LACEWINGS (INSECTA: NEUROPTERA) OF IRANIAN RICE FIELDS AND SURROUNDING GRASSLANDS

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ABSTRACT: Lacewings (Neuroptera) are the efficient predators of pests in different agroecosystems. In this paper, totally 23 species of 14 genera including, *Anisochrysa*, *Chrysopa*, *Chrysoperla*, *Cunctochrysa*, *Dichochrysa*, *Mallada*, *Suarius* of family Chrysopidae, *Coniopteryx*, *Hemisemidalis* of family Coniopterigidae, *Hemerobius*, *Sympherobius*, *Wasmaelius* of family Hemerobiidae and *Myrmeleon*, *Palpares* of family Myrmeleontidae were collected from Iranian rice fields and surrounding grasslands.

KEY WORDS: Neuroptera, Rice field, Iran

Lacewings (Neuroptera) belong to one of the most important group of insects because of their significant roles in integrated pest management as predators of aphids, mites and several other agricultural pests, and also as the valuable indicators for assessing ecological statement of an habitat (Stelzl & Devetak, 1999; Canbulat, 2007). The Neuroptera includes the lacewings, mantidflies, antlions, and their relatives. The order contains some 5,500 species in 21 families. Traditionally, the group that was once known as Planipennia, with the Neuroptera at that time also including alderflies, fishflies, dobsonflies and snakeflies, but these are now generally considered to be separate orders (the Megaloptera and Raphidioptera). Within the endopterygotes, the closest living relatives of the neuropteridan clade are the beetles (Aspöck et al. 2001).

Neuropterans first appeared during the Permian Period, and continued to diversify through the Mesozoic Era. During this time several unusually large forms evolved, especially in the extinct family Kalligrammatidae, often referred to as "the butterflies of the Jurassic" due to their large, patterned wings (Martynova, 1952; Ponomarenko and Shcherbakov, 2004; Engel, 2005).

Larvae are mostly terrestrial except for Sisyridae. Their mandibles are long, sicklelike. The larvae of most families are predators and suck the body fluid of their preys. Many chrysopids eat aphids and other pest insects, and have been used for biological control (either from commercial distributors but also abundant and widespread in nature). Some species (especially *Chrysoprla carnea*) are reared and sold commercially as biocontrol agents. Larvae of some Ithonidae are

root feeders, and larvae of Sisyridae are aquatic, and feed on freshwater sponges. A few mantispids are parasites of spider egg sacs (New, 1996).

The Neuropteran fauna of Iran has been studied rather well and the total identified species of Iranian Neuroptera is 168. The most important researches on Iranian Neuroptera which were recently conducted are Mirmoayedi (1998, 2002), Yassayie and Mirmoayedi (1998) and Mirmoayedi et al. (1999).

Rice fields, together with their contiguous aquatic habitats and dry land comprise a rich mosaic of rapidly changing ecotones, harboring a rich biological diversity, maintained by rapid colonization as well as by rapid reproduction and growth of organisms (Fernando, 1995, 1996). The variety of organisms inhabiting rice field ecosystems includes a rich composition of fauna and flora. These organisms colonize rice fields by resting stages in soil, by air and via irrigation water (Fernando, 1993). The fauna are dominated by micro, meso and macro invertebrates (especially arthropods) inhabiting the vegetation, water and soil sub-habitats of the rice fields, while vertebrates are also associated with rice fields. The aquatic phase of rice fields generally harbors a varied group of aquatic animals. Those that inhabit the vegetation are mainly the arthropod insects and spiders (Bambaradeniya et al. 1998). In relation to the rice crop, the fauna and flora in rice fields include pests, their natural enemies (predators and parasitoids) and neutral forms.

