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Beetle Communities of Alfalfa (*Medicago sativa* L.) in the Republic of Moldova

Natalia Munteanu*, Svetlana Bacalb, Anna Moldovana, Nadejda Malevanciuc and Ion Toderasa

*Laboratory of Sistematyys and Molecular Phylogeny, Institute of Zoology, Academy of Sciences of Moldova, Academiei 1, Chisinau 2028, Republic of Moldova

bLaboratory of Entomology, Institute of Zoology, Academy of Sciences of Moldova, Academiei 1, Chisinau 2028, Republic of Moldova

**Abstract**

This article reports on the beetle diversity and abundance study conducted during 2009 and 2010 in three alfalfa fields located near Lozova, Ivancea and Trebujeni in the central part of the Republic of Moldova. All insects were collected using pitfall traps and sweeping techniques. In total, 843 beetle specimens were collected, representing 63 species from 49 genera and 12 families. The largest family was Curculionidae, followed by Scarabaeidae, Carabidae, Coccinellidae, Silphidae, Cerambycidae, Dermentidae, Staphylinidae, Tenebrionidae and Trogidae. Weevils (Curculionoidea) also, represented the greatest proportion in terms of number of individuals. During the present study captured beetles from all three localities were compared and Shannon indices were calculated as a measure of diversity within the habitat. The Shannon diversity index has been found maximum (1.035) in Trebujeni, moderate (1.017) in Ivancea and low (0.936) in Lozova. Five of the recorded species are known to feed on alfalfa (*Medicago sativa*) and cause serious damage in the Republic of Moldova: *Sitona lineatus*, *S. inops*, *Hybera postica*, *Protapion trifolii*, *Subcoccinella vigintiquatuorpunctata*. Of these, *S. inops* is thought to represent the greatest potential threat based on adult abundance at all three sites and the negative impact of this species. A significant number of beetles collected during this study are adventive species associated with forest ecosystems of the Republic of Moldova.

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* Corresponding author. Tel.: +373-22-24-20-09; fax: +373-22-73-12-55.
*E-mail address:* munteanu_natalia_v@yahoo.com
1. Introduction

Biodiversity research has become a key subject in modern ecology. Throughout the last decade, a plethora of studies has been conducted to elucidate the status quo and distribution of global biodiversity (Gaston, 2000), to determine major threats (Purvis and Hector, 2000), to link biodiversity with ecosystem functioning and services (Loreau et al., 2013; Hooper et al., 2005; Balvanera et al., 2006), and to stop biodiversity loss by applying appropriate conservation measures (Perfecto et al., 2003).

Agricultural ecosystems constitute about 75.6% of the territory of the Republic of Moldova. This leads to a drastic ecological disturbance and intensive exploitation of natural resources. In the agricultural sector, which has a significant impact upon the environment, the measures on maintaining ecological balance, including the preservation of insect complexes, are very important. It is known that in agrocenoses, during many years of using, specific communities were formed, which include species of harmful, useful and neutral insects. Useful insects in agricultural ecosystems must be maintained in spite of the agricultural activities, also should be preserved and renewed the adjacent forest shelter belts where the insects migrate after crops’ harvesting. The successful agriculture derives from the stability of ecosystems, where the entomofauna is a basic component. Thus, alfalfa crop has been selected and faunistic studies were accomplished in order to identify existing beetle communities.

Alfalfa is an increasingly important pasture legume for a wide range of livestock. It provides high yield, forage quality and adapts to wide climatic and soil conditions (Van Keuren and Matches, 1988). At present, it is estimated that there are around 250,000 ha occupied by alfalfa within the region, which represents 9.9% of the total arable land area. Alfalfa is attacked by a great number of insect species that cause considerable damage and reduce forage yield.

Because Republic of Moldova’s agriculture depends heavily on legumes to fix atmospheric nitrogen, it is important to identify alfalfa insect communities.

To our knowledge there is no published information on insect communities associated with alfalfa in the Republic of Moldova. To fill this void we report on a study in which insect communities were sampled in fields of alfalfa at three geographically separated locations in central part of the Republic of Moldova. We determined the species inhabiting the crop, their diversity and richness.

