

SPECIES RICHNESS AND SPATIAL STRUCTURE OF THE ASSEMBLAGE OF SOIL LARVAL ELATERIDAE (COLEOPTERA) OF A FRESH MEADOW

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Summary. The paper refers to the description of species richness and spatial structure of the assemblage of soil larval click-beetles (Elateridae) of fresh meadows of the protected area. The studies were conducted in the meadow community *Arrhenatheretum medioeuropaeum*, belonging to the class *Molinio-Arrhenatheretea*. 11 species of Elateridae were recorded, in which *Agriotes obscurus*, *Hemicrepidius niger* and *Synaptus filiformis* were dominating, and the diversity index according to Margalef was 5.6. *Agriotes obscurus* reached the highest values of index C and Q. The beetles were the most numerous in spring, less numerous in summer and not numerous in autumn. In the whole material, the most specimens were found in the superficial soil layer, the least – in layer 20–30 cm. The general number of larvae and every single species depending on the season and the depth of soil layer were different.

Key words: Elateridae, click-beetles, south-eastern Poland, park, fresh meadows, species diversity, ecology, zoogeography

INTRODUCTION

The assemblages of larval click-beetles (Elateridae) of meadow biotopes have been described in Polish literature by a few researchers so far [Pawelska 1951, Szyfter 1955, Honczarenko 1956, 1962, 1968, 1970, Nowakowski 1981, Tarnawski 1987]. These papers refer mainly to dry meadows, medium-wet, wet and sod wastelands. Only single data refer to the assemblages of soil elaterofauna of fresh meadows of the order *Arrhenatheretalia* which are the subject of this paper. The aim of the paper was to study species richness and spatial structure of the assemblage of soil larval Elateridae in general and for every single species, in relation to the season and the level of soil depth in edaphic conditions of a fresh meadows of this type. The paper also complete faunistic data concerning click-beetles of Poland.

The knowledge on adaptations of many click-beetles to particular habitats can be used for their ecological characteristic. Therefore, the systematic studies on the assemblages of Elateridae in particular habitats may be helpful in monitoring and determining the changes in the habitat influenced by e.g. succession or anthropopression.

STUDY AREA

The studies on the assemblages of larval Elateridae were conducted in Flisy (UTM: FB 01, 50°39'34"N and 22°29'24"E) situated within the boundaries of the Lasy Janowskie Landscape Park. This park is located in the south-eastern Poland, in the area of the Biłgoraj Plain which is the northernmost mesoregion of the Sandomierz Basin [Kondracki 2000].

Click-beetles were collected in the meadow community *Arrhenatheretum medioeuropaeum* belonging to *Molinio-Arrhenatheretea* class. This community covers well-fertilized, highly productive fresh meadows. The dominating plants are high-grade, soft leaf sod grasses, especially tall oat-grass (*Arrhenatherum elatius*). Other species like red fescue (*Festuca rubra*), common meadow grass (*Poa pratensis*) and creeping bentgrass (*Agrostis stolonifera*) are also numerous. This community is found in fine-grained fertile and alluvial soils (pH 6.5–7.5) in eutrophic river valleys, often managed by a full crop. In the form of smaller or larger patches it also occurs in fertile and poorly moist loamy or sand-loamy soil [Fijałkowski 1997, Matuszkiewicz 2001]. The described study area was near the River Trzebensz and fields and was used as a multi hay-growing meadow.

MATERIALS AND METHODS

Larval Elateridae were obtained from soil using the method of soil pits. For this purpose the modified instrument of Morris was used [Pawelska 1951]. Quantitative samples were collected in the years 1999–2001, once during the season – spring, summer and autumn. Every quantitative sample consisted of 4 soil pits of the size 50 × 50 cm – which gave the area of 1 m² and the depth of 30 cm. 8 qualitative samples were collected in total. Soil pits were made in unique, randomly selected sites of a community. From each soil pit larvae were obtained separately from each of three consecutive levels of soil depth, 10 cm each one: level I – 0–10 cm, level II – 10–20 cm and level III – 20–30 cm. This allowed to analyze the structure of spatial larval distribution.

