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Biodiversity of Auchenorrhyncha in sugar beet fields of Mashhad region and new records for Khorasan Razavi province

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ABSTRACT

In a faunistic survey conducted on Auchenorrhyncha in sugar beet fields of Mashhad and Chenaran regions during 2008-2010, a total of 2741specimens belonging to 5 families were collected. As a result, 10 species were added to the fauna of the study area including: Family Cicadellidae: *Rhytidodus decimusquartus* (Schrank 1776)*, Viridicerus malicola (*Dubovxdy 1966); *Handianus procerus* (Herrich-Schaffer l835), *Euscelidius mundus* (Haupt 1927), *Doraturopsis* sp., *Agallia* sp.; *Platymetopius* sp.**,** Family Tettigometridae: *Tettigometra sordida* (Fieber 1865); Family Aphrophoridae: *Aphrophora salicina* (Goeze 1778); Family Cixiidae: *Reptalus bitinctus* (Dlabola 1961). *Empoasca meridiana* (Zachvatkin 1946) and *Circulifer haematoceps* (Mulsant and Rey 1855), with 23.7 and 11.2 percent respectively, were the most abundant species in the study sites. The maximum and minimum values calculated for Shannon-Wiener index of diversity, based on data collected fortnightly from the selected fields in Mashhad region were observed in August and November, respectively. At mid-summer, when the index of biodiversity was the highest, the relative abundance of most species was high and there was more uniformity among the collected species.

Keywords: Auchenorrhyncha, biodiversity, fauna, Iran, sugar beet

INTRODUCTION

Leafhoppers (Suborders of Auchenorrhyncha) (with 44,000 characterized species in the world: Dietriech 2005, Wilson 2005) are one of the important groups of damaging insects for agricultural crops. The insect, through sucking the plant sap, laying eggs on the shoot tips or the young vegetative organs or transmitting the plant disease pathogens, could cause economic losses. In the scientific literature, about 22 plant diseases have been mentioned which are transmitted by leafhoppers in sugar beet fields (Kheyri and Alimoradi 1968; Nejat et al. 2000; Bressan et al. 2008; Brezikova and Linhartova 2007). Considering the importance of these insects in agriculture, many studies have been carried out in various regions of the world. Unfortunately, the Fonestic evaluation on leafhoppers of sugar beet in Iran has been restricted to researches done by Kheyri and Alimoradi (1968), Karimzadeh Isfahani (1987) and Mosavi Mavelati and MidarresAwal (2011). Before the present study, the total reported species from the sugar beet fields in Iran were less than 44 (Kheyri and Alimoradi 1968; Karimzadeh Isfahani 1987; Mosavi Mahvelati and Moddarres Awal 2011; Kiomarsi et al. 1985; Modarres Awal 2002; Monsef and Kheyri 1968; Farzdafar et al. 2006 and 2008). Among these, 22 species have been reported from Khorasan Razavi. In spite of the significance of sugar beet as one of the important industrial crops in the world as a great part in provision of human required energy, and also considering Khorasan Razavi province as the largest area for sugar beet production in Iran, the knowledge about the species variety and seasonal occurrence of sugar beet leafhoppers is insufficient. In recent years, the high-input agriculture has caused the increase in field crops yield, but this matter has