2. Material and methods

A 2-yr study was conducted during 2009 and 2010 to determine composition and distribution of beetle communities of alfalfa. We selected three alfalfa fields located near Lozova (47°07’58” N, 28°23’09” E), Ivancea (47°28’49” N, 28°85’63” E) and Trebujeni (47°18’50” N, 28°58’25” E) in the central part of the Republic of Moldova. Alfalfa fields were 2- to 5-yrs old, maintained according to standard agronomic practices including a final late-fall (October or November) harvest. No insecticides were applied to any of the fields for alfalfa pest control in the spring time.

Specimen capture was carried out using sweeping techniques and pitfall traps distributed across the fields. Sampling took place every month, with a few exceptions due to unforeseeable circumstances. For above-ground fauna a standard sweep net, 25 cm in diameter was used at the rate of 50 sweeps per plot. Below-ground fauna was defined by classic pitfall traps method. The trap was made of a 700 cm³ recipient, installed at the soil level and filled with 4% formaldehyde solution. Recovered specimens from each plot were kept into a cloth bag and counted in the laboratory.

The taxonomy of the collected beetle species dealt with below is based primarily on the works of, Alonso-Zarazaga and Lyal (1999), Kabakov (2006), Bouchard (2011). Also, for taxonomical identification, museum collections of the Institute of Zoology have been used. All samples are deposited in the collection of the
Entomological Museum, Institute of Zoology, Academy of Sciences of Moldova.

Various methods are available for analyzing the richness and diversity of samples (Magurran, 1988). For measurement of species’ richness Margalef index was used. To assess the diversity, we used the Shannon index. The value of Shannon index usually falls between 1.50 and 3.50 and increases when many species are present and the individuals across these species are more evenly spread (Hayek and Buzas, 1997). Diversity of non-random collections was estimated using Brillouin index. Biodiversity of habitats was quantified using Simpson's diversity index. Also the Pielou’s index was used for calculating the evenness of species. Sample based rarefaction and other methods for evaluation of the community composition were considered using the statistic software Biodiversity Pro version 2 (Neil McAleece et al., 1997).

