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DIVERSITY AND THE MAIN ECOLOGICAL REQUIREMENTS OF THE EPIGEIC SPECIES OF CARABIDAE (COLEOPTERA, CARABIDAE) FROM THREE TYPES OF AGRICULTURAL ECOSYSTEMS IN SUCEAVA COUNTY (MOLDAVIA)

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***Key words**: Carabids, agricultural ecosystems (potatoes, maize, clover), alpha diversity, relative abundance, Sörrensen's coefficient, Shannon index, evenness, main ecological requirements*

INTRODUCTION

Suceava county is located in the northern, north-east extremity of Romania, in the north part of Moldavia, in the upper catchment of the Siret and Bistrița rivers.

The county has an area of 8553 square kilometres, representing 3.6 % of Romania's area, being the second large county of Romania.

The relief is varied: Mountains, plateaus, hills, intramountain and intrahills depressions, valleys etc. The mountain zone covers about two thirds of the county's area. To the east of mountain zone, there is the Suceava Plateau, which covers about one third of the county's area. The Suceava Plateau is divided into two plateaus. The Dragomirna Plateau (altitude 300-525 m) and the Fălticeni Plateau (altitude 400 - 481m).

The Climate is temperat – continental with a cooler character because of the northen geographical position of the county and of the predominantly mountain relief. Because of the relief and altitude, the annual average temperature of the air varies between 0º and 8º C. 0º C on the high peaks of the mountains; about 2º C in the middle mountains ;5º C in depressions, and 8º C in the Suceava Plateau.

The annual average amount of precipitations varies altitudinally, from 550 mm in the plateau zone to 800 mm in the subcarpatian hills; and from 1200 mm in the regions of the small and middle – seized mountains to 1400mm on the high mountains.

Within the ecological conditions of the Suceava county, faunistic research on the curculionids published: (THEODOR and DANILA 1994). Results on the ecological aspects concening the epigeic fauna of carabidae in the potato, maize and clover crops, from Suceava county published: (VARVARA, DONESCU, DASCALU, 1999); VARVARA, BRUDEA, 1999, VARVARA, 1999, 2001). The purpose of this paper is to present a synthesis on the alpha diversity of epigeic ground beetles, the variation of their relative abundance, the Shannon index and evenness, the degree of similitude between sites according to Sörrensen's coefficient and to have a general view on the main ecological requirements, at the level of individuals and coenoses.

MATERIAL AND METHOD

The presentation of the work method has to detail the answers for three questions: **Where, when and how**.

Where and when. The material of carabids was collected from three types of agricultural ecosystems.Potato crops, maize crops and clover crops.

From the potato crop ecosystem, the material was collected from 5 sites: Zvorişteа (1993, 1995, 1998; Dragomirna (1995) and Vicovul de Jos (1998). From the maize crop ecosystem, the material was collected from one site for three years running: Suceava (1994, 1995, 1996). From the clover crop ecosystem , the material was collected from one site, for two years running: Suceava 1977, 1978.

How. As collecting method, pitfalls were used with preserving liquid and protection from precipitation. 12 pitfalls were used in each site.In this way, the collecting of material had a statistic, objective basis. The pitfalls functioned in ecosystems from May to September included of each year and locality. The collecting of carabids was made twice a month. Other details on the collecting method are to be found in our published papers (10, 11, 13).

For the characterization of the carabid coenoses (carabid communities) we have used the following parameters: relative abundance, ecological requirements (time of breeding, preference for humidity, biotope, food and geographical distribution), Shannon diversity index, evenness, Sörrensen's coefficient.

Nomenclature of the species was used according to FREUDE, HARDE, LOHSE 1974.

To characterize the coenoses of ground beetles from those three types of agricultural ecosystems, referring to breeding season, preferences for humidity, biotopes, food regime, geographical distribution, I used my personal observation in the field and information from the literature. (PETRUSENKO,C.B.1970), (PETRUSENKO, C.B and PETRUSENKO O. A. 1972), (TURIN and colab. 1991, 2003), (NECULISEANU 1991, 2003), (ŠUSTEK 2000). I also used some information and verifications received from ŠUSTEK and NECULISEANU 2003.

RESULTS OBTAINED

Relative abundance, alpha and gama diversity

Our data are expressed in tables (1-7) and histograms (2-6).

Table 1. Relative abundance of the species of carabidae in three types of agricultural ecosystems from Suceava county, Moldavia

