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SPECIES COMPOSITION AND ECOLOGICAL STRUCTURE OF CARABID'S ASSEMBLY IN A FODDER'S MIXTURE FIELD IN NORTH POLAND

KARABĪDU KOPUMA SUGU SASTĀVS UN STRUKTŪRA ZIEMEĻPOLIJAS JAUKTAJĀS LOPKOPĪBAS PĻAVĀS

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Abstract. *It June-September of 2007 the qualitative and quantitative composition of carabids were investigated in annual fodder's mixture field in vicinity of Bukowina village in Pomeranian province (N Poland, UTM XA83, 17°50'E and 54°25'N). It was trapping 509 specimen belonged to 23 species. The studied carabid assembly had very specific species composition and ecological structure. Was observed 7 dominant species: Calathus fuscipes, Harpalus griseus, Harpalus rufipes, Harpalus calceatus, Poecilus lepidus, Broscus cephalotes and Harpalus froelichii (more than 5% specimen). This assembly is characterized by low species richness, polydomination, high value Shannon and Pielou indexes, and not typical high seasonal activity of "autumn breeders" in first half of June. Possible reasons of such phenomena are soil condition (dry sand soil) and extreme warm winter 2006/2007.*

Keywords: *Carabidae, ground beetles assembly, sandy soil, crop field.*

Introduction

Carabids traditionally are object of attention of practical entomologists, their value as predators of depredators of crops is widely known. Recently carabids are used as bioindicators at an assessment of various man impacts – from application of pesticides before urbanization processes (Luff 1996, Holland 2002).

In Poland the peak of interest to field carabids has fallen to 60-70 years of the XX-th century (Kabacik 1962, Kabacik-Wasylik 1970, Honczarenko 1964, Górny 1971). Researches of last years have especially practical character and concern, mainly species richness and assembly's structure in winter rape fields (Pałosz 1996, 1997; Gabryś, et al. 1999) and, seldom, a winter wheat (Jaworska 2001, Huruk 2002, 2008, Grabarkiewicz 2003, Jaworska, Wiącek 2006).

Feature of the Polish farm-production is the abundance of small-scale enterprises, with small arable lands, within 5-10 hectares, and the area of a concrete field can compound only 1-2 hectares. In such conditions modern technologies on fields are used seldom.

Revealing of a species composition, frame of the population and seasonal dynamics of activity of carabids in the field of grain mixture in a small peasant farm during all season of vegetation was the purpose of our researches.

Place and methods

In 2007 ground beetles were intensively sampled from fodder's mixture field in the North of Pomeranian province (N Poland), nearby in Bukowina village (UTM XA83, 17°50'E and 54°25'N).

The village Bukowina is situated in South Baltic Lakeland, at mesoregion of Kaszubian Lakeland.

Studies were carried out on farmland with fodder's mixture: oat 50%, barley 25% and wheat 25%. The field's area was 0, 96 h. Field was on wavy basis and its area was 0, 96 h.

The field in the form of a irregular trapeze, from the North is limited by a rye field, from the West – a field of grain mixed, from the East with mixed forest and from the South – with the road

(Fig. 1). Soil represents the field complex N 7 – weakest, for rye only. This light soil was originated from loose sands.

Ammonium nitrate was used as fertilizer, and the Chwastox as herbicide. The lupine was a preceding crop.

Ground beetles were collected in pitfall traps exposed in the field for two-week-long periods from 28 May to 10 September of 2007. Each trap was constructed from one 500 ml plastic cup (92 mm diameter) placed into the ground so the lip of the cup was at or slightly below the ground surface. Approximately 50 ml of 25% ethylene glycol was then added as a preservative. Each of traps has been designated by individual number. Beetles from each trap were fixed separately. In total 1080 trap-days are fulfilled. Activity density level was counting as number of specimen per trap per day.

Statistical processing was spent with use of a package of applied statistical programs "Statistica 8.0".

At an estimation of structure of domination Renkonen's scale is used (Renkonen 1938). According to which are allocated dominant (more than 5%), subdominant (3-5%), recedent (1-3%) and subrecedent (less than 1%) species.

For an estimation of structure of assembly were used: a Shannon's index of variety, Pielou index of evenness (Песенко 1982).

The ecological characteristics of the species have been excerpted from the following publications: Larsson (1939), Lindroth (1945), Thiele (1977), Koch (1989). The following classifications are used: by habitat (open-area species, forest and open-area species), by trophic group (predators, hemizoophagous, phytophagous), by humidity preferences (hygrophilous, mesohygrophilous, mesophilous, mesoxerophilous, and xerophilous) and by development type (autumn and spring breeders).

