturniids. [1- ***Meteorus luridus*** Ruthe, 2- ***Cotesia glomerata*** (Linnaeus), 3- ***Cotesia juniperatae*** (Bouché), 4- ***Cotesia melanoscela*** (Ratzeburg), 5- ***Dolichogenidea aethiopica*** (Wilkinson), 6- ***Protapanteles immunis*** (Haliday), 7- ***Anomalon signatum*** Gravenhorst, 8- ***Campoplex quadrimaculatus*** Ratzeburg, 9- ***Amblyteles erythronotus*** Rondani, 10- ***Agrothereutes fumipennis*** (Gravenhorst), 11- ***Coccygomimus indra*** (Cameron), 12- ***Gelis insolens*** (Gravenhorst), 13- ***Itoplectis viduata*** (Gravenhorst), 14- ***Pimpla robusta*** Rondani, 15- ***Anastatus bifasciatus*** Fourcroy, 16- ***Dibrachys cavus*** (Walker)].

ACKNOWLEDGEMENT

The authors are indebted to Dr. K.J. Hedqvist (Höstvägen 1, SE-186 31 Vallentuna, Sweden), Dr. J. Kolarov (University of Plovdiv, Bulgaria), Dr. M. Fischer (Naturhistorisches Museum, Austria), Dr. M.C. Townes (Corvallis, Oregon 97330; USA) and Dr. T. Finlayon (Burnaby BC V3J 7E3, Canada) for invaluable helps in progress of the project and sending the necessary papers. We are also thanks to M. Tabari, H. Sakenin, M. Havaskary and N. Samin for loaning some specimens. Dr. Karen Rachel Sime (Berkeley, California) reviewed the manuscript kindly and perfectly. The research was supported by Shahre Rey Islamic Azad University, Cairo University of Egypt and Fars Science & Research Branch.

REFERENCES

Arzone, A. (1971). Biocenosi di Philosamia *cynthia* Drury in Piemonte. 3. *Anastatus bifasciatus* parassita delle uova. Bolletino della Società Entomologica Italiana, **103**: 87-97.

Boucek, Z. (1988). Australasian Chalcidoidea (Hymenoptera). A biosystematic revision of genera of fourteen families, with a reclassification of species. CAB International, Wallingford, Oxon, U.K., Cambrian News Ltd; Aberystwyth, Wales, 832 pp.

Carlson, R.W. (1979). Family Ichneumonidae, pp. 315-741; family Trigonalidae, pp. 1197-1198. *In*: Krombein, K.V., Hurd, P.D., Smith, D.R., and Burks, B.D., Eds, *Catalog of Hymenoptera in America north of Mexico*. Smithsonian Institution Press, Washington, D.C. Vols. 1-3: 2735 pp.

Ebert, G. (1994**).** Saturniidae (Pfauenspinner), pp. 104-117. *In*: Ebert, G. Ed., Die Schmetterlinge Baden-Württembergs, vol. 4: Nachtfalter 2. E. Ulmer, Stuttgart, 535 pp.

Esmaili, M. (2007). Important pests of fruit trees. Tehran University Publishing, 4th editing, 578 pp.

Gauld, I. (2002). The family Ichneumonidae. *In*: Gauld, I., Godoy, C., Ugalde, J., and Sithole, R. The Ichneumonidae of Costa Rica, 4. Memoirs of the American Entomological Institute, **66**: 1-768.

Gauld, I. and Bolton, B. (1988). The Hymenoptera. British Museum (Natural History) and Oxford Univ. Press.

Gómez Bustillo, M.R., and Fernández-Rubio, F. (1976). Mariposas de la Península ibérica, vol. 3, Heteróceros (I) Superfamilias Cossoidea, Zygenoidea [*sic*], Bombycoidea, Sphingoidea. Ministerio de Agricultura, Madrid.

Gordth, G. (1978). Taxonomic notes on Zagrammosoma, a key to the Nearctic species and descriptions of new species from California. Proceedings of the Entomological Society of Washington, **80**: 344-359.

Grimaldi, D. and Engel, M.S. (2005). Evolution of the Insects. Cambridge University Press: xv+755pp.

Grisell, E.E. and Schauff, M.E. (1997). A handbook of the families of Nearctic Chalcidoidea (Hymenoptera). Second Edition, Revised. Entomological Society of Washington, 87pp.

Kugler, J. (1961). *Orgyia dubia* Tausch. and its parasites in Israel. The Bulletin of the Research Council of Israel, Zoology, **10B** (1-2): 62-72.

Lederer, G. (1951-1952). Ein Beitrag zur Lebensweise von *Perisomena caecigena* (Kupido, 1825) (Lep. Saturnidae [*sic*]). Entomologische Zeitschrift, **61**: 131-136, 142-144.

