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Theses of PhD Dissertation

Investigations of ground beetle assemblages in the Lajta-Project (Mosonszolnok, W-Hungary)

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Introduction and aims

Ground beetles (Carabidae) populate almost every imaginable habitat, even those under human influence, such as parks, arable lands and orchards. Natural habitats as well as agricultural areas have their characteristic ground beetle associations, these may show more or less permanency in time. Mass occurences of a single species are characteristic in ground beetle associations of arable lands and other disturbed habitats.

Systematic researches, with prioritised quantitative examinations of insect associations of the plough fields were carried out in Hungary since the 1950s. Apart from composing insect species lists from specific vegetation types, researchers assessed population density, numbers of individuals and frequencies of occurrences. Using basic data, it was possible to develop various ecological indexes, such as diversity, evenness and similarity. From the 1980s community ecology developed different aims from those of traditional faunistic research and became a separate science.

Ground beetles, which are the subject of this thesis originate from the Lajta-Hansági State Educational Agricultural Holdings No. II. area of Mosonszolnok. The extensive research, that started in 1984, and in 1992 was named Lajta-Project, examined effects and interaction between game animals and their intensive agricultural surroundings (Faragó 1990b). This program is carried out in the western part of the country, in Győr-Moson- Sopron county, in an area of about 3000 hectares, in the vicinity of Albertkázmérpuszta, Mosonszolnok and Jánosmorja.

The material collected with Barber-traps, operating since 1984 in the Lajta-Project area, chiefly consists of ground beetles. Therefore it is appropriate to carry out their detailed analysis. Based on the material collected between 1984 and 1996 the following questions need closer examination:

– How many ground beetles live in the examined area and what are they?

– Which are the most common species and how are they distributed in the individual habitats?

– Do exist protected and/or rare species in intensive agricultural environments and in which habitats and cultures?

– Are there any ground beetles which are expressively linked to specific habitats and cultures?

– Are there any cultures/habitats which are specially favorable for ground beetles and where great diversity or dense populations can be seen?

– How does the number of individuals within a populous species of ground beetle develop during summer and are there characteristic seasonal activity patterns?

– How do develop ecological indexes characteristic to ground beetle associations in various cultures and years, numerical values of dominancy, species diversity, Shannon-diversity, evenness and Berger-Parker dominancy?

– Can the effect of treatments be shown?

– How does treatment effect the diversity of associations?

2. Materials and methods

2.1. Characterisation of the examined areas and cultures

The area of the Lajta-Project is an intensively worked agricultural environment with practically no grazing lands present. Apart of small, forestry-managed belts of forests, uninterrupted woods are also absent. In the agricultural areas mainly cereals, corn, alfalfa and rape are cultivated. In each cultivating cycle 10–15 plant-cultures are grown and parcels of land are about 52 hectares on average. The following cultures or/and vegetation types were examined between 1984 and 1996: banks of ditches, fallow fields, fields for bustards, forage maize, forest belts, grass, grassy clover, hybrid maize, alfalfa, maize, new alfalfa, partridge fields, pea, Phacelia, potato, silo maize, spring barley, sugar beet, Triticale, weedy patches, winter barley and winter wheat.

While the plough fields were conventionally treated, the fallows, the fields for bustards and the weedy patches were not treated with chemicals. The banks of ditches, belts of forests and partridge fields were not treated at all. Where rotating cultivation was practiced, the investigated cultures were planted or sowed in varying parcels of land and their examinations were carried out accordingly. Research of the fields for bustards that also had a crop of alfalfa, was executed in the same area for two years. The localities of alfalfa, new alfalfa and grass changed through the years, but previous crops were the same.

2.2. Collecting the beetles and processing the material

Pitfall trapping was used as collecting method in the Lajta-Project area. Barber traps consisting of plastic cups of 300 decilitre capacity, with 80 mm diameter and 85 mm depth were used. They were fitted with aluminium roofs to prevent trapping small vertebrate animals such as lizards, rodents and shrews. The preserving liquid was 5% formaldehyde solution with minimal attraction properties and therefore it was expected that only insects living in the vicinity will be trapped. Five traps in a line, with 5m between them, were placed in the middle of each selected habitat. The traps were operated from May to August, some only until July. They were emptied in every two weeks.

Most of the collected beetles were examined under the microscope by the author and determination was based on external characteristics. Occasionally 50 × magnification was necessary to examine finer details. In some cases specific determination was not possible through morphological examination only (e.g. *Brachinus elegans – B. psophia*). In such cases detailed genital examinations were necessary. The determined beetles specific names, the numbers of specimens and the relevant habitats as well as the dates of collections constituted the most important data, serving as basis for further evaluations.