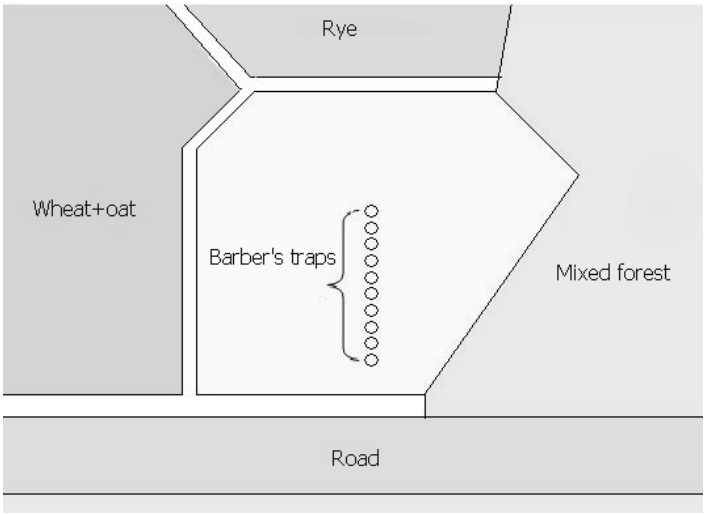

Fig. 1. **Location of trapping research area and neighbouring fields**

Results

Number of specimens and activity

In total, 509 ground beetles from 23 species and 8 genera were collected (Tab. 1). Activity density was 0.47±0.06 individuals per trap per day. The most species richness were registered in genera *Harpalus* (8 species) and *Calathus* (4 species).

Structure of dominance

A group of dominants included 7 species: *Calathus fuscipes*, *Harpalus griseus*, *Harpalus rufipes*, *Harpalus calceatus*, *Poecilus lepidus*, *Broscus cephalotes* and *Harpalus froelichii*. A group of subdominants consisted of *Harpalus smaragdinus* and *Amara fulva*. Recedent was represented by

Calathus ambiguus. The other 13 species were classified as subrecedent species. Diversity indexes reached accordingly: Shannon H' = 2.38; Pielou index of evenness' e=0.76 (Tab. 1).

Table 1.

Species composition and domination in carabid assembly on crop field

Species	***Domination, %***
Dominant	
Calathus fuscipes (Goeze,1777)	17.49
Harpalus griseus (Duftschmid,1812)	15.13
Harpalus rufipes (Degeer,1774)	14.73
Harpalus calceatus (Duftschmid,1812)	13.95
Poecilus lepidus (Leske,1785)	9.82
Broscus cephalotes (Linnaeus,1758)	8.06
Harpalus froelichi Sturm,1818	6.09
Subdominant	
Harpalus smaragdinus (Duftschmid,1812)	3.54
Amara fulva (Degeer,1774)	3.14
Recedent	
Calathus ambiguus (Paykull,1790)	1.96
Subrecedent	
Amara consularis (Duftschmid,1812)	0.59
Amara equestris (Duftschmid,1812)	0.59
Calathus cinctus Motschulsky,1850	0.20
Calathus erratus (Sahlberg,1827)	0.20
Carabus cancellatus Illiger,1798	0.39
Carabus convexus Fabricius,1775	0.39
Dolichus halensis (Schaller,1783)	0.98
Harpalus affinis (Schrank,1781)	0.20
Harpalus distinguendus (Duftschmid,1812)	0.20
Harpalus tardus (Panzer,1797)	0.98
Poecilus cupreus (Linnaeus,1758)	0.39
Poecilus versicolor (Sturm,1824)	0.59
Pterostichus niger (Schaller,1783)	0.39
Total individuals	509
Total species	23
Mean activity density, specimen/per trap/per day	0.47
Standard deviation of mean activity density	0.06
Shannon diversity index H'_{ln}	2.38
Pielou index of evenness' e	0.76

Ecological characteristics

All dominating species are widespread in Palearctic on arable field and meadow. The dominant group was open-area species (20 species and 98.83% of specimen). Species of forest and open-area (*Carabus convexus, Carabus cancellatus, Pterostichus niger*) were represented by single individuals (1.17%) (Tab. 2).

Breakdown by trophic type revealed a dominance of predators (*Broscus, Calathus, Dolichus, Poecilus* etc.) in terms of species (12) and a quantitative dominance of hemizoopgagous (*Harpalus* spp., *Amara equestris*) in terms of individuals (41.46%). Share of predators specimen was very closely: 40.86%. Phytophagous species (*Harpalus calceatus, Amara fulva, A. consularis*) consisted 17.68 of assembly.

Table 2.

