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EVALUATION OF THE IMPACT OF AGROCLIMATIC ELEMENTS ON GROUND BEETLES (*CARABIDAE*) OCCURRENCE IN AGROECOSYSTEMS WITH A METHOD OF CORRELATION

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Abstract: From May to July in the years 1995–2000 studies on the numbers of density of *Carabidae* on two fields with different cultivation systems (intensive and conventional) were performed. Including other elements like kind of a crop and weather conditions during the investigations it was possible to compile a summary numerical index of main factors having the influence on the occurrence of *Carabidae* and being in a very good correlation with the number of these insects in agroecosystems.

Key words: *Carabidae* number, cultivation treatments, crop, temperature, rainfalls, correlation

INTRODUCTION

In a literature there is emphasized the impact of several managament practices on activity density of *Carabidae* i.e. the different tillage systems, the kind of crop or pesticide application (Carcamo 1995; Clark et al. 1997; Fadl et al. 1996; Huusela-Veistola 1996). The attractiveness of crops to different species is related mainly with provided suitable microclimatic condition, and food supply (Górny 1968). From the investigations it is known that a spring tillage has an adverse effect on occurrence of species that overwinter in larval stages. As regards the impact of weather conditions on *Carabidae* density, more ground beetles were caught at moderate rainfalls and temperatures than at drought and heat (Scherney 1962).

MATERIAL AND METHODS

The investigations were conducted on two cultivated fields (within a distance of 5 km) in the community Debrzno in Pomerania (Poland). The soil texture of both fields was classified to sandy loam. Humus content was a little higher on field no. 2

Table 1. Crop and weather conditions characteristic in a period of 1995–2000

Year	Crop rotation (no. of insecticidal treatments)		May		June		July	
	Field no. 1 (3.9 ha)	Field no. 2 (80.0 ha)	Temp. °C	Rainfalls mm	Temp. °C	Rainfalls mm	Temp. °C	Rainfalls mm
1995	winter rape (2)	winter rape	11.3	51.0	15.4	77.0	18.9	27.0
1996	winter wheat (1)	winter wheat	11.7	101.0	14.9	65.0	14.6	107.0
1997	potatoes (2)	spring barley	10.9	87.0	15.6	65.0	17.2	7.0
1998	spring barley (1)	spring wheat	15.1	31.4	15.8	78.8	16.4	70.6
1999	winter rape (2)	spring rape (1)	12.2	73.0	15.9	39.9	19.6	48.5
2000	– *	spring wheat	14.6	46.6	15.8	39.4	15.3	131.1
Averages			12.2	41.8	14.9	64.1	16,6	63.3

* – out of investigation

(2.1%) than on field no. 1 (1.7%). Soil acidity was similar on both fields and varied in a range of pH 5.8–6.1. Much more epigeal and soil insect fauna occurred on the field no. 2 than on the field no. 1.

On the field no. 1 considerably more intensive agriculture treatments were performed (frequent protective chemical treatments, high doses of fertilizers, no manure) than on field no. 2 (Tab. 1).

The sampling of ground beetles was performed in the period of May–July using a method of Barber's pitfall traps (∅ 12 cm, 10 traps with a solution of ethylene glycol on each field) checked once a week.

Estimation of the relative significance of main factors having the impact on the catch numbers of ground beetles was made apart for each factor according to a completely randomized design (variance analysis, test F) and by means of several approximations in order to obtain the best correlation coefficients. No data transformations were done as the means were calculated from a sufficiently great numbers and their variances were similar.

RESULTS AND DISCUSSION

The mean numbers on both investigated fields in a period of May–July 1995–2000 are presented in table 2. The numbers representing separate months and years of investigation and their relation to the established factors are shown in table 3.

The number value of separate component elements (a, b, c, d) of the summary index "x", the maximal value of which should be equal to one ($x_{max} = a_{max} + b_{max} + c_{max} + d_{max} = 1.00$), was defined as follows:

"a": the index of edaphic value of a habitat:

- a_1 – the high value (=0.50) for a habitat with a rich food supply for zoophagous insects, where almost no insecticidal treatments were practiced (the field no. 2 in the years 1995–2000 with an exception of July 1997, see below);
- a_2 – the low value (=0.10) (the field no. 1, where insecticidal treatments were performed each year and the field no. 2 in July1997 – the negative impact of complete crop lodging on locomotive ability of ground beetles);

Table 2. The mean number of *Carabidae* (individuals/trap/week) in a period of 1955–2000 on fields no. 1 and 2