	Name of species	1	2	3	4	5	6	7	8	9	10	Total
1	Cicindela germanica (L.)	-	2	-	21	-	3	2	-	-	9	37
2	Carabus cancellatus (Illig.)	-	40	4	-	-	-	-	-	-	-	44
3	C. granulatus (L.)	-	-	-	-	-	-	-	-	2	6	8
4	C. scabriusculus (Oliv.)	68	112	41	68	-	-	-	-	2	-	291
5	C. violaceus (L.)	-	-	6	1	38	-	-	-	61	20	126
6	C. variolosus (Creutzer)	-	-	-	-	1	-	-	-	-	-	1
7	C. excellens	-	-	-	-	-	2	-	-	-	-	2
8	Notiophilus palustris (Duft.)	-	-	-	-	2	-	-	-	-	-	2
9	Loricera pilicornis (F.)	-	-	-	-	1	1	-	-	-	8	10
10	Clivina fossor (L.)	3	6	-	6	-	-	-	-	-	-	15
11	Broscus cephalotes (L.)	-	106	-	1	-	-	1	-	-	2	110
12	Bembidion properans (Stephens)	-	-	-	4	5	-	-	-	-	-	9
13	B. lampros (Herbst)	53	2	-	5	-	-	-	-	-	-	60
14	B. quadrimaculatum (L.)	4	-	-	-	-	-	-	-	-	-	4
15	Asaphidion flavipes(L.)	-	-	-	-	1	-	-	-	-	-	1
16	Anisodactylus signatus (Panzer)	14	-	-	-	-	7	-	1	11	15	48
17	A. binotatus (F.)	-	-	-	-	-	-	-	-	6	4	10
18	A. poeciloides (Stephens)	-	-	-	-	-	-	-	-	-	2	2
19	Metophonus azureus F.	-	-	-	-	-	1	-	-	-	-	1
20	Pseudophonus rufipes (De Geer)	258	171	64	223	269	867	48	365	354	243	2862
21	P. griseus (Panzer)	-	1	-	4	3	6	7	-	3	14	38
	H. calceatus (Duft.)	-	-	-	-	-	-	-	-	-	2	2
22	Harpalus aeneus (F.)	6	-	1	6	2	24	2	3	9	4	57
	H. rubripes(Duft.)	-	-	-	-	-	-	-	-	-	2	2
24	H.distinguendus (Duft.)	-	-	-	-	-	-	-	-	3	2	5
25	H. latus (L.)	-	1	-	-	1	-	-	-	2	-	4
27	Acupalpus meridianus (L.)	-	-	-	10	-	-	-	-	-	-	10
28	Stomis pumicatus (Pz.)	-	1	-	6	-	-	-	-	-	-	7
29	Poecilus cupreus (L.)	742	108	159	358	20	106	46	61	461	1575	3636
30	Poecilus lepidus (Leske)	-	-	-	-	2	-	-	-	-	-	2
31	Pt. melanarius 9(Illig.)	13	700	231	61	495	247	21	138	1817	3918	7641
32	Pt. macer (Marsham)	-	-	-	3	-	-	-	-	-	-	3
33	Pt. nigrita (Payk.)	-	-	-	-	-	-	-	-	2	-	2
34	Pt. anthracinus (Illig.)	-	1	-	-	-	-	-	-	-	-	1
35	Pt. ovoideus (Sturm)	-	-	-	-	-	-	-	-	2	7	9
36	Abax carinatus (Duft.)	-	-	-	-	4	-	-	-	-	-	4
37	Calathus fuscipes (Goeze)	-	32	60	4	12	-	-	1	2	-	111
38	C. ambiguus (Payk.)	-	1	-	-	-	-	-	-	-	-	1
39	C. melanocephalus (L.)	-	1	-	1	1	-	-	-	-	2	5
40	Dolichus halensis (Schall.)	-	3	-	5	-	54	10	22	-	3	97
41	Agonum dorsalis (Pont.)	1	-	1	-	-	-	-	-	-	-	2
42	A.sexpunctatum (L.)	-	-	-	-	-	-	-	-	-	2	2
43	A. mülleri (Herbst)	-	-	-	1	-	-	-	-	-	-	1
44	A. moestum (Duft.)	-	-	-	2	1	-	-	-	-	-	3
45	Platynus assimilis (Payk.)	-	-	-	-	5	-	-	-	-	-	5
46	Zabrus tenebrioides (Goeze)	-	-	-	1	-	18	2	15	-	-	36
47	Amara equestris (Duft.)	-	-	-	-	-	-	-	-	2	-	2
48	A. aulica (Pz.)	-	-	-	-	4	4	-	-	-	-	8
49	A. apricaria (Payk.)	-	-	-	-	-	4	2	1	-	-	7
50	A. ovata (F.)	-	-	-	-	-	-	-	-	-	2	2
51	A. similata (Gyll.)	-	-	-	-	-	-	-	1	-	12	13
52	A. familiaris (Duft.)	-	-	-	1	-	-	-	-	-	2	3
53	Chlaenius vestitus (Payk.)	-	-	-	-	-	-	-	-	-	2	2
54	Ch. Nitidulus (Schrank)	-	-	-	-	8	-	-	-	-	-	8
55	Microlestes minutulus (Goeze)	-	-	-	10	-	-	-	-	-	-	10
56	Brachinus psophia (Serv.)	5	-	-	-	-	-	-	-	-	-	5
	Total species	**11**	**17**	**9**	**23**	**20**	**14**	**10**	**10**	**16**	**24**	
	Total individuals	1167	1288	567	802	875	1344	141	608	2739	5858	15389
	% of the total	7.58	8.37	3.68	5.21	5.69	8.73	0.92	3.95	17.80	38.07	100.00
	H	**1.61**	**2.18**	**2.16**	**2.40**	**1.76**	**1.69**	**2.35**	**1.66**	**1.48**	**1.28**	
	Evenness %	**46**	**53**	**68**	**53**	**40**	**44**	**70**	**50**	**37**	**28**	

Legend 1.Potatoes (Zvoriştea,1993); 2. Potatoes (Zvoriştea,1995);3.Potatoes (Zvoriştea, 1998) ; 4. Potatoes (Dragomirna,1995);5.Potatoes (Vicovul de Jos,1998);6. Maize (Suceava,1994);7.Maize (Suceava,1995);8.Maize (Suceava,1996);9. Clover (Suceava,1977);10.Clover (Suceava 1978).

