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RESEARCH ON THE BIODIVERSITY OF CARABIDS (ORDER *Coleoptera*, FAMILY *Carabidae*), PREDATORY INSECTS IN SOME AGRICULTURAL ECOSYSTEMS ACCORDING TO THE APPLIED TECHNOLOGY AND IN THE CONTEXT OF NEW CLIMATE CHANGES

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Abstract

Research was done during 2023 on three field crops: wheat, corn and sunflower. The collection of the material was done with the soil traps Barber type, and the collection of biological material was made every two weeks, starting from May to September depending on the culture. We were organized two variants in the experimental stationary, depending on the technologies (treatment scheme applied) to each culture as follows: V1, the field where no chemical treatment was done (ecological variant); V2, the field to which chemical treatments were applied, if necessary to the seeds and during the vegetation period (conventional variant). From the material collected from the Barber soil traps during to the five months, were selected only the carabid species that were then identified. Regarding the analysis and interpretation of the results, two indices of the diversity of the species were also calculated, namely: the Sorensen index and the Spearman index whose values show how similar the cultures compared to each other are, two by two.

Key words*: predatory insects, agricultural ecosystems, climate changes, Barber traps*.

INTRODUCTION

Carabids comprise more than 20,000 species, spread all over the globe. In temperate regions it walks more on the ground and in the ground, under stones, leaves, etc. They are of varied size, they have their own habitus that makes them easily distinguishable. (Neculiseanu, 2000). Both larvae and adults are predators and useful to humans.

However, there are also harmful species, such as, for example, the species *Zabrus tenebrioides* (the scaly beetle) which both as a larva and as an adult is harmful to cereal crops, then *Harpalus pubescens* harmful to cereal crops (Antonescu, 2011).

In agricultural crops and even in forest areas, many carabid species are important ecological indicators responding immediately to human interventions, such as pesticides that cause paralysis or even death of adult insects or larvae shortly after the application of treatments.

For this reason and for other reasons (climate changes, etc.) many carabid species have decreased, are on the verge of extinction or have even disappeared.

A determining factor is also the anthropization of nature, in general and general excessive pollution (Ciochia et al., 1997).

MATERIALS AND METHODS

The collection of the material from this work was done with the help of Barber type soil traps (Mocanu, 2016), in the year 2022.

A number of three crops were studied: wheat, corn and sunflower, each with 2 variants:

- conventional variant, with seed treatments and during the vegetation period, with insecticide products;
- the ecological variant, without insecticide treatments.

Samples were collected at intervals of about two weeks, in total 10 harvests for corn and 6 harvests each for wheat and sunflower.

The harvest dates were:

- Harvest I on 15.05;
- Harvest II on 29.05;
- Harvest III on 12.06;

- Harvest IV on 26.06;
- Harvest V on 10.07;
- Harvest VI on 24.07;
- Harvest VII on 07.08;
- Harvest VII on 21.08;
- Harvest IX on 04.09;
- Harvest X on 18.09.

A salt solution (NaCl) 25 g/l was used to capture the material. At each collection, the solution inside the trap was replaced, and the material collected after being cleaned of plant debris or other impurities, soil debris, snails, mice, etc. was brought to the laboratory (Talmaciu, 2005)

Only carabids species that were then determined were selected in the laboratory.

The determination of the biological material was made with the help of determinants books that belong Panin, 1951, Reitter, 1908-1916.

RESULTS AND DISCUSSIONS

In the wheat crop, 269 carabid specimens belonging to 27 species were collected in the untreated variant, while 142 carabid specimens belonging to 4 species were collected in the chemically treated variant (Table 1).

Table 1. The situation regarding the dynamic structure and abundance of carabid species in the wheat crop