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decreased the frequency and diversity of plants and animals species. For example, using pesticides in agriculture, with the removal of a great number of sensitive animal species, has reduced the biodiversity and, through the decreasing in-species competition, paved the way for dominance of some other species. In this way, the functional structure of some ecosystems has been changed, so that some of the herbivorous species, in absence of natural effective enemies or the competitor species, have turned out to be as pests. Meanwhile, the increase of biodiversity, in the agricultural systems, is a key strategy for the sustainability in production. On this basis, sustainable agriculture has been considered in the recent years as an approach for the protection of agricultural ecosystems productivity, without destruction of the natural resources (Altieri 1999). Among the different components of agricultural ecosystems, insects have high potentiality for our better understanding about conditions and evaluation of ecosystem safety, but inadequate knowledge and resource limitations have increased the problems of studying insects biodiversity. According to the different forms of organisms, the evaluation of biodiversity does not seem to be a simple issue. Despite being so many interests in the biodiversity and its assessment, there is no consensus on utilization of a specific index (Ricklefs and Scholter 1995). The assessment of biodiversity is based upon the relative comparisons, which can be done either simultaneously in different places or with different durations in one place. Among the various indices used for assessment of biodiversity, some researchers pay attention to the species richness, some do to the species dominance and others consider both richness and mode of species distribution in an ecosystem (Hill et al. 2003). One of the current indices of biodiversity is the Shannon-Wiener Index, which defines the biodiversity on the basis of two elements: species richness and frequency of individuals (Southwood 1978). The population ecologists take as necessary the biodiversity and the complexity of species relations for the stability of a society. The omission or addition of even one species could cause major unpredictable effects on ecology (Pimentel et al. 1997). Therefore, knowing about species and frequency of population of pests in the different times are basic issues in pests management. In the past, such a study has not been done in Khorasan Razavi province. The present research was carried out in order to provide such a knowledge and infrastructural preparation for practical researches over sugar beet leafhoppers in Mashhad and Chenaran as the major sugar beet production areas in the province of Khorasan Razavi.

MATERIALS AND METHODS

The study of species diversity and relative frequency of sugar beet leafhoppers population in the fields were done in 3 selected farms, with approximate areas of one hectare each, in the village of Shir-Hesar in Mashhad. The samplings were carried out, starting from the 20th April and after the emergence of the sugar beet plants until 20th November in the same year at two- week intervals regularly. The sampling method was in such a way that in each field movement was in the zigzagged form, using the standard insect-net, with a diameter of 35 cm and handle length of 80cm and 1 m distance. One return netting and 50 times netting in each field were carried out. The collected samples in each sampling by using Aspirator, were put in a glass container, filled with 75% ethanol, and then transferred to the laboratory in order to determine the biodiversity indices. At the end of the sampling and after the identification of samples, the average frequency for each species of leafhoppers was obtained with dividing the total of each species by the total numbers of gathered leafhoppers per each specific date, based upon the average of frequency percentages per sampling date of dominant species in the area. According to the species numbers and their frequencies for each sampling date, the biodiversity of the sugar beet leafhoppers in the fields of the areas was determined by calculation of Shanon-Wiener Index (Southwood 1978).

In order to determine the sugar beet leafhoppers species diversity in the area, in addition to regular sampling in the selected fields, visits to the other sugar beet fields in Mashhad and Chenaran were carried out during 3 recent years and the samplings were done through different methods of insect-netting and aspirator-using.

The species were indentified, according to the indo and ecto-morphological characteristics, especially male insects genitals and by characterization keys and the existing definitions in the scientific resources and were sent to Dr. Dmitry Dmitriev in the Natural History Museum of Illinois, USA, and confirmed by him.

RESULTS

In this research, about 2741 samples of mature leafhoppers, belonging to 5 families, were

Table 1. Leafhoppers collected from sugar beet fields in different areas of Mashad and Chenaran in 2010

No.	Figure No.	Collection site	Sampling date	Scientific name
1	1A & 2A	Ye Abad	2010/8/16	*Rhytidodus decimusquartus*
2	1B & 2B	Nazer Abad	2010/8/17	*Viridicerus malicola*
3	1C & 2C	Amerghan	2010/8/6	*Handianus procerus*
4	1D & 2D	Govareshak	2010/5/31	*Euscelidius muadus*
5	1E	Nazer Abad	2010/8/10	*Doraturopsis sp.*
6	1F	Marian	2010/7/15	*Agallia sp.*
7	1G	Golgoon, Shir-Hesar and Nazer Abad	2010/8/17 2010/8/6	*Platymetopius sp.*
8	1 H	Nazer Abad	2010/8/17	*Tettigometra sordid*
9	1 J	Field of Astane-Ghods	2010/5/15	*Aphrophora salicina*
10	1 J	Golgoon	2010/7/8	*Reptalus bitinctus*

collected. The family of Cicadellidae, with 18 species, had the maximum species richness followed by the families of Delphacidae, Tettigometridae-Cixiidae and Aphrophoridae, with 4, 2, 2 and 1 species, respectively. Among these numbers, up to present, 24 Taxa at species level and 3 Taxa at the genesis level were identified, 17 species of which had been reported before (Mosavi Mahvelati and Modarres Awal 2011). Now, with 10 new species, reported in the Table 1 in the present study, the recognized and collected leafhoppers Founa amounted to 27 species. The completed figures of all species and the male insects' genitals, 4 Taxons of family Cicadellidae, identified at the species level were illustrated (Figures 1 and 2).