Previous studies on the biodiversity of rice fields deal mainly with agronomic aspects, where the rice pests, their natural enemies and weeds have been surveyed extensively. Comprehensive studies on the ecology and biodiversity of rice fields are scanty. Among the earliest published records on the subject, Weerakoon (1957) has given a brief popular account on the ecology of rice field animals in Sri Lanka. A preliminary study on fauna and flora of a rice field in Sri Lanka by Bambaradeniya et al. (1998) has documented 77 species of invertebrates, 45 species of vertebrates and 34 species of plants. Roger and Kurihara (1989) have dealt with the aquatic ecology of rice fields in detail. Bambaradeniya (2000) has carried out the most recent comprehensive survey on the ecology and biodiversity in an irrigated rice field ecosystem. This survey documented 494 species of invertebrates belonging to 10 phyla, 103 species of vertebrates, 89 species of macrophytes, 39 genera of microphytes and 3 species of macrofungi from an irrigated rice field ecosystem in Sri Lanka. The majority of the invertebrates were arthropods (82%, 405 species), dominated by insects (78%, 317 species). The high number of animal and plant species documented in the above survey indicates that the irrigated rice field is an agroecosystem with a high diversity. The above study not only documented the overall biodiversity associated with this unique man-made temporary aquatic ecosystem, but elucidated the spatial and temporal variation of biodiversity, in relation to various governing factors affecting this ecosystem. For instance, using terrestrial arthropods as a surrogate group, the survey clearly documented the spatial variation of rice field biodiversity in two rice fields in the same locality and irrigated by the same reservoir, but differing in agronomic practices. Furthermore, it also highlighted how an increase in the structural complexity of the habitat contributed to a temporal gradient in biodiversity through the progression of each rice cultivation cycle, while significant seasonal variations were less likely to occur in a particular rice field that follows generally similar agronomic practices during each cycle.

According to Dale (1994) who has given a comprehensive account of the biology and ecology of insect pests of rice, over 800 species of insects damage rice plants in several ways, although the majority of them cause minor damage. The number of insect species that cause economic damage to rice varies from 20

(Pathak and Khan, 1994) to 30 (Riessig et al. 1986). Bambaradeniya (2000) recorded 130 species of phytophagous insects in Sri Lankan rice fields, of which the majority (76 species) consisted of visitors or other insects associated with weeds. In addition to causing direct damage to rice plants, many rice insect pests also act as vectors of viral diseases of rice, such as the Tungro virus (Dale, 1994). The insect pests of rice are either monophagous feeding only on the rice plant, or polyphagous, where they move in and out of adjacent vegetation including largely rice field weeds. Loevinsohn (1994) has discussed various forces that determine the presence and abundance of insect pests in rice agro-ecosystems, including their adaptations to the rice environment, the influence of the cropping system and the dynamics of the pest populations in relation to the cultural environment.

MATERIALS AND METHODS

Among the several Iranian provinces which included paddy fields, five provinces including, Chaharmahal & Bakhtiari, East Azarbayjan, Golestan, Guilan, Isfahan and Mazandaran were surveyed. Materials were captured by sweeping net of 50 cm in diameter and the light traps (200 watts tungsten) from the rice fields and surrounding grasslands. In addition to the collected specimen by the Iranian authors, several other collected specimens by many researchers and amateur students have also been included in this study. Additionally, the preserved specimens in Ghaemshahr and Amol Islamic Azad Universities were checked too. The collected specimens were preserved in 75% ethanol and sent to the specialists of Natural History Museum Vienna for identification to species level. The information concerning the species' name, describer, locality and the date of collection were collected and the number of species (in brackets) was also given.

RESULTS

In a total of 23 species of 14 genera and 4 families (Chrysopidae, Coniopterigidae, Hemerobiidae, Myrmeleontidae) were collected from different Iranian rice fields and surrounding grasslands. The list of species is below.

I. Family Chrysopidae Schneider, 1851

The Chrysopidae is one of the largest and economically most important families of the Neuroptera. The family includes over 1200 currently recognized species and subspecies that are divided between 86 genera and subgenera. The larvae of all species and adults of a few genera are predaceous and most feed on aphids, coccids and other soft-bodied insects they encounter on foliage. For this reason, some species have been reared and successfully used for the biological control of agricultural pests (Brooks & Barnard, 1990).

The family Chrysopidae included several predators which have efficient role in biological control programs. While depending on species and environmental conditions, some green lacewings will eat only about 150 prey items in their entire life, in other cases 100 aphids will be eaten in a single week. Thus, in several countries, millions of such voracious Chrysopidae are reared for sale as biological control agents of insect and mite pests in agriculture and gardens. They are distributed as eggs, since as noted above they are highly aggressive and cannibalistic in confined quarters; the eggs hatch in the field. Their performance

is variable; thus, there is a lot of interest in further research to improve the use of green lacewings as biological pest control.