No	Name of species	First vatiant (no treatments)						Total I	Second variant (with treatments)						Total II
		1	2	3	4	5	6		1	2	3	4	5	6	
1.	*Carabus coriaceus*	2	1	0	1	0	0	4	0	0	0	0	0	0	0
2.	*Carabus calceatus*	1	1	0	0	0	0	2	0	0	0	0	0	0	0
3.	*Pterostichus cylindricus*	17	16	23	15	5	8	84	26	18	19	17	10	7	97
4.	*Pseudophonus pubescens*	24	15	7	6	10	6	68	13	7	9	1	-	-	30
5.	*Harpalus distinguendus*	6	5	2	7	3	1	24	0	0	0	0	0	0	0
6.	*Calathus fuscipes*	1	3	2	4	2	0	12	0	0	0	0	0	0	0
7.	*Pseudophonus griseus*	5	3	3	3	7	1	22	0	0	0	0	0	0	0
8.	*Platynus assimilis*	1	2	1	0	0	0	4	0	0	0	0	0	0	0
9.	*Pterostichus niger*	3	5	4	4	1	1	19	1	1	3	1	1	3	10
10.	*Pterostichus vulgaris*	4	0	1	0	0	0	5	0	0	1	1	3	0	5
11.	*Amara aenea*	1	0	0	0	0	0	1	0	0	0	0	0	0	0
12.	*Amara familiaris*	1	0	0	0	0	0	1	0	0	0	0	0	0	0
13.	*Carabus intricatus*	1	0	0	1	0	0	2	0	0	0	0	0	0	0
14.	*Harpalus smaragdinus*	1	0	0	0	0	0	1	0	0	0	0	0	0	0
15.	*Amara similata*	1	0	0	0	0	0	1	0	0	0	0	0	0	0
16.	*Harpalus aeneus*	0	2	0	1	0	0	3	0	0	0	0	0	0	0
17.	*Carabus scabriusculus*	0	1	0	0	0	0	1	0	0	0	0	0	0	0
18.	*Carabus auronitens*	0	1	0	0	0	0	1	0	0	0	0	0	0	0
19.	*Nebria brevicallis*	0	3	0	2	1	0	6	0	0	0	0	0	0	0
20.	*Brachynus crepitans*	0	1	0	0	0	0	1	0	0	0	0	0	0	0
21.	*Calathus melanocephalus*	0	0	1	0	0	0	1	0	0	0	0	0	0	0
22.	*Pterostichus lepidus*	0	0	1	0	0	0	1	0	0	0	0	0	0	0
23.	*Pterostichus cupreus*	0	0	0	1	0	0	1	0	0	0	0	0	0	0
24.	*Carabus auratus*	0	0	0	1	0	0	1	0	0	0	0	0	0	0
25.	*Harpalus tardus*	0	0	0	1	0	0	1	0	0	0	0	0	0	0
26.	*Pterostechus nigrita*	0	0	0	0	1	0	1	0	0	0	0	0	0	0
27.	*Carabus cancellatus*	1	0	0	0	0	0	1	0	0	0	0	0	0	0
Total		70	60	45	47	30	17	269	40	26	32	20	14	10	142

In the corn culture, a number of 520 specimens of Carabidae belonging to a number of 23 species were collected in the untreated variant, and a number of 421 specimens of Carabidae belonging to a number of 7 species were collected in the treated variant (Table 2).

Table 2. The situation regarding the dynamic structure and abundance of carabid species in the corn crop

No	Name of species	First vatiant (no treatments)										Total I	Second variant (with treatments)										Total II
		1	2	3	4	5	6	7	8	9	10		1	2	3	4	5	6	7	8	9	10	
1.	*Pseudophonus pubescens*	34	57	40	39	26	21	4	6	1	7	235	66	44	35	29	24	44	6	5	6	7	266
2.	*Pterostichus niger*	1	0	0	0	1	2	4	1	4	-	13	0	0	0	0	0	1	1	1	0	0	3
3.	*Pseudophonus griseus*	20	22	9	12	6	12	16	9	7	1	114	0	15	25	14	36	1	19	14	7	0	131
4.	*Harpalus distinguendus*	4	1	2	3	5	7	3	2	2	1	30	0	1	0	0	0	0	0	0	0	0	1
5.	*Nebria brevicallis*	2	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
6.	*Pterostichus cylindricus*	10	11	4	7	11	13	9	10	3	4	82	0	5	0	0	2	3	2	1	3	0	16
7.	*Harpalus aeneus*	1	1	0	0	1	0	2	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
8.	*Ophonus azureus*	1	3	1	3	0	1	0	0	0	0	9	0	0	0	0	0	1	0	0	0	0	1
9.	*Pterostichus koyi.*	1	0	0	1	0	1	0	0	0	0	3	0	0	0	0	0	1	0	0	0	0	1
10.	*Harpalus rufipes*	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
11.	*Ophonus puncticallis*	1	0	0	2	1	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
12.	*Carabus coriaceus*	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
13.	*Pterostichus melas*	0	0	1	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
14.	*Abax carinatus*	0	0	1	1	0	2	0	0	0	0	4	-	0	0	0	0	0	0	0	0	0	0
15.	*Calathus fuscipes*	0	0	1	1	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
16.	*Amara aenea*	0	0	0	1	1	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
17.	*Carabus canlceatus*	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
18.	*Harpalus tardus*	0	0	0	1	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
19.	*Amara apricaria*	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
20.	*Anisodactylus nemovivagus*	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
21.	*Bembidion properans*	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
22.	*Pterostichus vulgaris*	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
23.	*Brachynus explodens*	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Total		77	95	59	71	55	63	38	28	17	14	520	66	65	60	43	62	51	28	21	16	7	421

In the sunflower culture, 507 specimens belonging to a number of 19 species were collected in the untreated variant, and 413 specimens of carabids belonging to a number of 8 species were collected in the treated variant (Table 3).