α **diversity**.In the conditions of the agricultural ecosystems from Suceava county (in the north part of Romania), the α diversity ranged as follows: between **9 and 23** species in the potato crop ecosystem ; between **10 and 14** species in the maize crop ecosystem and between **16 and 24** species in the clover crop ecosystem

Shannon index. The values of the Shannon index within the agricultural ecosystems ranged as follows . between **1. 61 and 2. 40** (potatoes crop), **1. 66 – 2. 35** (maize crop) and **1. 28 –1. 48** (clover crop).

Evenness The **v**alues of this index for the agricultural ecosystems of the Suceava county ranged as follows**.** Between **40** % and **68** % (potatoes crop**)** ; between **44** % and **70 % (**maize crop**)** and between **28** % and **38** % **(** clover crop **)**

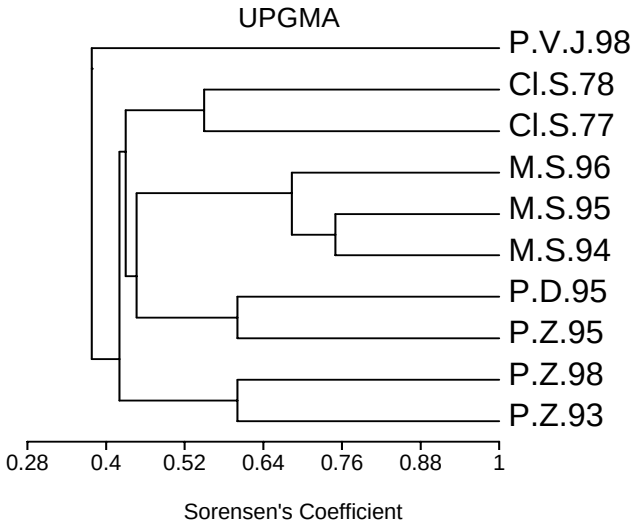

Fig. 1. Hierarchical dendrogram of the sites from which the material of carabids was collected

Legend: P.Z.93 (Potatoes, Zvoriştea,1993); P.Z.95 (Potatoes, Zvoriştea,1995); P.Z.98 (Potatoes, Zvoriştea, 1998); P.D.95 (Potatoes, Dragomirna,1995); P.V.J.98 (Potatoes, Vicovul de Jos,1998); M.S.94 (Maize, Suceava,1994); M.S. 95 (Maize, Suceava, 1995); M.S.96 (Maize, Suceava, 1996); Cl.S.77 (Clover, Suceava, 1977); Cl.S.78 (Clover, Suceava, 1978).

Table 2. Main ecological requirements of the species of Carabidae in three agricultural ecosystems from Suceava county, Moldavia

	Name of species	1	2	3	4	5
1	Cicindela germanica (L.)	Sp	M	St, Cr	Z	Wp
2	Carabus cancellatus (Illig.)	Sp	M	F	Z	Pl
3	C. granulatus (L.)	Sp	M-H	Eu	Z	Pl
4	C. scabriusculus (Olivier)	Sp	M	Ols	Z	E
5	C. violaceus (L.)	A	M-X	F	Z	Wp
6	C. variolosus (Creutzer)	Sp	H	F	Z	E
7	C. excellens	Sp	M-X	F	Z	EstE
8	Notiophilus palustris (Duftsch.)	Sp	M	Eu	Z	Wp
9	Loricera pilicornis (F.)	Sp	H	F	Z	Hl
10	Clivina fossor (L.)	Sp.	M	F,Rip	Z	Pl
11	Broscus cephalotes (L.)	Sp	X	St,Cr	Z	E
12	Bembidion lampros (Herbst)	Sp	M	Cr	Z	Hl
13	B. properans (Stephens)	Sp	M	Cr	Z	Hl
14	B. quadrimaculatum (L.)	Sp	M	Cr	Z	Hl
15	Asaphidion flavipes (L.)	Sp	M-H	Cr	Z	Wp
16	Anisodactylus signatus (Pz.)	Sp	M	Cr	P	Pl
17	A. binotatus (F.)	Sp	M	St	P	Wp
18	A. poeciloides (Stephens)	Sp	M	Cr	F	Em.
19	Metophonus azureus (F.)	A	M	Cr	Fit	Wp
20	Pseudophonus rufipes (De Geer)	A	M-X	Ols	P	Wp
21	P. griseus (Panzer)	A	M-X	Ols	P	Pl
22	Harpalus aeneus (F.)	Sp	M-X	Cr	P	Pl
23	H. calceatus (Duftsch.)	A	M-X	St	P	Pl
24	H.distinguendus (Duftsch.)	Sp,S	M	Ols	P	Pl
25	H. latus (L.)	A	M	F, St	P	Pl
26	H. rubripes (Duftsch.)	A	X	F	P	Wp
27	Acupalpus meridianus (L.)	Sp	M	Cr	P	E
28	Stomis pumicatus (Panzer)	Sp	M	F	Z	E
29	Poecilus cupreus (L.)	Sp	M	Cr	Z	Wp
30	P. lepidus (Leske)	A	M-X	Cr	Z	Es
31	Pterostichus macer (Marsham)	Sp	M	Cr	Z	Wp
32	Pt. melanarius (Illig.)	Sp	M	F,Cr	Z	Wp
33	Pt. nigrita (Paykull)	S	H	F,St	Z	Pl
34	Pt. anthracinus (Illig.)	Sp	H	F,St	Z	Es