In a total of 16 Chrysopidae species were collected from Iranian rice fields and around grasslands. The fauna of Chrysopidae of Iran was studied better than the other families of Neuroptera. Holzel (1966, 1967, 1981) studied the fauna of Iranian Chrysopidae very well and totally 33 species are listed in the check-list Modarres Awal (1997). After many other researches by Mirmoayedi (1998, 2002) and other authors in recent years, the total number of Iranian Chrysopidae is 45 species.

***Anisochrysa* Nakahara, 1955**

***Anisochrysa flavifrons* Brauer, 1850**

Material: Golestan province: Kordkoy (1 specimen), June 2005.

***Chrysopa* Leach, 1815**

***Chrysopa caviceps* McLachlan, 1898**

Material: Guilan province: Rasht (1 specimen), July 2005.

***Chrysopa dubitans* McLachlan, 1887**

Material: Isfahan province: Lenjan (1 specimen), August 2000. East Azarbayjan province, Arasbaran (2 specimens), July 2003.

***Chrysopa perla* Linnaeus, 1758**

Material: Chaharmahal & Bakhtiari province: Sahrekord (1 specimen), August 2003.

***Chrysopa viridana* Schneider, 1845**

Material: Guilan province: Rasht, Fooman (3 specimens), July 2005.

***Chrysoperla* Steinmann, 1964**

***Chrysoperla carnea* (Stephens, 1836)**

Material: Isfahan province: Lenjan, Isfahan, Najaf-Abad (7 specimens), August 2000. Guilan province: Rasht, Fooman, Lahijan (4 specimens), July 2002. Chaharmahal & Bakhtiari provinc: Shahrekord (4 specimens), August 2004. East Azarbayjan province, Arasbaran (6 specimens), July 2004. Mazandaran province: Amol, Babol, Ghaemshahr, Sari, Behshar, Savadkooh (14 specimens), September 2005. Golestan province: Gorgan, and Kordkoy (8 specimens), June 2006.

Comment: *C. carnea* is a dominant species of Neuroptera in Iranian rice fields (Ghahari et al. 2008), and in the present research was collected all over of Iranian rice fields and surrounding grasslands. The egg and pupal parasitoids, *Telenomus acrobates* Giard 1895 (Hymenoptera: Scelionidae) (Chaharmahal & Bakhtiari provinc: Shahrekord) and *Dichrogaster modesta* (Gravenhorst, 1829) (Hymenoptera: Ichneumonidae) (Guilan province: Lahijan), respectively, were reared from *C. carnea*. Also, three asilid flies including, *Acnephalum futile* Wulp, 1899, *Cerdistus debilis* Becker, 1923 and *Trichomachimus curtusus* Lehr, 1989 (Diptera: Asilidae) were observed as the predators of *C. carnea* in Lahijan (Guilan province), Arasbaran (East Azarbayjan province) and Najaf-Abad (Isfahan province), respectively.

***Chrysoperla iranica* Holzel, 1967**

Material: Isfahan province: Lenjan (3 specimens), August 2000. Guilan province: Fooman (2 specimens), July 2005.

Comment: *Erax nubeculus* (Loew, 1848) (Diptera: Asilidae) was observed as the predator of *C. iranica* in Lenjan (Isfahan province).

***Chrysoperla mutata* (McLachlan, 1898)**

Material: Guilan province: Rasht (1 specimen), July 2005. Mazandaran province: Amol (1 specimen), September 2005.

***Chrysoperla rotundata* (Navás, 1929)**

Material: Guilan province: Rasht (1 specimen), July 2005.

***Chrysotropia* Navás, 1911**

***Chrysotropia ciliata* (Wesmael, 1841)**

Material: Chaharmahal & Bakhtiari province: Shahrekord (1 specimen), August 2004.

***Cunctochrysa* Hölzel, 1970**

***Cunctochrysa albolineata* (Killington, 1935)**

Material: Mazandaran province: Amol (1 specimen), September 2005. Guilan province: Rasht (2 specimens), July 2005.

***Dichochrysa* Yang, 1991**

***Dichochrysa prasina* (Burmeister, 1839)**

Material: Guilan province: Rasht (1 specimen), July 2005.

***Dichochrysa zelleri* (Schneider, 1851)**

Material: Mazandaran province: Amol, Babol (2 specimens), September 2005.

***Mallada* Navás, 1925**

***Mallada derbendicus* (Hölzel, 1967)**

Material: Golestan province: Kordkoy (1 specimen), July 2005.