Table 3. The situation regarding the dynamic structure and abundance of carabid species in the sunflower crop

No	Name of species	First vatiant (no treatments)										Total I	Second variant (with treatments)										Total II
		1	2	3	4	5	6	7	8	9	10		1	2	3	4	5	6	7	8	9	10	
1.	*Pterostichus cylindricus*	17	16	4	20	9	15	8	11	7	3	110	22	29	15	17	16	8	9	13	5	4	138
2.	*Pseudophonus pubescens*	24	26	88	57	46	12	3	5	3	3	267	14	23	6	4	1	11	0	1	1	0	61
3.	*Pseudophonus griseus*	13	32	3	6	19	3	2	2	5	2	87	5	6	0	4	0	1	0	1	1	0	18
4.	*Harpalus distinguendus*	4	2	1	0	2	2	0	0	0	0	11	1	1	2	0	0	0	0	0	0	0	4
5.	*Amara similata*	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
6.	*Pterostichus niger*	2	0	0	1	0	1	2	1	1	1	9	1	2	2	6	0	0	0	0	4	2	17
7.	*Calathus fuscipes*	3	1	1	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
8.	*Harpalus tardus*	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
9.	*Platinus assimilis*	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
10.	*Harpalus aeneus*	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
11.	*Leistus ferrugineus*	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
12.	*Amara familiaris*	0	3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
13.	*Ophonus puncticollis*	0	1	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
14.	*Bembidion ruficorne*	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
15.	*Carabus coriaceus*	0	1	2	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
16.	*Pterostichus lepidus*	0	0	0	1	2	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
17.	*Nebria brevicollis*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
18.	*Zabrus tenebrioides*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
19.	*Abax carinata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Total		69	83	99	85	79	33	15	19	16	9	507	43	62	25	31	18	20	9	16	11	6	241

Regarding the predatory carabids collected in the three crops, the situation is as follows:
- in the wheat crop, a number of 146 specimens belonging to 17 species were collected in the untreated variant, and 112 specimens belonging to a number of 3 species were collected in the chemically treated variant (Table 4).

Table 4. Structure and abundance of predatory carabids species collected from the wheat crop in the two variants

No.	Name of species	Variant	
		No treatments	With treatments
1.	*Carabus coriaceus*	4	0
2.	*Carabus cancellatus*	2	0
3.	*Pterostichus cylindricus*	84	97
4.	*Calathus fuscipes*	12	0
5.	*Platynus assimilis*	4	0
6.	*Pterostichus niger*	19	10
7.	*Pterostichus vulgaris*	5	5
8.	*Carabus intricatus*	2	0
9.	*Carabus scabriusculus*	1	0
10.	*Carabus auronitens*	1	0
11.	*Nebria brevicallis*	6	0
12.	*Brachynus crepitans*	1	0
13.	*Calathus melanocephalus*	1	0
14.	*Pterostichus lepidus*	1	0
15.	*Carabus auratus*	1	0
16.	*Pterostechus nigrita*	1	0
17.	*Carabus calceatus*	1	0
Total		146	112

A number of 116 specimens belonging to 13 species were collected in the untreated version of corn, and 20 specimens belonging to a number of three species were collected in the chemically treated version (Table 5).

Table 5. Structure and abundance of predatory carabids species collected from the maize crop in the two variants

No.	Name of species	Variant	
		No treatments	With treatments
1.	*Pterostichus niger*	13	3
2.	*Nebria brevicallis*	3	-
3.	*Pterostichus cylindricus*	82	16
4.	*Pterostichus koyi*	3	1
5.	*Carabus coriaceus*	1	-
6.	*Pterostichus melas*	2	-
7.	*Abax carinatus*	4	-
8.	*Calathus fuscipes*	1	-
9.	*Carabus cancellatus*	1	-
10.	*Bembidion properans*	1	-
11.	*Anisodactylus nemovivagus*	1	-
12.	*Pterostichus vulgaris*	1	-
13.	*Brachynus explodens*	1	-
Total		116	20

In the sunflower culture, 133 carabid specimens belonging to a number of 8 species were collected in the untreated variant, and 178 carabid specimens belonging to a number of 4 species were collected in the chemically treated variant (Table 6).