3. Results and Discussions

Altogether for the three different surveys, a total number of 843 beetles, stored to 63 species, are considered in this analysis. The largest family proved to be Curculionidae, which includes 22 species from 12 genera, followed by Scarabaeidae, with 12 species from 5 genera, Carabidae with 9 species and 5 genera, Coccinellidae and Silphidae both represented by 5 species from 4 genera and Cerambycidae - by 2 species belonging to one genus. Families Dermestidae, Staphylinidae, Tenebrionidae and Trogidae had only by one species each. Of all collected beetles, weevils (Curculionoidea) represented the greatest proportion in terms of number of individuals (428 specimens), followed by Tenebrionidae family with 188 specimens, Coccinellidae (101) and Scarabaeidae (46 specimens), Cerambycidae (40), Silphidae (18), Carabidae and Dermestidae (14), Trogidae (12) and Staphylinidae (1). Furthermore, from the total number of sampled beetles 26 species were recorded only from Trebujeni: Anchomenus dorsale (Pontopp.), Amara familiaris (Duft.), Ophonus rufibarbis (F.), Harpalus distinguendus (Duft.), H. tardus (Pnz.), Nicrophorus verspilloides Hbst., Tanathophilus rugosus (L.), Silpha carinata Hbst., S. obscura L., Phosphuga atrata (L.), Trox sabulosus (L.), Lethrus aterus (Laxm.), Aphodius fessor (L.), A. luidus (F.), A. rufipes (L.), A. sticticus (Pnz.), Onthophagus verticicornis Lch., O. coenobita (Hbst.), O. fracticornis Prslr., O. vacca (L.), O. ovatus (L.), Cetonia aurata (L.), Opatrum sabulosum (L.), Dorcadion tauricum Wall., Sitona callosus Gyll. and Tychius quinquepunctatus (L.). Other 16 species were collected from Lozova: Subcoccinella vigintiquatuorpunctata (L.), Hippodamia tredecimpunctata (L.), Coccinula quatuordecimpustulata (L.), Propylaea quatuordecimpunctata L., Psyllobora vigintiduopunctata (L.), Gastrophysa polygoni (L.), Altica oleracea (L.), Psyllodes attenuata (Koch), Oxystoma pomonae (F.), Otiorhynchus multipunctatus (F.), O. ovatus (L.), Liophloeus lenticus Germ., Cyphocleonus dealbatus (Gmln.), Larinus obtusus Gyll., Lixus pulverulentus (Scop.) and Rhinoncus pericarpius (L.). Five species were found only in Ivancea: Amara ingenua Duft., Curtonotus aulica Pnz., Harpalus atratus L., S. inops (L.), Propylaea quatuordecimpunctata L., Dorcadion tauricum Wall., Sitona inops (L.), Opatrum sabulosum (L.), Coccinula quatuordecimpunctata (L.), Propylaea quatuordecimpunctata L., Psyllobora vigintiduopunctata (L.), Gastrophysa polygoni (L.), Altica oleracea (L.), Psyllodes attenuata (Koch), Oxystoma pomonae (F.), Otiorhynchus multipunctatus (F.), O. ovatus (L.), Liophloeus lenticus Germ., Cyphocleonus dealbatus (Gmln.), Larinus obtusus Gyll., Lixus pulverulentus (Scop.) and Rhinoncus pericarpius (L.). Five species were found only in Ivancea: Amara ingenua Duft., Curtonotus aulica Pnz., Harpalus atratus L., S. inops (L.), Propylaea quatuordecimpunctata L., Dorcadion tauricum Wall., Sitona inops (L.), Opatrum sabulosum (L.), Coccinula quatuordecimpunctata (L.), Propylaea quatuordecimpunctata L., Psyllobora vigintiduopunctata (L.), Gastrophysa polygoni (L.), Altica oleracea (L.), Psyllodes attenuata (Koch), Oxystoma pomonae (F.), Otiorhynchus multipunctatus (F.), O. ovatus (L.), Liophloeus lenticus Germ., Cyphocleonus dealbatus (Gmln.), Larinus obtusus Gyll., Lixus pulverulentus (Scop.) and Rhinoncus pericarpius (L.). Five species were found only in Ivancea: Amara ingenua Duft., Curtonotus aulica Pnz., Harpalus atratus L., S. inops (L.), Propylaea quatuordecimpunctata L., Dorcadion tauricum Wall., Sitona inops (L.), Opatrum sabulosum (L.), Coccinula quatuordecimpunctata (L.), Propylaea quatuordecimpunctata L., Psyllobora vigintiduopunctata (L.), Gastrophysa polygoni (L.), Altica oleracea (L.), Psyllodes attenuata (Koch), Oxystoma pomonae (F.), Otiorhynchus multipunctatus (F.), O. ovatus (L.), Liophloeus lenticus Germ., Cyphocleonus dealbatus (Gmln.), Larinus obtusus Gyll., Lixus pulverulentus (Scop.) and Rhinoncus pericarpius (L.).

The rank-abundance plots show (Fig. 1 (a)) that three species were dominant (relative abundance >10%) when considering the total capture list (Opatrum sabulosum (188 specimens), Sitona inops (156) and S. lineatus (101)). Analyzing localities in particular, Sitona lineatus and S. inops were dominant, with 101 specimens each, in Lozova. Dermestes laniarius (10), Sitona macularius and S. inops (by 9) were dominant in Ivancea. Two species, Opatrum sabulosum (188) and Sitona inops (55) were dominant in Trebujeni.

During the present study collected beetles from all three localities were compared and Shannon indices were calculated as a measure of diversity within the habitat. The Shannon diversity index has been found
maximum (1.035) in Trebujeni, moderate (1.017) in Ivancea and low (0.936) in Lozova (Table 1.). Berger-Parker, Brillouin and Fisher indices revealed almost the same order. The Simpson’s index showed the highest value (0.129) for Lozova, medium value (0.134) for Ivancea and the lowest value (0.203) for Trebujeni. The Margalef index and Pielou’s evenness, highlight Ivancea with the highest value (37.079 and 0.827), followed by Lozova (24.467; 0.664) and Trebujeni (23.334; 0.646).