Mason, W.R.M. (1981). The polyphyletic nature of *Apanteles* Förster (Hymenoptera: Braconidae): a phylogeny and reclassification of Microgastrinae. Memoirs of the Entomological Society of Canada, **115**: 1-147.

Modarres Awal, M. (1997). *List of agricultural pests and their natural enemies in Iran*. 2nd ed. Ferdowsi University. Press. Publication No. 147, 429 pp.

Nordström, F. (1916). Lepidopterologiska notiser. Entomologisk Tidskrift, Uppsala, **37(2)**: 115-130.

Noyes, J.S. (1990). The number of described chalcidoid taxa in the world that are currently regarded as valid. Chalcid forum, **13**: 9-10.

Noyes, J.S. (1998). Catalogue of Chalcidoidea of the world. CD-ROM Series, ETI, Amsterdam, Netherlands (ISBN 3-540-14675-X).

Noyes, J.S. and Valentine, E.W. (1989). Chalcidoidea (Insecta: Hymenoptera) - introduction, and review of genera in smaller families. Fauna of New Zealand, **18**: 1-91.

Packard, A.S. (1914). *Monograph of the bombycine moths of North America*, part 3 (edited by T.D.A. Cockerell). Memoirs of the National Academy of Sciences, **12**: ix + 1-516.

Papp, J. (1990). A survey of the European species of *Apanteles* Förster (Hymenoptera, Braconidae: Microgastrinae) XII. Supplement to the key of the *glomeratus* group. Parasitoid/host list 2. Annales Historico-Naturales Musei Nationalis Hungarici, **81**: 159-203.

Peck, O. (1963). A catalogue of the Nearctic Chalcidoidea (Insecta: Hymenoptera). Canadian Entomologist, Supplement, **30**: 1-1092.

Peigler, R.S. (1994). Catalog of parasitoids of Saturniidae of the world. Journal of Research on the Lepidoptera, **33**: 1-121.

Rasnitsyn, A.P. (1980). The origine and evolution of Hymenoptera. Trudy Paleontologichesko Instuta Academiya Nauk SSSR, **174**: 1-191.

Rasnitsyn, A.P. (1988). An outline of the hymenopterous insects. Oriental Insects, **22**: 115-145.

Rougeot, P.C. (1971). Les Bombycoïdes (Lepidoptera-Bombycoïdea) de l'Europe et du Bassin Méditerranéen, Tome 1: Lemoniidae, Bombycidae, Brahmaeidae, Attacidae, Endromididae. Faune de l'Europe et du Bassin Méditerranéen, **5**: 159 pp., 2 col. pls., 1 portrait. Masson et Cie, Paris.

Sharkey, M.J. and Wahl, D.B. (1992). Cladistics of the Ichneumonoidea (Hymenoptera). Journal of Hymenoptera Research, **1**: 15-24.

Testout, H. (1947). Contributions à la connaissance des Lépidoptères Saturnioïdes (XV): Revision des Saturnioïdes macroures, *Actiens* de Sonthonnax, 7. Faune Européenne (*Graëllsia isabelae* Graells) avec 6 figures et 1 carte. Bulletin Mensuel de la Société Linnéenne de Lyon, **16**: 99-116.

Thompson, W.R. (1944)**.** A catalogue of the parasites and predators of insect pests, Section 1, Parasite Host catalogue, Part 5, Parasites of the Lepidoptera. The Imperial Parasite Service, Belleville, Ontario.

Townes, H., Momoi, S. and Townes, M. (1965). A catalogue and reclassification of the eastern Palearctic Ichneumonidae. Memoirs of the American Entomological Institute, Number 5: v + 661.

Wahl, D.B. and Sharkey, M.J. (1993). Superfamily Ichneumonoidea, pp. 358-509. *In*: Goulet, H. and Huber, J.T. (Eds.), *Hymenoptera of the World: An Identification Guide to Families*, Agriculture Canada, Ottawa.

Walker, A.K. (1994). Species of Microgastrinae (Hymenoptera: Braconidae) parasitizing lepidopterous cereal stem borers in Africa. Bulletin of Entomological Research, **84**: 421-434.

Ylla, I. (1992). Biologia del saturnid *Graellsia isabelae* (Graells, 1849). Unpublished Ph.D. thesis. Universitat Autonoma de Barcelona. 432 pp. [in Catalan].

Yu, D.S. and Horstmann, K. (1997)**.** A catalogue of world Ichneumonidae (Hymenoptera). Memoirs of the American Entomological Institute, **58(1-2):** 1558 pp.

Yu, D.S., Achterberg, K., and Horstmann, K. (2005)**.** World Ichneumonoidea 2004 - Taxonomy, Biology, Morphology and Distribution. DVD/CD. Taxapad. Vancouver, Canada http://www.taxapad.com.

Zehzad, B., Kiabi, B.H., and Madjnoonian, H. (2002). The natural areas and landscape of Iran: an overview. Zoology in the Middle East, **26**: 7-10.