35	Pt. ovoideus (Sturm)	Sp	M	F	Z	Ec
36	Abax carinatus (Duftsch.)	Sp	M	F	Z	E
37	Calathus fuscipes (Goeze)	A	M	Eu	P	Wp
38	C. ambiguus (Paykull)	A	M-X	St,Cr	P	Wp
39	C. melanocephalus (L.)	A, Sp	M	Eu	P	Pl
40	Dolichus halensis (Schaller)	A	M	Cr	P	Pl
41	Agonum dorsalis (Pontop.)	Sp	M-H	Cr	Z	Wp
42	Agonum sexpunctatum (L.)	Sp	M-H	Eu	Z	Pl
43	A.mülleri (Herbst)	Sp	M-H	Eu	Z	Pl
44	A.moestum (Duftsch.)	Sp	M-H	F	Z	Pl
45	Platynus assimilis (Paykull)	Sp	M-H	F	Z	Pl
46	Zabrus tenebrioides (Goeze)	A	M	Ols	F	Ec
47	Amara equestris (Duftschm.)	Sp	M	Cr	P	Wp
48	A. aulica (Panzer)	Sp	M	Cr	P	Wp
49	A. apricaria (Paykull)	Sp	M	Cr	P	Wp
50	A. ovata (F.)	Sp	M	F,Ols	P	Pl
51	A. similata (Gyllenhal)	Sp	M	F,St	P	Pl
52	A. familiaris (Duftschm.)	Sp	M	Cr	F	Wp
53	Chlaenius vestitus (Paykull)	Sp	H	Cr	Z	Wp
54	Ch. nitidulus (Schrank)	Sp	H	Rip	Z	Wp
55	Microlestes minutulus (Goeze)	Pl	X	Cr	Z	Pl
56	Brachinus psophia (Serv.)	Sp	M-h	F	Z	CE

1 = Breeding type; 2 = Humidity preference; 3 = Biotope preference; 4 = Food regime; 5 = Zoogeographical distribution

Legend: Sp = Spring; A = Autumnal; S = Summer; Pl = Plastic; M = Mesophilous; M-H = Mesohygrophilous; M-X =Mesoxerophilous; M-h = Meso-halophilous; H = Hygrophilous; F = Forest; St = Steppe; Eu = Eurytopi; Ols = Open landscape; Cr = Crops; Rip = Riparious; Cl = Clover; Z = Zoophag; P = Pantophag; Fi t= Phytophag, Wp = West Palaearctic; Pl = Palaearctic; E = European; Em = Euromediterranian; Ec = Eurocaucasian; Es= Eurosiberian; CE = Central European; EstE = East- European; SestE = South-East-European; Hl = Holarctic

Table 3. Types of breeding of the carabids in three types of agricultural ecosystems from Suceava county

	A	B	C	D	E	F	G
No.species	40	1	12	1	1	1	56
% of total	71.42	1.79	21.42	1.79	1.79	1.79	100.00

Legend: A= Spring; B = Summer ; C = Autumnal ; D = Spring-Summer ; E = Autumnal –Spring; F = Plastic; G = Total species

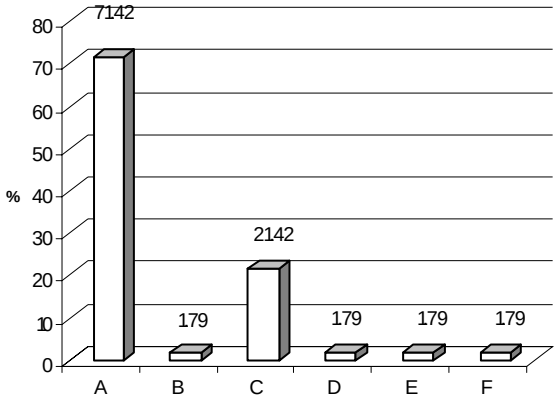

Fig. 2. Percentage representation of the breeding types of the carabids in three types of agricultural ecosystems from Suceava county (Legend in table 3).