Carabidae	May		June		July	
	Field no. 1	Field no. 2	Field no. 1	Field no. 2	Field no. 1	Field no. 2
Total number	4.3	56.7	20.8	118.8	38.6	112.2
from that %:						
Carabus auratus	–	35.6	–	20.8	–	15.3
Pterostichus cupreus	46.5	37.9	14.4	24.2	4.1	9.0
Pterostichus vulgaris	7.0	5.5	9.1	12.4	25.6	28.6
Ophonus rufipes	–	2.3	16.8	8.5	22.0	10.2
Agonum dorsalis	–	2.5	14.9	3.8	5.9	4.7
Calathus fuscipes	–	–	2.4	3.0	4.9	7.5
Amara sp.	7.0	0.9	22.1	1.8	15.5	15.1

Table 3. A correlation between the summary index of habitat factors (x) and the numbers of *Carabidae* in individuals/trap/week (y) in a period of 1995–2000

Year – field no.	May		June		July	
	x	y	x	y	x	y
1997 – 1	0.35*	2.2	0.30	6.0	0.35	16.4
1995 – 1	0.35	3.1	0.30	22.3	0.60	35.5
1999 – 1	0.30	3.2	0.35	56.1	0.60	80.3
1996 – 1	0.50	6.2	0.50	13.0	0.55	26.5
1998 – 1	0.55	6.8	0.50	10.5	0.50	34.5
1995 – 2	0.70	12.3	0.65	41.3	1.00	146.5
2000 – 2	0.95	42.0	0.95	139.2	0.95	123.3
1997 – 2	0.95	47.2	0.90	135.0	0.55	35.0
1996 – 2	0.90	56.3	0.90	212.9	0.95	196.5
1999 – 2	0.90	82.0	0.75	65.0	0.80	51.0
1998 – 2	1.00	100.2	0.95	119.7	0.90	121.2
Coeff. of correlation (r)	0.858		0.831		0.877	
$r_{crit.0.01}$ =0.73						

Explanation: * $a_2 + b_2 + c_1 + d_2 = 0.35$

"b": the index of crop kind:

b_1 – winter and summer cereals; winter rape (July), summer rape (May) (=0.30);

b_2 – winter rape (May–June), summer rape (June–July), potatoes (=0.10);

"c": the index of thermal conditions:

c_1 – the mean month's temperature above or lower as more as 1°C of an average (t_o) (= 0.10);

c_2 – the mean month's temperature in a range of: $t_o \pm 1$°C (=0.05);

"d": the index of rainfalls:

d_1 – the rainfalls lower at least 10 mm of an average norm (=0.10);

d_2 – the rainfalls within or above at least of 10 mm of an average norm (=0.05);

As it results from table 2, great differences occurred between both fields in the catch numbers to the benefit of the field no. 2. The differences were the highest in May and then decreased gradually in June and July, which indicates progressive settlement of ground beetles in the field no. 1 (immigration process).

The species composition of *Carabidae* also differed significantly on the the both fields., There were more typical zoophagous species (*C. auratus*) and less phytophagous species (*Amara* sp., *O. rufipes*) on field no. 2 in comparison with field no. 1.

The results showed in table 3 indicate, on the other hand, that it was possible to match the values of the summary index, in order to obtain a very good correlation with the catch numbers surpassing the critical value of correlation coefficient on the significance level of 0.01. The correlation coefficients for May, June and July amounted to: 0.858, 0.831 and 0.877 respectively.

It can therefore be assumed on the basis of the performed investigations, that the greatest impact on occurrence of *Carabidae* in agroecosystems had in the described conditions the edaphic characteristics of the habitat (up to 50%), followed by the kind of a crop accompanied by an intensity of cultivation and pesticide application or crop density (up to 30%), thermal conditions and rainfall sum (up to 20%).

It can also be assumed, that in such cases where the impact of many habitat factors on the catch numbers of epigeal insects is to be simultaneously valuated, the method of quantyfied indexation of habitat factors and a metod of correlation may be useful for this purpose.

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POLISH SUMMARY

OCENA WPŁYWU CZYNNIKÓW SIEDLISKA NA LICZEBNOŚĆ BIEGACZOWATYCH (*CARABIDAE*) W AGROCENOZACH METODĄ KORELACJI

W okresie maj–lipiec 1995–2000 r. badano liczebność biegaczowatych (*Carabidae*) na dwóch polach uprawnych o różnych systemach uprawy (intensywny, konwencjonalny). Uwzględniając także inne czynniki siedliska (rodzaj uprawianych roślin, temperatura i opady) można było wyliczyć dla każdej liczebności odłowów sumaryczne wskaźniki liczbowe tych czynników w taki sposób, aby uzyskać ich najlepszą korelację z liczebnością odłowów dla poszczególnych miesięcy. Na podstawie wykonanych badań oszacowano cząstkowy