Participation of the ecological elements in carabid assembly

Ecological characteristic	***Number of species***	***% of specimen***
Habitat group		
Open-area	20	98.83
Forest and open-area	3	1.17
Trophic group		
Predator	12	40.86
Hemizoophagous	8	41.46
Phytophagous	3	17.68
Humidity preferences group		
Mesophilous	7	34.96
Mesoxerophilous	7	4.52
Xerophilous	9	60.52
Development type		
Autumn breeders	17	97.84
Spring breeders	6	2.16

In terms of humidity preferences, xerophilous species prevailed both with regard to the number of species and individuals (9 species, and 60.52% of specimen). Mesophilous species were in second position: 7 species, 34.96% of individuals.
Finally, classification with respect to developmental type showed a predominance of autumn breeders in quality (17 species) and quantity (97.84% specimen) aspects.

Seasonal dynamic of activity density

It is revealed two not appreciable peaks of activity density (Fig. 2). The first period of mass activity was noted in the end of July, and the second – in second half of August. High level activity in June was registered to all dominant species. Activity of carabids was in high whole summer. In the middle of September only observed decrease of activity density.
This two peaks of activity had been almost entirely generated by dominants: *Calathus fuscipes*, *Harpalus rufipes, Harpalus calceatus,* and *Harpalus froelichii* (Fig. 2). Second group of dominants had one appreciable peak only: *Broscus cephalotes* – in the first half of June; *Poecilus lepidus* – in beginning of August; and *Harpalus griseus* in the beginning of September (Fig. 2).

Discussion

Species richness of the assembly was typical to such kind community in light soil in Middle Europe. For annual crop species number was not more 30 (Thiele 1977, Luff 2002). Similar value of species richness, within 25-35 species are known for fields of grain crops in central Poland (Kabacik 1962, Jaworska 2001, Jaworska i Wiącek 2006, Huruk 2007).
For a long time it is known, that the species richness depend on type and mechanical composition of soil (Heydemann 1955). The specific composition and low species richness are characteristic to sandy soils (Thiele 1977, Andersen 2000). Such species as *Carabus convexus, Poecilus versicolor, Poecilus lepidus, Harpalus tardus, Harpalus distinguendus, Harpalus griseus, Broscus cephalotes, Calathus erratus*) are selected by Heydemann (1955) to qualitative indicators of winter grain and root crop fields on sandy soils. According to Andersen (2000) the carabid's fauna sandy soils of the Western Europe is generated by species from sandy coast of fresh water body and sea coasts. It is possible to species with westpalearctic areals, whereas euro-siberian elements such *Harpalus calceatus, H. froelichii, Harpalus smaragdinus, H. distinguendus, Calathus ambiguous, Dolichus halensis* have got into Middle Europe from the East, from forest-steppe and steppe zones where are numerous in grain crops (Васильева 1971, Александрович 1996, Колесников, Сумароков 1993).