Table 4. Moisture preferences of the species of carabids in three types of agricultural ecosystems from Suceava county, Moldavia

	A	B	C	D	E	F	G
No. species	6	31	7	8	1	3	56
% of total	10.71	55.36	12.50	14.29	1.79	5.35	100.00

Legend: A = Hygrophilous; B = Mesophilous ; C = .Mesohygrophilous; D = Mesoxerophilous; E = Mesohalophilous ; F =.Xerophilous; G =Total species

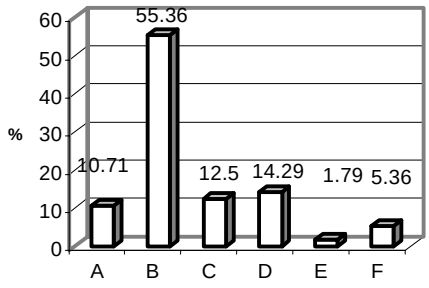

Fig. 3. Percentage representation of the moisture preferences of the carabids in three types of agricultural ecosystems from Suceava county. (Legend in table 4).

Table 5. Biotope preferences of the species of carabids in three types of agricultural ecosystems from the Suceava county, Moldavia

	A	B	C	D	E	F	G	H	I	J	K	L
No.species	12	4	1	1	1	20	2	3	5	1	6	56
% of total	21.42	7.14	1.79	1.79	1.79	35.71	3.57	5.36	8.93	1.79	10.71	100.00

Legend : A= Forest; B = Forest, steppe; C = Forest, crops; D = Forest, open land scape, E = Forest, riparious; F = Crops; G = Steppe; H = Steppe, crops ; I = Open landscape; J = Riparious; K = Eurytopic; L = Total species

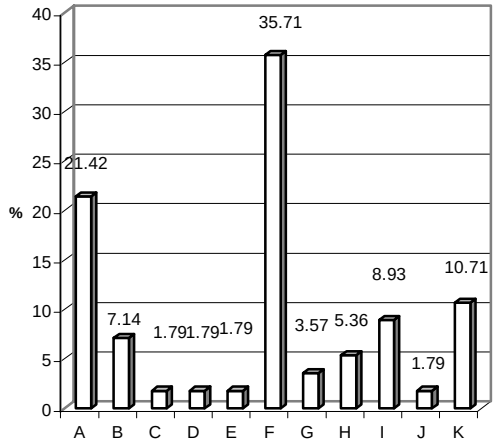

Fig. 4. Percentage representation of the general biotope preferences of the species of carabids in three types of agricultural ecosystems from Suceava county (legend in table 5)

Table 6. Trophic regime of the species of carabids in three types of agricultural ecosystems from Suceava county, Moldavia

	A	B	C	D
No of species	33	19	4	56
% of total	35.71	33.93	7.14	100.00

Legend: A = Zoophagous ; B = Pantophagous; C = Phytophagous; D = Total species

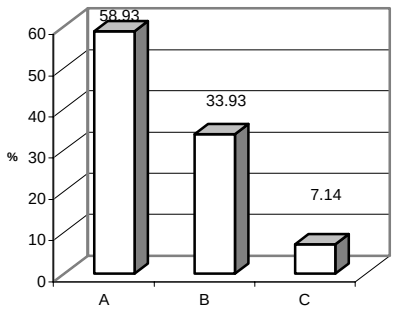

Fig. 5 . Percentage representation of the general trophic regime of the species of carabids in three types of agricultural ecosystems from Suceava county (Legend in table 6)

Table 7. Geographical distribution of the species of carabids in three types of agricultural ecosystems from Suceava, Moldavia

	A	B	C	D	E	F	G	H	I	J
No.species	20	19	4	6	1	1	1	2	2	56
% of total	35.71	33.93	7.14	10.71	1.79	1.79	1.79	3.57	3.57	100.00

Legend : A = Westpalaearctic; B = Palaearctic; C = Holarctic; D =.European; E=.Central European; F = East-European; G = Euromediterranean; H = Eurosibirian; I = Eurocaucasian; K = Total species

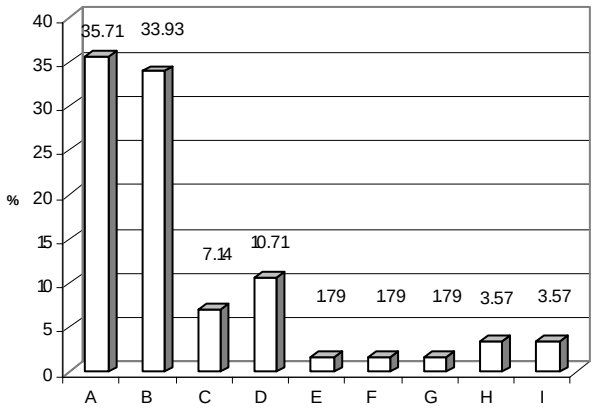

Fig. 6. Percentage representation of the general geographical distribution of the species of carabids in three types of agricultural ecosystems from Suceava county (Legend in table 7)

DISCUSSIONS

As it can be seen from the dendrogram, the potato crop from the locality Vicovul de Jos is distinctly separated from the other localities with agricultural ecosystems: Potato, maize and clover crops. The similarity degree between Vicovul de Jos and all the other localities was 37 %, according to Sörennsen's coefficient. The potato crop was placed near a forest. This explains the presence of the species *Abax carinatus* within the potato crop.The Shannon index had the value of 1.75 and evenness 40, because of two dominant species: *Pterostichus melanarius* and *Pseudophonus rufipes* whose individuals totalized 87.31 % of the whole number of individuals collected from that locality.