2.3 Applied indexes and statistical methods employed during data processing

Yearly data related to the cultures of Mosonszolnok and other relevant habitats was used. Important data were those of species diversity or the number of species occuring in the area and the number of specimens. Only species present in 5% or in greater percentage are shown in the tables indicating yearly breake-downs. The Berger-Parker dominancy-index indicates

the dominant species' specimen number. The tables also indicate the Shannon- or H-diversity, as well as levels of equitability. Jaccard's formula is used as a basis to establish species similarity.

Metric ordination, and within that, PCoA single-link method (Syntay 2000 software, Podani 1993) was used in the examination of the various ground beetle associations. The author employed Jaccard's as well as Horn's similarity indexes to research similarity functions (Krebs 1989). In relation to metric ordination, the distance between numbers in the figures indicate the samples' similarity.

Yates' correct Chi-square test was used to examine habitat preferences or linkage to habitats. The author applied Spearman's rank correlation coefficient as the basis when examining the ranking of distribution of the various ground beetle associations and by analysis of variance (ANOVA) the linkage to cultures in five ground beetle species was established in 1991 and 1992. Analysis of variance was also employed to examine pesticide effects on two selected ground beetle species.

Effects of pesticide applications and mowing were investigated by applying Rényi's diversity profiling (Tóthmérész 1997). Analysis were carried out by Statistica (Statsoft 2000) and DivOrd (Tóthmérész 1993) softwares.

3. New scientific results

1. The author found 117 ground beetle species in the 113 553 determined specimens collected in the 3000 hectares Lajta-Project area. It is an intensively used agricultural environment, where between 1984 and 1996 the beetles were collected with pitfall traps in 29 plant-cultures and habitats. There were no faunistic surveys (of beetles) conducted previously in this area. It was established that the number of individual specimens

within the various species vary greatly. More than 64% of the captured beetles were made up by two species: *Poecilus cupreus* and *Harpalus rufipes*. Specimens of the first 10 most common species constituted more than 93% of all the collected beetles.

2. Only 28 amongst the 117 species occur at least with 5% frequency in any culture or habitat. The ground beetle associations' constituancy is fundamentally determined by dominant species. They are ranked here in descending order, from the highest numbers of specimens per species to the lowest numbers per species: *Poecilus cupreus*, *Harpalus rufipes*, *Anchomenus dorsalis*, *Poecilus sericeus*, *Brachinus explodens*, *Calathus fuscipes*, *Pterostichus melanarius*, *Harpalus distinguendus*, *Dolichus halensis*, *Calosoma auropunctatum*. These 10 species are the most typical ground beetles of our tilled fields, occasionally appearing *en masse*.

3. In the Lajta-Project the author found 8 protected ground beetle species. These are as follows (numbers in brackets indicate the number of specimens collected): *Calosoma auropunctatum* (1286), *C. inquisitor* (1), *C. sycophanta* (1), *Carabus clathratus* (1), *C. coriaceus* (14), *C. granulatus* (11), *C. scheidleri* (2), *C. ulrichii* (6). From these listed species *Calosoma sycophanta*, *Carabus clathratus* and *C. scheidleri baderlei* occur only rarely.

4. 20 species are found only occasionally in the Lajta-Project area and two of these, *Amara littorea* and *Cymindis angularis,* are rarities in Hungary, Mosonszolnok is being one of the very few localities where they occur.

5. Research shows that rare species occur almost in every culture and habitat, but most of them came from the banks of ditches, fields of alfalfa and grassy clover. The most valuable rare species: *Harpalus albanicus*, *H. signaticornis*, *H. zabroides*, *Licinus cassideus* and *Ophonus schaubergerianus* are thermo- and xerophilous beetles, found in grassy steppe and rock swards. They hardly ever occur to the North or to the West of Hungary.

6. In each of the researched habitats an average of 16,5 species and 941 specimens were counted. The richest species diversity was found in the fields of alfalfa and new alfalfa while from the untreated habitats the banks of ditches had the most diverse ground beetle fauna. In 10 years 56 species were collected from the alfalfa and new alfalfa and in 4 years 53 species were trapped in the banks of ditches. In 1993 over 5000 specimens were collected in the banks of ditches, in 1992 in fields of pea, in 1993 in silo maize and in 1996 in partridge fields. The occasional very high species numbers always signified mass occurances of *Poecilus cupreus* or *Harpalus rufipes.*

7. The Shannon-diversity of ground beetle associations strongly fluctuated annually and by habitats. The highest numbers (2,3446) were noted in 1992, in weedy patches, while the minimal value (0,3776) was noted in the belts of forests. Diversity values were high in alfalfa (1984, 1991), in the No.1. belt of forest (1986), in maize (1988), in winter wheat (1993), in spring barley (1994), in forage maize (1996), in grassy clover (1984) and in banks of ditches (1992). Diversity values were constant where stable ground beetle associations lived: in grassy clover, in rape and winter wheat.