Seasonal changes of diversity and frequency of species

In this study, the species *Empoasca meridian* and *Circuliferhaematoceps* were present all over the growing season in the sampled field, having the maximum frequencies of 23.7% and 11.2% during the growing season in the area, respectively. From the species richness point of view, the maximum species numbers were observed in August and July, 15 and 14, respectively. The minimum species diversities were in October followed by November and May. With combination of species diversity and their frequencies, the leafhoppers biodiversity index was obtained in the sugar beet fields. The quantities variances of this index during the growing season are illustrated in the Figure 1. As seen, the maximum and minimum calculated quantities for biodiversity index (H) were 1.72 and 0.73, respectively. The relative frequency of the dominant species (*Empoascameridiana*) in May, June, July, August, September, October and November were 42, 44, 33, 23, 37, 85 and 64, respectively. As a matter of fact, at the beginning and end of growing season, the frequencies of dominant species, in comparison with August and July, were more, but in mid-summer when the biodiversity index showed its maximum, the populations of most species were high and the individual distribution among species, in comparison with other months of growing seasons, had more uniformity.

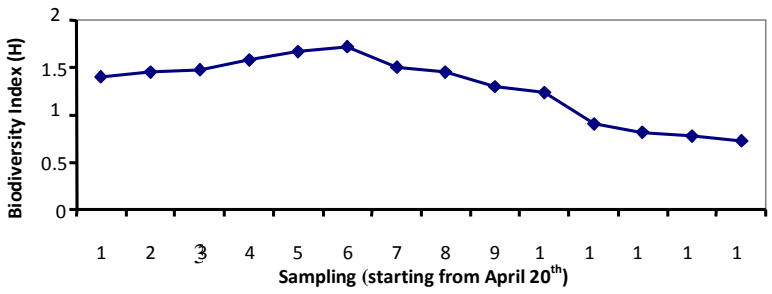

Fig. 1. Seasonal variations of biodiversity index of leafhoppers of sugar beet fields in Mashad and Chenaran in 2010. In the present study, biodiversity index for different samplings was calculated by Shanon-Wiener index. The sampling was started on April 20th and continued until November 20th with two-week intervals.

DISCUSSION

For assessment of biodiversity, by using Shanon-Wiener Index, the index variances ranges are between 0-5 and usually 1.5-3.5 (Southwood 19780). In this study, the quantity of this index was changed between 1.72 and 0.73. On the other hand, in the most sampling dates, the biodiversity index was low. The reason was probably the considerable frequencies of species such as *Empoascameridiana* and *Neoaliturushaematoceps*, in comparison with other species and their dominance. It is taken for granted where and when one or more species in a sampled population have a considerable dominance, the biodiversity index will be low (Disney 1999). In this study, the species presence and diversity of leafhoppers in the