The fauna of Carabidae of the other localities is grouped into the fauna of clover crop, maize crop and potato crop. The similarity percentage between the fauna of Carabidae in those two localities with clover crop was 55 %. Another group is the fauna of carabidae from the maize crop. The similarity percentage ranged between 68 and 75 % percentage.The last group is formed by the localities with potato crop, that is four sites from which the material was collected for four years The similarity degree is 60 %.

Alpha diversity has varied between **9** and **23** species (potato crop); **10-14** (maize crop); **16** –**24** (clover crop).Gama diversity has been **40** species in the potato crop; **17** in the maize crop,and **29** in the clover crop. The different ecodiversity within these ecoystems may explain the different number of the alpha and gama diversity.

Of those 56 species of carabidae living in agricultural ecosystems , only three were found in all the localities. These species are in the order of their relative abundance:.*Pterostichus melanarius, Poecilus cupreus and Pseudophonus rufipes.*

The diversity and stability of a biocenosis is measured and shown by indexes of diversity. I calculated the value of the Shannon index because it is

widely used. In those three agricultural ecosystems, the lowest value of the Shannon index was **1. 28** in the clover crop, Suceava, 1978**,** and the highest value was **2.40** in the potato crop, Dragomirna, 1995. Though,in the clover crop, Suceava 1978, 24 species of carabidae were collected, the lowest value of the Shannon index was due to the evenness, which was 28 % because of the two species *Pterostichus melanarius* and *Pseudophonus rufipes*. The specimens of these two species totalised 5493, that is 93.77 % of the whole material collected. From our observation, in the agricultural ecosystems, the limits of the values of the Shasnnon index are lower in comparison with the forest ecosystems,within the same county Thus, in Suceva county, in forests, the lower limit of the index was **2.1**5 by comparison with **1.28** in agricultural ecosystems. In forests, the highest limit was **3.63** to **2.40** in crops

Life and the activity of the epigeic carabidae is strongly linked to the characteristics of ecosystems and the biological and ecological adaptations of the species. Taking into account the ecological requirements of species, I clasified the species according to their breeding type , moisture and biotope preferences, the food regime and geographical distribution Data and percentages are shown in tables and histogrames.

As for the breeding type, the species of carabidae within those three ecosystems have been put into five classes: Spring, summer, autumnal, spring summer, autumnal- spring and plastic species (table 3 and histogram 2)

Both in forest and agricultural ecosystems, the great majority of species are breeding in spring 70 % (forests) and 71 % (agroecosystems). The main ecological factors for this are temperature, food, competion, natural selection.The species breeding in autumn have much lower percentages. 21 % in agricultural ecosystems and 24 % in forest ecosystems. The species breeding in spring hiberrnate as adults.

Edaphic and atmosferic humidity is a very variable ecological factor. As concerns the humidity requirements, in the agricultural ecosystems, we have grouped the species of carabidae in five classes: Hygrophilous, mesophilous, mesohygrophilous, mesoxerophilous and xerophilous species. (table 4, histogram 3 show the percentages of these classes).

55 % of the species are mesophilous ones by comparison with 82 % in coniferous forests.(Varvara 2006, in press, Entomologica Romaniae).Neculiseanu , in an ample synthesis presented in his work, 2003, pg. 81, affirms that of those 505 species on the territory of the Republic of Moldavia, 45.7 % of species are mesophilous ones, being the most numerous group of species in the Republic of Moldavia.The percentages of the other classes of humidity, that is, meso-hygropilous, meso-xerophilous and xerophilous species are low in the forest ecosystems (Varvara, 2006. in press, Entomologica Romaniae) and higher in agricultural ecosystems.

For example, meso-hygrophilous species in the coniferous forests had a percentage of 4 % and 14 % in agroecosystems (histogram 3).

An important parameter of the population to survive in an ecosystem, as a result of the interactions with the abiotic and biotic factors , is the abundance, refelected in our collectings by the relative abundance. Biotopes and habitats by their objective ecological properties dictate the number of the individuals. In conformity with the prefered biotopes by the carabid species, we have grouped the species into 11 classes. *Forest species, forest and steppe species, forest and crop species, forest and open land scape species, forest,riparious species, crop species,steppe species, steppe and crop species, open land species, riparious species and plastic species*, according to quoted literature and personal observation. According to the law of tolerance, for each ecological factor, a population has its optimum number of individuals at the optimum of that ecological factor. (histogram 4). In the coniferous ecosystem from Suceava county, Ecologically,and based on our observation, a percentage of 70 % of the species are and prefer the coniferous forest ecosystem, 10 % of them live in crops and 10 % are eurytopic species. The last two groups of the species have small relative abundances, that is, they are subrecedent and recedent species (Varvara 2006, in press, Entomologica Romaniae).