For identification of click-beetle larvae the keys of Dolin [1964, 1988], Reitter [1911] and Tarnawski [2000] were used. Names of taxa and their systematic arrangement were given after Tarnawski [2000].

The following biocenotic indices were used to analyse the material collected (in the case of C/x100%): dominance (D%), constancy of occurrence in

the samples (C%), ecological significance index (Q%), Margalef diversity index (d). The occurrence of larvae depending on the level of depth and the season were also analyzed. Ecological and zoogeographical analyses were also conducted. Species were assigned to particular zoogeographical elements according to Tarnawski [Tarnawski 2000].

RESULTS

As a result of three-year long studies on soil elaterofauna of fresh meadows, 11 species of Elateridae were found, comprising the collection of 70 specimens. Species diversity index of Margalef was 5.6. Despite the low number of specimens, the indices D, C and Q were calculated in order to show the general picture of the structure of the assemblage. The classes of dominance (D%) were as follows: eudominants – *Agriotes obscurus* (52.8%), *Hemicrepidius niger* and *Synaptus filiformis* (each 12.8%); dominants – *Cidnopus aeruginosus* (7.1%); subdominants – *Hemicrepidius hirtus*, *Selatosomus aeneus* and *Agriotes lineatus* (4.9%); recedents – *Agrypnus murinus*, *Adrastus pallens*, *Agriotes sputator* and *Agriotes ustulatus* (each 1.4%); subrecedents – none. The most common species in the samples was *Agriotes obscurus* (C = 62.5%). Relatively rarely caught were: *Agrypnus murinus*, *Selatosomus aeneus*, *Adrastus pallens*, *Agriotes sputator* and *Agriotes ustulatus* (for each of them C = 12.5%). The remaining species reached the following values of constancy of the occurrence in samples (C%): *Hemicrepidius niger* and *Synaptus filiformis* (37.5% each of them), *Cidnopus aeruginosus*, *Hemicrepidius hirtus* and *Agriotes lineatus* (25% each of them). The highest ecological importance obtained *Agriotes obscurus* (Q = 57.4%). Lower one – *Hemicrepidius niger* and *Synaptus filiformis* (each 21.9%). The values of the index Q for the remaining species ranged from 4.2 to 13.3%. Almost all of the mentioned species in terms of habitat preferences were obviously the ones preferring open biotopes. The species typical of meadows and wet environments (45.5% of qualitative and 81.4% quantitative share) were the most numerous. The remaining species were eurytopes (3 species, 8 specimens) and xerothermic ones (2 species, 2 specimens), only one species (2 specimens) was a representative of the group of forest, occasionally found in other environments.

Analyzing the numbers of larvae in different seasons it was found that they were the most numerous in spring (48.6%), less numerous in summer (41.4%) and not numerous in autumn (10.0%). Depending on the level of the soil, the highest number of specimens in general was noted in the superficial layer of the soil, the lowest one at the depth of 20–30 cm (Tab. 1). At the deepest layer only *Synaptus filiformis* was found. Both in I and II soil level, definitely the most numerous was *Agriotes obscurus* (60.5 and 42.3% of share relatively). The remaining species were less numerous or occurred as a single ones.

Table 1. Quantitative structure of larval Elateridae at different levels of soil depending on the season of year (in %)

| Season of year | Soil levels* | | |
|----------------|--------------|------|-----|
| | I* | II | III |
| Spring | 35.7 | 12.9 | - |
| Summer | 20.0 | 21.4 | - |
| Autumn | 5.7 | 2.9 | 1.4 |
| Summary | 61.4 | 37.1 | 1.4 |

*I – 0–10 cm, II – 10–20 cm, III – 20–30 cm

The number of larvae was different depending on season and the level of soil depth. The detailed arrangement of their quantitative percentage share is shown in Table 1.

The density of Elateridae larvae in the studied biotopes of fresh meadows was 8,8 individ./1 m² of soil area.

Analyzing the qualitative structure of the assemblage of larval click-beetles it was found that the same number of species was caught in spring and summer (Tab. 2). However, qualitative similarity between them was only 45.5%. In autumn 3 species were noted, although at each of the examined level of soil depth. The detailed structure of the occurrence of the species as well as their number depending on season and soil level is given in Table 2.