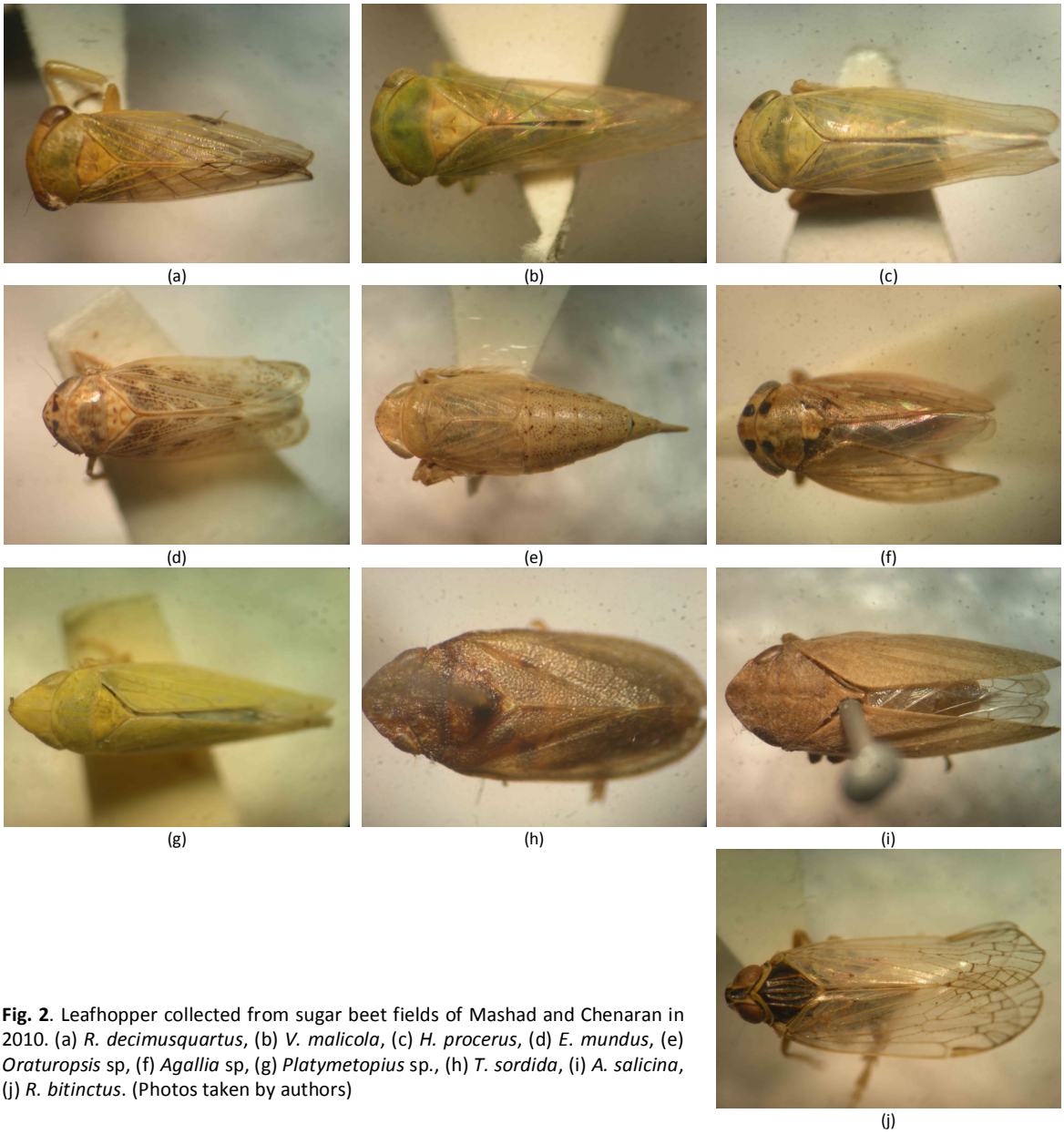

Fig. 2. Leafhopper collected from sugar beet fields of Mashad and Chenaran in 2010. (a) *R. decimusquartus*, (b) *V. malicola*, (c) *H. procerus*, (d) *E. mundus*, (e) *Oraturopsis* sp, (f) *Agallia* sp, (g) *Platymetopius* sp., (h) *T. sordida*, (i) *A. salicina*, (j) *R. bitinctus*. (Photos taken by authors)

sugar beet fields selected for the different sampling times during the growing season were various. The species like *Retalusbitinctus*, Agallia sp., Doraturopsis sp., *Rhytidodusdecimusquartus*, *Handianusprocerus*, *Viridicerusmalicola*, Doraturopsis sp., *Tettigometrasordica*, *Euscelidius mundus*, were collected, just for one time, in July and August, which was the reason for increasing biodiversity index in these months. The enhancement of species richness and also the relative frequencies of most leafhoppers in the sugar beet fields in the summer months might have been resulted by phonological characteristics of leafhoppers species.