Within the agricultural ecosystems from Suceava county, in conformity with our results, 35 % of the species live in crops, 21 % of them prefer the forest but in crops they have few individuals because they are not in their prefered biotope. 10 % of the species are eurytopic, like in coniferous forests from the same county.

Nourishment is a fundamental physiological process which provides energy to individual systems. From trophic point of view, there are two categories of species in coniferous forests: zoophagpous and pantophagous species, plus one, phytophagous species in agricultural crops as concerns the epigeic species. Thus, in forests, **82%** of the species of carabidae are zoophagous and **59 %** in crops. It results that this trophic group is dominant as it is more ample documented in the work of Neculiseanu. (3). In forests, **18** % from the ensemble of the species are pantophagous,and **34** % in crops, almost double by comparison with the coniferous forest. 7.14 % of the species in crops are phytophagous.On the territory of the Republic of Moldavia, six trophic groups were made evident: Zoophagous, phytophagous, mixo-zoophagous, mixo phytophagous, parasitoid, mixophagous- parasitoid. The group of zoophagous species represent 69 % of the known species, that is, it is dominant like in our observation. (Neculiseanu, 2003, pg. 88).

From zoogeographical point of view, the species of carabidae from the three crops belong to 9 zoogeographical units. These units are: Westpalaearctic, Palaearctic, Holarctic,European, Central-European, East-European, Euromediterranean,

Eurosibirian, Eurocaucasian. Of these 9 gropus, three are dominant, namely.About 35 % of the species are West Palaearctic species, 34 % are Palaearctic, and 11 % are European species In total, these groups include 80 % of the epigeic species,found in agricultural crops. In the coniferous forests from the same county, the same groups dominate, but in the following order: European species, 28 %, Palaearctic species 20 % and west palaearctic species 16 % (Varvara 2006, in press, Entomologica Romaniae). In the zoogeographical distribution of the species of Carabidae the three above mentioned groups are also dominant in the Republic of Moldavia. The west palaearctic, and Palearctic species are, in their majority, mesophilous and zoophagous species.

REZUMAT

Lucrarea prezentă este o lucrare de sinteză asupra speciilor de carabide epigee din trei ecosisteme agricole, ecosistemul culturii de cartofi, ecosistemul culturii de porumb şi ecosistemul culturii de trifoi din judeţul Suceava. Pentru colectarea materialului s-a folosit metoda clasică de colectare, câte 12 capcane Barber în fiecare stationar. Materialul s-a colectat din 10 staţionare (cinci staţionare pentru cultura de cartofi (1993, 1995, 1998) ; trei staţionare pentru cultura de porumb (Suceava, 1994, 1995, 1996); două staţionare pentru cultura de trifoi (Suceva 1977,1978) în total, 10 sezoane de colectare.

Alfa diversitatea a variat între **9 şi 23** specii în ecosistemul culturii de cartofi; între **10 şi 14** specii în ecosistemul culturii de porumb şi între **16 şi 24** specii în ecosistemul culturii de trifoi. Gama diversitatea a avut următoarele valori: 40 specii în cultura de cartofi,17 specii în cultura de porumb,29 specii în cultura de trifoi. Gama diversitatea este numărul total de specii apartinand unui taxon (familie) din aceiasi biocenoză, dar colectate în ani şi localităţi diferite.

Indicele Shannon a avut valori între **1, 61 şi 2, 40** (cultura de cartofi), **1, 66 - 2, 35** (cultura de porumb) si **1, 28 -1,48** (cultura de trifoi). In cultura de trifoi, limitele de variaţie ale indexului Shannon sunt sub minima normală de variaţie a indicelui (1,50 – 3,50). Echitabilitatea a avut valori între **40 % şi 68 %** (cultura de cartofi) , între **44 % şi 70** % (cultura de porumb) şi între **28 % şi 38 %** (cultura de trifoi) din cauza dominanţei foarte ridicate a două specii: *Pterostichus melanarius si Pseudophonus rufipes*.

Cenozele de carabide din cele trei tipuri de ecosisteme, în ce priveşte principalele cerinţe ecologice, se caraterizează prin predominarea speciilor cu reproducere în primăvara, mezofile, cu preferinţe pentru biotopul de pădure (dar cu indivizi mai putiini în culturile agricole), zoofage, distribuite preponderent geografic în Palearctic, vest Palearctic, europene. Observatiile noastre ecologice asupra speciilor de carabidae epigee din ecosistemele forestiere şi agricole din judeţul Suceava se încadrează şi confirmă rezultatele ecologice de ansamblu obtinute în Republica Moldova de Neculiseanu Zaharia, in teza sa de doctor habilitat, 2003.