Table 2. Qualitative and quantitative structure of distribution of Elateridae species in particular season and soil levels (data per 1 m²)

| Species | L* | Spring | | | Summer | | | Autumn | | | |
|-----------------------------|-------------|--------------|-----|-----|------------|-----|-----|------------|-----|-----|---|
| | | soil level** | | | soil level | | | soil level | | | |
| | | I | II | III | I | II | III | I | II | III | |
| <i>Agrypnus murinus</i> | 1 | - | - | - | 0.3 | - | - | - | - | - | |
| <i>Cidnopus aeruginosus</i> | 5 | 0.3 | - | - | - | 1.3 | - | - | - | - | |
| <i>Hemicrepidius hirtus</i> | 2 | - | 0.3 | - | 0.3 | - | - | - | - | - | |
| <i>Hemicrepidius niger</i> | 9 | 1.3 | - | - | - | 0.3 | - | 1.5 | 0.5 | - | |
| <i>Selatosomus aeneus</i> | 2 | - | 0.7 | - | - | - | - | - | - | - | |
| <i>Synaptus filiformis</i> | 9 | 1.0 | 0.3 | - | 0.3 | 0.7 | - | - | 0.5 | 0.5 | |
| <i>Adrastus pallens</i> | 1 | - | - | - | - | 0.3 | - | - | - | - | |
| <i>Agriotes ustulatus</i> | 1 | 0.3 | - | - | - | - | - | - | - | - | |
| <i>Agriotes obscurus</i> | 37 | 5.0 | 1.3 | - | 3.3 | 2.3 | - | 0.5 | - | - | |
| <i>Agriotes lineatus</i> | 2 | 0.3 | 0.3 | - | - | - | - | - | - | - | |
| <i>Agriotes sputator</i> | 1 | - | - | - | 0.3 | - | - | - | - | - | |
| Total | individuals | 70 | 25 | 9 | 0 | 14 | 15 | 0 | 4 | 2 | 1 |
| | species | 11 | 6 | 5 | 0 | 5 | 5 | 0 | 2 | 2 | 1 |
| Total species | | | 8 | | | 8 | | | 3 | | |

*L – general number of larvae collected using the method of soil pits,

**I – 0–10 cm, II – 10–20 cm, III – 20–30 cm.

The assemblage of larval Elateridae was characterized by a high share of wide range species (72.7%). 2 species belonged to the element of medium range, only one species – to narrow one. In general, the species belonged to 7 zoogeographic elements.

DISCUSSION

As a result of studies on soil elaterofauna of fresh meadows of the protected area, 11 species of those beetles were found. The number of the collected species is neither high nor low in comparison to the results of different authors. In the papers devoted to the elaterofauna of soils of different meadow types (dry, medium-wet, wet, sod wastelands), Honczarenko [1956, 1962, 1968, 1970] collected from 7 to 18 Elateridae species. Tarnawski [1987] from four communities of meadows situated in forests of Wrocław reported 13 species and Pawelska [1951] from meadows and wastelands of the vicinities of Lublin as well as Szyfter [1955] from the vicinities of Plewiska gave the same number of 12 species. However, comparing the obtained number of species to the number of fresh meadows themselves it is equal or higher. Tarnawski [1987] from fresh meadows situated in forests of Wrocław gave 11 species and Nowakowski [1981] from fresh meadows of Białołęka Dworska – 8 click-beetle species.

In the whole collected material *Agriotes obscurus*, *Hemicrepidius niger* and *Synaptus filiformis* were dominating. The first of the mentioned species was given as a dominant in different meadow communities by Honczarenko [1956, 1970] and Tarnawski [1987]. In the papers of Szyfter [1955], Honczarenko [1962] and Pawelska [1950] it was also included among dominating species, however, not the most numerous. Similarly, *Hemicrepidius niger* occurred among numerous caught species by the mentioned authors except for the data of Tarnawski [1987]. Only in meadows with turf-peat substratum it was a dominant [Honczarenko 1962]. The most of the cited researchers have not collected *Synaptus filiformis* at all.