8. In the ground beetle associations, the common, spring breeding species, which over-wintered as imagoes, were in majority, while the autumn breeding species which over-wintered as larvae, were in minority. From 17 cultures and habitats only in one; maize, had greater numbers of autumn breedig species. Dominancy of the „autumn species" can be seen in the banks of ditches, sugar beet, belts of forests, maize, weedy patches and partridge fields. Amongst the 7 dominant species in rape only one breeds in autumn. While other „spring species" could exceed 98% in specimen numbers, in the fields of sugar beet half of the dominant species belong to the „spring" group and the other half to the „autumn" group. On the specimen level

77% are autumn breeding. In the banks of ditches there are 7 spring breeding and 3 autumn breeding species, however by sheer numbers of specimens, 91% of the total are autumn breeding.

9. The ground beetle associations of pea, potato, Phacelia, grassy clover, winter barley, rape, spring barley and Triticale were not researched previously in Hungary, therefore data originating from these plant cultures (species and specimen numbers, Shannon-diversity, Berger-Parker-dominancy index, equitability) are new results. From pea in 5 years 36 species and 10 115 specimens, from potato in 5 years 34 species and 2519 specimens, from Phacelia in one year 22 species and 2212 specimens, from grassy clover in 7 years 42 species and 1178 specimens, from winter barley in 7 years 34 species and 4861 specimens, from rape in 7 years 38 species and 7263 specimens, from spring barley 23 species and 2945 specimens, from Triticale 22 species and 3133 specimens were collected.

10. Findings regarding the affinity of dominant spcies to particular habitats:

a. *Brachinus expodens* in 1988 showed stronger affinity to winter barley than any other habitats (belt of forest, alfalfa, rape).

b. *Calosoma auropunctatum* in 1989 showed significantly stronger affinity to pea than any other cultures.

c. Same species in 1996 occured in significantly larger numbers in Phacelia than alltogether in the other cultures.

d. *Harpalus albanicus* in 1991 occured in significantly larger numbers in pea than alltogether in the other 4 cultures (potato, winter barley, rape).

e. *Poecilus sericeus in* 1993 showed significantly stronger linkage to forage maize than any other habitats.

f. *Pterostichus melanarius* in 1988 showed significantly stronger linkage to potato than any other habitats. The same species in 1996 showed significantly stronger linkage to hybrid

and forage maize than any other habitats. Linkage to the two types of maize didn't differ significantly.

11. The author examined the effects of mowing and the application of pesticides on ground beetle associations. He found that in 1992 in fields of mowed alfalfa the diversity of ground beetles is significantly less than that in the unmowed alfalfa. Species numbers (14 and 22) of the treated and untreated parcels of land differ markedly, but not significally. He also found that in 1992, the effects of pesticides in winter wheat were not unambiguous. From two untreated and three treated sections of a field of wheat, while the first untreated section's ground beetle diversity was significantly greater than the combined total of the other, based on the principles of the Rényi-diversity profiles, the second section's diversity did not differ sharply from that of the combined total of the three treated sections. Regarding individual species: in 1992, in *Poecilus punctulatus* and *Brachinus explodens* there was no significant difference in specimen numbers in pesticide treated and untreated winter wheat. Specimen number however differed greatly in the case of *Anchomenus dorsalis* since it was much higher in the treated sections. In section 1. (untreated) specimen numbers of *Poecilus cupreus* were significantly lower than in the other 3 treated sections and in the 5. section (untreated). Of three treated sections of land specimen numbers of *Poecilus sericeus* were higher only in two, while the third didn't show much difference from the other untreated sections.

4. Suggestions

During the 10 years of pitfall trapping in the various cultures of the Lajta-Project, the majority of the ground beetle fauna was researched and explored. It would be beneficial however, if trapping would continue at least in some of the

habitats from April to September or to October, as the autumn breeding species' specimen numbers are on the increase from the second half of the summers. This additional trapping would further explore the species' gradation dynamics and it is quite possible that it would result in new species occurance records for the area.

It would also be necessary to continue trapping in a selected section and in the same year, in order to further investigate the effects of previous crops on the ground beetle associations.

Between 1984 and 1996 traps were always placed in the middle of the sections of land, while in recent years trapping was carried out on the edges. Analysis of the results yielded from the two methods of trapping would provide further conclusions. It would also be worthwhile if trapping would be conducted in the middle of the sections and on the edges, in the same year.

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