The general idea is that many leafhoppers species are philothermic and heliotropist, so their presence and activities are mainly limited to the warm months of year. Additionally, some other leafhoppers, especially those which overwinter in mature forms on the non-cultivated plants and on the non-cultivated lands, in the growing season and only when the primary host, with the beginning of hot season and water stresses would be faded away and unsuitable to be lived over, immigrate to the crops such as sugar beet as host (Hamilton and Whitcomb 2010). Also, the density of leafhoppers population during the sowing season affected by the predators and parasitoids could be seriously fluctuated (Meyerdirk and Hessein 1985). It is worth mentioning that not all the leafhoppers reported from sugar beet fields were the pests for the crops, or that there is no

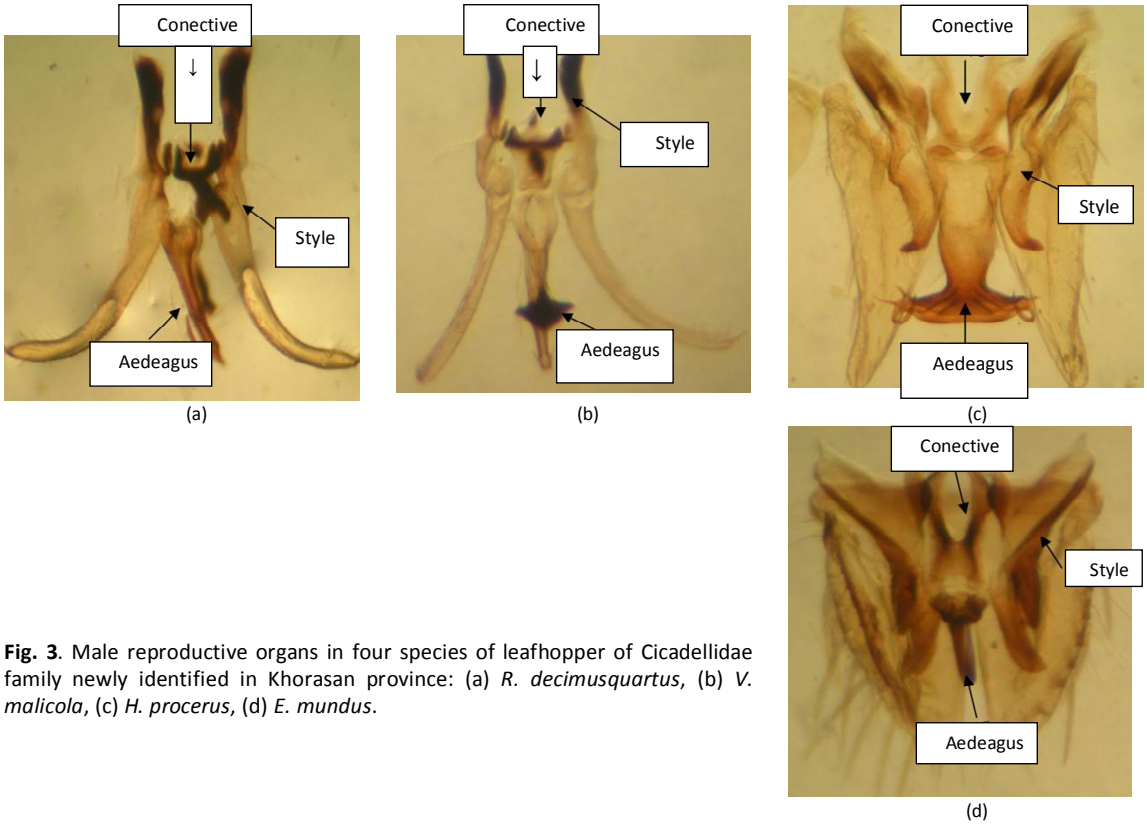

Fig. 3. Male reproductive organs in four species of leafhopper of Cicadellidae family newly identified in Khorasan province: (a) *R. decimusquartus*, (b) *V. malicola*, (c) *H. procerus*, (d) *E. mundus*.

knowledge relating their host preference in Iran conditions. For example, the species like *Macrostelesquadrilineatus*, which was collected in this study, in Canada conditions was active in meadows and considered as the migrant species (Hamilton and Whitcomb 2010). This type of possibility does not seem to be far-fetched idea in the area and Iran in general, but considering the insufficient or lack of knowledge about the environmental factors affecting the presence time of leafhoppers, activity duration, role of natural enemies, and host preference of active leafhoppers in sugar beet fields, the necessity of more evaluation in the area conditions appears to be absolutely clear.

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