The analysis of the numbers of larvae in particular soil levels showed that the most of the specimens (61.4%) concentrated in the superficial layer (0–10 cm). This corresponds with the results of studies of many authors [Honczarenko 1956, 1962, 1970, Tarnawski 1987, Pawelska 1951]. Those researchers recorded (described) from this soil level of different types of meadows from 70 to 90% of all specimens. Slightly lower number of larvae from this level – but still the highest – was given by Honczarenko [1968]. At the deeper soil level (10–20 cm) 37.1% of specimens were caught. However, at the soil level III (20–30 cm) only one larva of *Synaptus filiformis* was found. It confirms the results of the authors cited above, concerning the tendency of vertical distribution of numbers of larval Elateridae. Nevertheless, at the soil level II they gave lower numbers of larvae – from 15.3 to 25%, and in the deeper layer – predominantly slightly higher – from 1.1 to 5%. The most numerous occurrence of larvae in the superficial layer

can be explained by the presence of large amount of food in the form of organic parts. Falconer [1945] and Honczarenko [1956] also indicated this point.

Analyzing the numbers of soil larvae in particular seasons it can be concluded that they were most numerous in spring (48.6%), less numerous in summer (41.4%), and the least numerous – in autumn (10.0%). The presented results are different from the ones obtained by the majority of the mentioned authors which pointed out summer as the period of the mostly abundant collection of click-beetle larvae.

Many authors draw attention to the influence of soil humidity on the occurrence and vertical migration of larvae [Honczarenko 1962, Dolin 1964, Tarnawski 1987, 2000 among others]. With the decreasing of environmental humidity larvae start to migrate to find favorable conditions. Temperature as well influences migrations and concentration of larvae at different soil depths. In the superficial soil layer in the open habitats of fresh meadows the most larvae occurred in spring and in summer there were significantly less (Tab. 1). It can be explained in that way that during summer the upper soil layers of open areas are often more heated and dryer. This results in migrations of larvae sensitive to the lack of humidity to deeper, wetter soil layers. In summer they gathered numerously at the depth of 10–20 cm.

CONCLUSIONS

1. Species richness of soil Elateridae larvae was similar to the clusters of these beetles in other types of meadow habitats from different parts of the Polish.

2. Species diversity of click-beetles was at the average level. On the seasonal vertical distribution of Elateridae larvae in the soil a definite influence had, among others, the type of the examined habitat, and therefore exposure to direct sunlight, causing warming of the surface layer of soil – especially in summer – and thus the migration of larvae into the deeper, more moist layers.

3. The overall distribution of the number of larvae at different levels of soil maintained trends described by other authors of this type of work.

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BOGACTWO GATUNKOWE I STRUKTURA PRZESTRZENNA
ZGRUPOWANIA LARW GLEBOWYCH ELATERIDAE (COLEOPTERA) ŁĄKI ŚWIEŻEJ

Streszczenie. Praca dotyczy bogactwa gatunkowego i struktury przestrzennej zgrupowania larw glebowych sprężykowatych (Elateridae) łąk świeżych obszaru chronionego. Badania prowadzono w zespole łąkowym *Arrhenatheretum medioeuropaeum* należącym do klasy *Molinio-Arrhenatheretea*. Stwierdzono 11 gatunków Elateridae, wśród których dominowały *Agriotes obscurus*, *Hemicrepidius niger* i *Synaptus filiformis*, a wskaźnik zróżnicowania gatunkowego wg Margalefa wyniósł 5,6. *Agriotes obscurus* osiągnął także najwyższe wartości wskaźników C i Q. Chrząszcze najliczniej występowały wiosną, mniej licznie latem, a nielicznie jesienią. Z całości materiału najwięcej osobników stwierdzono w powierzchniowej warstwie gleby, najmniej w warstwie 20–30 cm. Różnie jednak kształtowała się liczebność larw ogółem oraz dla każdego gatunku w zależności od pory roku i głębokości warstw gleby. Liczba pozyskanych gatunków nie była ani duża, ani mała w porównaniu z badaniami innych autorów dotyczących elaterofauny różnych typów łąk, a część wyników była zbliżona.

Słowa kluczowe: Elateridae, sprężykowate, południowo-wschodnia Polska, świeże łąki, różnorodność gatunkowa, ekologia, zoogeografia