Table 6. The structure and abundance of predatory carabidae species collected from the sunflower crop in the two variants

No.	Name of species	Variant	
		No treatments	No treatments
1.	*Pterostichus cylindricus*	110	138
2.	*Pterostichus niger*	9	38
3.	*Calathus fuscipes*	5	0
4.	*Platynus assimilis*	1	0
5.	*Leistus forregineus*	1	0
6.	*Bembidion ruficorne*	1	0
7.	*Carabus coriaceus*	3	0
8.	*Pterostichus lepidus*	3	0
9.	*Nebria brevicallis*	0	1
10.	*Abax carinatus*	0	1
Total		133	178

Regarding the Sorensen Index that shows us whether the fauna of different ecosystems are similar or different and was calculated according to: Is=$\frac{2c}{a+b}$, in which:
Is - the Sorensen index;
a - the total number of existing species in the first compared fauna;
b - the total number of existing species in the second compared fauna;
c - the number of species common to the two compared fauna;
- from a qualitative point of view, the most appreciated carabid communities resulted from the comparison of the carabids from the treated wheat crop with the treated corn one (IS = 72.73), which leads to an appreciation of the two carabid entomofaunas, followed by the variant untreated wheat-untreated sunflower (IS = 65.12) and treated wheat-treated sunflower variant (Is = 50.00); at the opposite pole with low values of the Sorensen index were the variants: untreated wheat - treated wheat (Is = 12.99), untreated corn - untreated sunflower (Is = 17.95) untreated corn - treated sunflower (Is = 19.36) and the variant treated corn - untreated sunflower (Is = 21.74).
The Spearman index (Table 8) had the highest value for the untreated sunflower variant (0.90), followed by the treated wheat-untreated wheat variant (0.60) and then the treated maize-untreated maize variant (0.50).
The weakest similarities are found in the variants treated corn-untreated corn and treated wheat-untreated corn, which fall into value class 3 (0.41-0.60).

The greatest similarity of the carabid fauna was recorded in the treated sunflower-untreated sunflower variant, which falls into class 5 values (0.81-1.00).

Table 7. Presentation of the results regarding the Sorensen index

No.	Variant	Index value	Reference class
1.	Untreated wheat - Treated wheat	12.99	I - 0-20
2.	Untreated wheat - Untreated corn	29.42	II - 21-40
3.	Untreated wheat - Treated corn	41.81	III – 41-60
4.	Untreated wheat - Untreated sunflower	65.12	IV - 61-80
5.	Untreated wheat - Treated sunflower	34.29	II - 21-40
6.	Treated wheat – Untreated corn	22.23	II - 21-40
7.	Treated wheat- Treated corn	73.73	IV - 61-80
8.	Treated wheat – Untreated sunflower	15.00	I - 0-20
9.	Treated wheat – Treated sunflower	50.00	III - 41-60
10.	Treated corn - Untreated corn	46.67	III - 41-60
11.	Treated corn - Untreated sunflower	21.74	I - 0-20
12.	Treated corn - Treated sunflower	40.00	II - 21-40
13.	Untreated corn - Untreated sunflower	17.95	I - 0-20
14.	Untreated corn - Treated sunflower	19.36	I - 0-20
15.	Untreated sunflower - Treated sunflower	41.67	III - 41-60

Table 8. Presentation of the results regarding the Spearman index

Wheat		Corn		Sunflower	
No treatments	With treatments	No treatments	With treatments	No treatments	With treatments
0.60		0.50		0.90	

CONCLUSIONS

In all three cultures in the untreated variant, the number of specimens and carabid species collected is higher, the situation being as follows for the cultures:

- in the wheat crop, in the untreated variant, carabids belonging to a number of 27 species were collected, totaling a number of 209 specimens compared to the treated variant, where specimens belonging to only 4 species were collected, totaling a number of 142 specimens;
- in the wheat crop, in the untreated variant, carabid specimens belonging to 23 species were collected, totaling 520 specimens, while in the treated variant, specimens belonging to 7 species were collected, totaling 421 specimens;
- in the sunflower culture, 507 carabid specimens belonging to 16 species were collected in the untreated variant, and 413 carabid specimens belonging to only 8 species were collected in the treated variant.

Regarding the species of predatory carabid collected, for the 3 crops it is found that the most predatory species were collected in the untreated variant as well as the number of specimens, with only one exception, in the sunflower crop.

By cultures and variants the situation is as follows:

- in the wheat crop, 146 specimens of predatory carabids belonging to a number of 17 species were collected, while in the treated variant, 112 specimens were collected belonging to only 3 species;
- 116 specimens belonging to a number of 13 species were collected in the untreated version of corn, while 20 specimens belonging to only 3 species were collected in the treated version;
- in the sunflower culture, the untreated variant, 133 specimens belonging to 8 species were collected, and in the treated variant, 178 specimens belonging to 4 species were collected.

Regarding the values of the Sorensen and Spearman indices, which reflect the degree of similarity between the fauna of two or more communities, the situation is as follows:

- the highest value of the Sorensen index of 72.73, which shows a high degree of similarity, was for the variant treated wheat-treated corn, and the lowest value 12.99 was recorded for the variant untreated wheat-treated wheat;
- the Spearman index had the highest value of 0.90 for the variant treated sunflower - untreated sunflower, followed by the variant treated wheat - untreated wheat with a value of 0.60 and then the variant treated corn - untreated corn, with a value of 0.50.

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