CONCLUSIONS

In Suceava county, alpha diversity of epigeic ground beetles has ranged between 9 and 23 species (potato crop), 10- 14 (maize crop), 16 – 24 (clover crop). Gama diversity has had the following values: 40 (potato crop), 17 (maize crop), 29 (clover crop). The species of carabidae common in all the agricultural crops with big number of individuals are: *Pterostichus melanarius*, *Poecilus cupreus and Pseudophonus rufipes.* The first two species are zoophagous and the last one is pantophagous.

The values of the Shannon index have been: 1.61-2.40 (potato crops), 1.66 – 2.35 (maize crops), 1.28 -1.48 (clover crop).

70 % of the species have their breeding season în Spring and 21 % in Autumn

55 % of the species are mesophilous and the mesoxerophilous,mesohigrophilous and hygrophilous species have percentage under 15 %.

The preference of the species for suitable biotope in the agricultural ecosystems is more variable, being identified 11 groups, of which 36 % of species prefer crops, 21 % prefer forests, 11 % are eurytopic. These groups represent 68 % of species.

59 % of species are zoophagous, 34 % pantophgous and 7 % are phytophagous.

From Zoogeographical point of view, 36 % of species are Palaearctic, 34 % westpalaearctic and 11 % European.

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REFERENCES

1. BURMEISTER FRITZ, 1939 - Biologie, Ökologie und Verbreitung der europäischen Käfer. Adephaga.Caraboidea, Hans Goecke Verlag, Krefeld.
2. FREUDE UND COLL., 1974 - Die Käfer Mitteleuropas, Band 2, Adephaga, Goecke and Evers, Krefeld.
3. NECULISEANU, ZAHARIA., 1991 - Obzor faunâ jujeliţ (Carabidae,) Moldovâ. Izvestia

Akademii Nauk CCR Moldova, biologiceskie i himiceskie nauki, 2, 37-42
4. NECULISEANU ZAHARIA., 2003 - Carabidele (Coleoptera, Carabidae) din zona de interferenţă biogeografică (Taxonomie, diversitate, zoogeografie, biologie şi importanţă practică), Chişinău, manuscris.
5. PETRUSENKO C.B.,1970 - Jujeliti na posivax zernovix kultur v umovax Krimskoi oblasti.Zahist Roslin, 11, p.52-57
6. PETRUSENKO O A., PETRUSENKO, C.B.,1972 - Do vivcenia jujeliti risovix poliv Ukraini, Zahist Roslin, 15, p.3-8
7. TURIN H., and collab. 1991 - Ecological characterization of carabid species (Coleoptera, Carabidae) in the Netherlands from thirty years of pitfall sampling. Tijdschrift voor Entomologie, Volume 34, p. 279-301.
8. TURIN H., PENEY L., CASALE A.(editors), 2003 - The genus Carabus in Europe, a synthesis, Pensoft, Sofia-Moscow .
9. ŠUSTEK ZBYŠEK, 2000 - Carabid beetles-their significance for bioindication of the landscape hydrological regmen.In VIIITh International poster Day Transport of Water, Chemicals and Energy in the System Soil-Crop Canopy-Atmosphere, Bratislava, p. 1-13.
10. ŠUSTEK ZBYŠEK, 2001 - Seasonal changes in distribution of ground beetles (Coleoptera, Carabidae) along a discontinous seminatural windbreak. Ekologicke Site, p. 143-148, Brne.
11. URSACHI RAMONA 1999 - Structura taxonomică şi dinamica artropodelor epigee din cultura de cartofi, Vicovul de Jos, Judeţul Suceava. Lucrare de licenţă, Facultatea de Biologie, Iaşi.
12. VARVARA MIRCEA, 2004 - Variation of the species diversity of Carabidae (Coleoptera, Carabidae) in two vegetal associations in the Bârnova Forest, Iasi (East of Romania), An. St. Univ. "Al.I.Cuza"Iaşi, s. Biologie animală, Tom L, pg.117-139.
13. VARVARA MIRCEA, DONESCU DANIELA, DASCALU ALEXANDRU - 1999, Coenological observations on the populations of Carabidae (Insecta, coleoptera) from some potato crops from Moldavia. An. St. Univ. Iaşi, Tom 44-45,p.105-116
14. VARVARA MIRCEA, BRUDEA VALENTIN, 1999 - The structure and distribution of the carabid communities in the maize crops from Moldavia,In Univ, Bacău, Studii şi Com. St.p.79-84
15. VARVARA MIRCEA**,** 2001 **-** Observations on the carabid coenosis (Coleoptera,Carabidae) in the potato crops from Suceava district**.** Simpozionul Jubiliar Consacrat Aniversării a 30 de ani de la Formarea Rezervaţiei (Codrii", Vol II, 27-28, Sept. Chisinău p.78-79
16. VARVARA MIRCEA, 2001 -Variation of diversity of Carabidae (Coleptera, Carabidae) in some potato crops from Romania **.**An. St. Univ."Alex. I. Cuza", Iaşi, Tom XLVII, p.53-63
17. VARVARA MIRCEA 2006 **-** Diversity and the main ecological requirements of the epigeic species of Carabidae (Coleoptera, Carabidae) from two types of forest ecosystems in Suceava County (Moldavia) In press, Entomologica Romaniae.

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