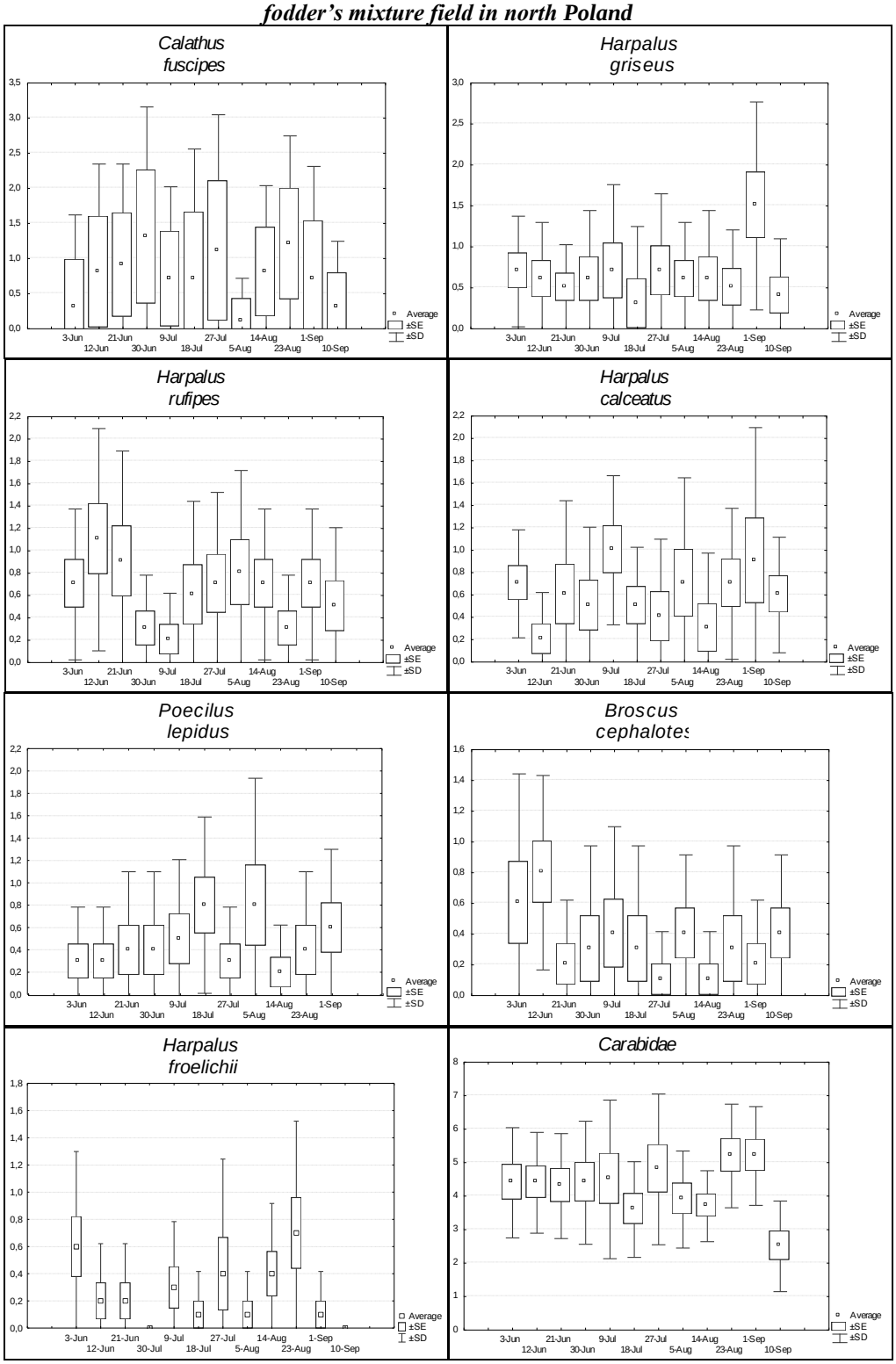

Fig. 2. **Seasonal dynamic of activity density in carabid's assembly at fodder's mixture field in 2007**

Studying assembly had domination structure is not usual for a corn field community. *Harpalus rufipes* and *Poecilus lepidus* only were known as dominant in cornfields, and *Broscus cephalotes* for root crop fields on sandy soil in West and Middle Europe (Thiele 1977). *Calathus fuscipes* is known as dominant in meadow assembly (Tietze 1973, Thiele 1977, Александрович 1996). *Harpalus griseus* was known as dominant in potatoes in Central Belarus (Aleksandrowicz 2002). Such dominants as *Harpalus calceatus* and *H. froelichii* and subdominants *Harpalus*

smaragdinus and *Amara fulva* were observed as dominants in East European fields in forest-steppe (Васильева 1971) and steppe zone (Колесников, Сумароков 1993).

One more assembly special feature was polydomination: established 7 dominant species. This polydomination and high evenness (Pielou index e=0.76) were the reasons of high level of Shannon diversity index. The value of Shannon index (H'=2.38) close to that, received for grain fields of Belarus: 2.49- 2.79 in different soil type (Александрович, 1979). However value of Shannon indexes for grain fields of Belarus are resulted by results of long-term researches.

The value of activity density is very differing in Europe cornfield assembly (Huruk 2007). According this author, average level activity density evaluate from 0.5 to 2.0 specimen/trap/day. We established low activity density (0.47±0.06 specimen/trap/day), that close to bottom known border.

In trophic structure the predators and hemizoophagous prevail: 87 % of species and 82.32 % of caught individuals. Domination of predators on Middle Europe fields has universal character (Thiele 1977; Александрович 1996).

Prevalence xerophilous and mesoxerophilous species is prominent feature of carabid assemblies on sandy soils (Andersen 2000).We established domination represent of this humidity groups in qualitative (16 species from 23) and quantitative (65.04% all specimen) aspects.

Domination of autumn breeders on sandy soil is well known (Thiele 1977), but has not been established anywhere such overwhelming prevalence: 97.84 %.

Figure 2 shows the seasonal dynamic of active density of dominant species. All of them (except *Poecilus lepidus*) known as autumn breeders with larval overwintering stadium (Larsson 1939). Extremely warm winter 2006/2007 was a possible reason of overwintering of numerous imagines too. To *Broscus cephalotes,* and *Harpalus rufipes, H. griseus, H. calceatus* and *H. froelichii* observed not typical peaks of activity in first half of June.

Conclusion

Thus, it is possible to conclude, that studied carabid assembly of fodder's mixture field on sandy soil had very specific species composition and ecological structure. This assembly is characterized by low species richness, polydomination, high value Shannon and Pielou indexes, not typical high seasonal activity of "autumn breeders" in first half of June. Possible reasons of such phenomena are soil condition (dry sand soil) and extreme warm winter 2006/2007.

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