***Suarius* Navás, 1914**

***Suarius mongolicus* (Tjeder, 1936)**

Material: Mazandaran province: Freydonkenar (2 specimens), September 2005.

***Suarius nanus* (McLachlan 1893)**

Material: Mazandaran province: Amol (1 specimen), September 2005.

II. Family Coniopterigidae Burmeister, 1839

The Coniopterygidae of Iran was studied by Aspock & Aspock (1965), Raush & Aspock (1978), Meinandr (1998), Mirmoayedi (1998, 2002), and the total number of species reported from Iran is 25 species. In this research two species of this family were collected from Iranian rice fields as below.

***Coniopteryx* Curtis, 1834**

***Coniopteryx* (*Holoconiopteryx*) *drammonti* Rousset, 1964**

Material: Chaharmahal & Bakhtiari province: Shahrekord (1 specimen), August 2003.

***Hemisemidalis* Meinander, 1972**

***Hemisemidalis pallida* (Withycombe, 1924)**

Material: Chaharmahal & Bakhtiari province: Shahrekord (2 specimens), August 2003. Golestan province: Gorgan (1 specimen), June 2004.

Comment: *Lasiopogon tarsalis* Loew, 1847 (Diptera: Asilidae) was observed as the predator of *H. pallida* in Shahrekord (Chaharmahal & Bakhtiari province).

III. Family Hemerobiidae Latreille, 1802

***Hemerobius* Linnaeus, 1758**

***Hemerobius humulinus* Linnaeus, 1758**

Material: East Azarbayjan province, Arasbaran (1 specimen), July 2005. Mazandaran province: Amol (1 specimen), September 2005.

***Sympherobius* Banks, 1904**

***Sympherobius pygmaeus* (Rambur, 1842)**

Material: Isfahan province: Isfahan (2 specimens), August 2000. Guilan province: Rasht (3 specimens), July 2005.

Comment: An asilid fly, *Theurgus kerzneri* Lehr, 1974 (Diptera: Asilidae) was observed as the predator of *S. pygmaeus* in Isfahan (Isfahan province).

***Wesmaelius* Krüger, 1922**

***Wesmaelius navasi* (Andreu, 1911)**

Material: Mazandaran province: Ghaemshahr, Savadkooh (2 specimens), June 2003.

IV. Family Myrmeleontidae Latreille, 1802

The Myrmeleontidae fauna of Iran was studied by Holzel (1968, 1972), Mirmoayedi et al. (1999) with 80 species, and recently Mirmoayedi (2002) with 9 species. In this research, two species were collected from Iranian rice fields.

***Myrmeleon* Linnaeus 1767**

***Myrmeleon hyalinus* Olivier 1811**

Material: Isfahan province: Isfahan (1 specimen), August 2000. Chaharmahal & Bakhtiari province: Shahrekord (2 specimens), September 2004. East Azarbayjan province, Arasbaran (1 specimen), July 2005.

***Palpares* Rambur, 19842**

***Palpares solidus* Gerstaecker, 1894**

Material: Isfahan province: Lenjan (1 specimen), August 2000.

DISCUSSION

The arthropod natural enemies of rice pest insects include a wide range of predators and parasitoids that are important biological control agents. Predators include a variety of spiders, and insects such as different coleopteran families, aquatic and terrestrial predatory bugs, lacewings, dragon flies, etc (Ghahari et al., 2008). They have stated that long histories of rice cultivation in many parts of the world have allowed stable relationships to evolve between rice insect pests and their natural enemies. In most instances, the species richness and abundance of predator populations may be greater than those of the pest populations, when little or no insecticides are used (Way and Heong, 1994). A pioneering study by Settle et al. (1996) conducted in Java demonstrated the existence of high levels of natural biological control in tropical irrigated rice systems. Bambaradeniya (2000) observed that more than 50% of the terrestrial arthropod species in Sri Lankan rice fields consisted of predators, with spiders being the dominant predatory group. Although fauna of Iranian Neuroptera was studied rather well (Modarres Awal, 1997; Mirmoayedi, 1998, 2002; Yassayie & Mirmoayedi, 1998; Mirmoayedi et al., 1999) same as Turkish fauna (Canbulat, 2007), neighboring of Iran, but Iran is a large country with various geographical climates and therefore more diverse species of this taxon is expected for Iran.

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