Table 1. Ecological indices of the alfalfa beetle communities for three study sites. Numbers of species and individuals are given as integers. Data for total investigation period.

<table>
<thead>
<tr>
<th>Index</th>
<th>Lozova</th>
<th>Ivancea</th>
<th>Trebujeni</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total species S</td>
<td>29</td>
<td>17</td>
<td>40</td>
</tr>
<tr>
<td>Total individuals N</td>
<td>342</td>
<td>47</td>
<td>454</td>
</tr>
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<td>Shannon (H' (Log))</td>
<td>0.936</td>
<td>1.017</td>
<td>1.035</td>
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<tr>
<td>Simpson’s Diversity λ</td>
<td>0.129</td>
<td>0.134</td>
<td>0.203</td>
</tr>
<tr>
<td>Pielou’s evenness J’</td>
<td>0.664</td>
<td>0.827</td>
<td>0.646</td>
</tr>
<tr>
<td>Margalef D Base 10</td>
<td>24.467</td>
<td>37.079</td>
<td>23.334</td>
</tr>
<tr>
<td>Berger-Parker (d)</td>
<td>0.295</td>
<td>0.213</td>
<td>0.414</td>
</tr>
<tr>
<td>Brillouin</td>
<td>2.033</td>
<td>1.947</td>
<td>2.251</td>
</tr>
<tr>
<td>Fisher</td>
<td>7.565</td>
<td>9.565</td>
<td>10.575</td>
</tr>
</tbody>
</table>

Rarefaction curves for three alfalfa beetle communities are shown in Fig. 1 (b). Expected number of species has been plotted against number of individuals. This plot provides a measure of species diversity. Stepper curve indicated that Ivancea habitat is slightly more diverse than Trebujeni and much more than Lozova. All three curves are rising and do not yet reach a flat progression, which means that the beetle community has not been recorded completely.

This study is the first to investigate the fauna of beetle families from alfalfa, which is an ecologically and economically important culture. The study was designed to obtain information about alfalfa beetles biodiversity at both above- and below-ground fauna. Almost an equal amount of beetle species was captured using pitfall traps and sweep netting methods (32 and 31 respectively). The revealed beetle community was mainly composed by phytophagous (50.7 %), followed by predators (25.3 %), coprophagous (14.2 %), necrophagous (6.3 %), saprophagous and micophagous (by 1.5 %). Using pitfall traps four species of phytophagous ground beetles were collected that otherwise would not have been reported. Among these are species Opatrum sabulosum, Dorcadion tauricum, Lethrus apterus and Pentodon idiota which usually injure plants at ground level. A significant proportion of the sampled beetle fauna (76.2 % of species and 53.38 % of specimens collected) are adventive species often associated with forest ecosystems.

In total, five species were recorded as dominant in at least one site, the dominant species composition varied from site to site and only Sitona inops was dominant for all three sites. As mentioned above, Opatrum sabulosum was the most abundant species during our study. It was dominant in Trebujeni; the significant dominance of this species was undoubtedly one of the reasons why the Pielou’s evenness value was consistently lower in Trebujeni alfalfa pasture.

Among the beetles that are known to cause serious damages to alfalfa in the Republic of Moldova, three species Sitona lineatus, S. inops and Hypera postica were recorded from all three sites, Subcoccinella vigintiquatuorpunctata was found in Lozova, Protapion trifolii was present in Lozova and Trebujeni. The number of specimens collected is not alarming at present especially for last two species, but a careful monitoring of adult activity may be required.
It is very important to know the status of predatory populations in agricultural ecosystems and to increase their potential as biological control agents. Soil processing of the agricultural crops has strong influences on insect complexes, during this period they find refuge to the edge of fields and adjacent forest belts.
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