COMPOSITION AND THE STRUCTURE OF ECOLOGICAL REQUIREMENTS OF THE SPECIES OF CARABIDAE (COLEOPTERA: CARABIDAE) IN THE MAIZE CROP ECOSYSTEM FROM MOLDAVIA, 1984 – 2000

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Abstract. *The present paper deals with the specific diversity of the epigeic ground beetles from the maize crop ecosystem from Moldavia (1984-2000). It presents the variation of the alpha diversity of the ground beetles, the variation of the relative abundance and diversity of the coenosis, evenness, and the main ecological requirements of the species, the general characteristics of the coenosis of ground beetles as concerns the classes of ecological requirements, reproduction, moisture, biotopes, food and geographical distribution.*

Keywords: *Maize crop, Carabidae, alpha diversity, gama diversity, relative abundance, dominance, diversity, main ecological requirements.*

Rezumat. Compoziţia si structura cerinţelor ecologice ale speciilor de carabide (Coleoptera: Carabidae) în ecosistemul culturii de porumb din Moldova, 1984–2000. *Lucrarea include unele aspecte ecologice asupra speciilor de carabide epigee colectate din 13 localităţi ale ecosistemul culturii de porumb din Moldova: Braila, 1984, (judeţul Brăila); Osoi, 1986; Osoi, 1988; Osoi, 1989, (judeţul Iaşi); Pogana, 1989; Negreşti, 1997, (judeţul Vaslui); Săbăoani, 1999; Secuieni, 1990, Tg. Neamţ, 1998, (judeţul Neamţ); Suceava, 1994; Suceava, 1995; Suceava, 1996, (judeţul Suceava); Cherchezeni, 2000, (judeţul Botoşani). Pentru colectarea speciilor s-au folosit câte 12 capcane în fiecare localitate (staţionar) în intervalul de ani,1984-2000, extrăgându-se, în total, 7.211 indivizi care aparţin la 15 subfamilii, 24 genuri şi 55 de specii de Carabidae. Principalele subfamilii, cu abundenţă numerică, sunt: Harpalinae, 65,37%, Pterostichinae, 23,67% şi Carabinae 7.02% (in special datorită speciei Carabus scabriusculus (OLIVIER, 1795), abundentă în staţionarele Săbăoani şi Târgul Neamţ. Speciile abundente numeric sunt: Pseudophonus rufipes (DE GEER, 1774), a cărui abundenţă relativă numerică pe staţionare a variat intre 5 (Osoi, 1988) şi 867 (Suceava, 1994), Poecilus cupreuis LINNE, 1758, mai abundent pe solurile mezofile, Pterostichus melanarius (ILLIGER, 1798), abundent numeric în nordul judeţelor Suceava şi Botoşani. Variaţia numerică a Alfei diversitate a fost cuprinsă între 8 şi 21 specii, iar gama diversitate (colectarea carabidelor din acelaşi fel de cultură, dar localităţi diferite) a fost de 55 de specii. Media valorilor diversităţii a fost 1,50 (limite: 0,49-2,07), iar media valorilor echitabilităţii a fost 0,36 (limite: 0,12-0,72). Principalele cerinţe ecologice (reproducere, preferinţă faţă de umiditate, biotopi, hrană, răspândire geografică ale cenozei de carabide în ecosistemul culturii de porumb din Moldova se caracterizează prin predominarea speciilor cu reproducere în primăvara (69,09%), mezofile, (60%), cu preferinţe pentru biotopii stepe-culturi (27,27),culturi (27,27%), zoofage (52,73%), pantofage (38,18%), distribuite preponderent zoogeografic: Vest-Palearctice (38,18%) şi Palearctice (21,82%).*

Cuvinte cheie: *cultura de porumb, Carabidae, alfa diversitate, gama diversitate, abundenţă relativă, dominanţă, diversitate, cerinţe ecologice.*

INTRODUCTION

Maize, wheat and potato are the main crops for the food of people in Moldavia. Zoocoenoses in agricultural crops are determined by an assemblage of abiotic and biotic factors in interaction with the respective monocrops (wheat, maize, potato, lucerne etc.)

According to KROMP (1989) "Carabid beetles communities of agroecosystems are well researched (mainly in Europe) in general (literature cited in THIELE, 1977)". "The occurrence of carabids in agriculture and their role in the suppression of insect pests have been well documented (THIELE, 1977; LUFF, 1983, 1987; NYFFELER and BENZ, 1987 "quoted according to BROIJ, NOORLANDER, 1992, p. 125). A very well documented and synthetic paper about the effects of agricultural practices on Carabidae in temperate agroecosystems was published in Integrated Pest Management Reviews 5, p 109-129, 2000.

Researches on the composition of the fauna of Carabidae in the maize crop were carried out by CASANDROVA and HMYROVAT (1982) and CARPOVA (1984) on dynamics.

On the line of ecological researches in Moldavia, VARVARA and collaborators published papers referring to the taxonomic and ecological structure (species, genera, subfamilies, relative abundance, the structure of dominance) on the coenoses of Carabidae in agricultural ecosystems (winter wheat, maize, potatoes, sugar beet crop, clover crop) (VARVARA and coll. 1984, 1993); VARVARA & CARLAN 1999; VARVARA et al., 1999; VARVARA & BRUDEA, 1999; VARVARA, 2001; VARVARA & BULIMAR, 2002; VARVARA, 2005; TURCULET, VARVARA, 2006, VARVARA & GALUSCA, 2007 (in press), VARVARA & APOSTOL, 2008 (in press).

The present paper has the purpose of knowing synthetically the taxonomic composition of the family of Carabidae, the diversity and the variation of the relative abundance of the species in different years in the specific ecological context of the maize crops and the characterization of the coenosis of Carabidae referring to reproduction, moisture, preference for biotops, food and zoogeographical distribution.

MATERIAL AND WORKING METHODS

The species of Carabidae and their individuals were collected from 13 sites with maize crops of Moldavia: Brăila, 1984 (Brăila County); Osoi, 1986; Osoi, 1988; Osoi, 1989 (Iaşi County); Pogana, 1989; Negreşti, 1997, (Vaslui County); Săbăoani, 1999; Secuieni, 1990, Tg. Neamț, 1998 (Neamț County); Suceava, 1994; Suceava, 1995; Suceava, 1996 (Suceava County); Cherchezeni, 2000 (Botoşani County).

The soil pitfall traps method is the most used for the purpose of faunal, taxonomic and ecological samplings because the pitfalls function continuously a delimited period of time and the pitfall traps can be used simultaneously in several sites.

The pitfalls were used with preserving liquid being protected from precipitation: 12 pitfalls were used in each site, the optimum number for the collection of material on a statistic basis. The pitfalls were functional from May to September in each site and in each year. The collection of the ground beetles was made twice a month.

We used as pitfalls, canisters of 800 millilitres -1 litre capacity, 12 cm in diameter and 10 cm in height. The pitfalls were placed in a relevant surface for the respective site, arranged on three rows, each row containing four soil pitfalls. The distance between rows and pitfalls was 5-6 metres. As preservation liquid a solution of 3 % formol was used, which assured a good preservation of the individuals till their sampling.

Diversity was calculated through species richness (S), Shannon Index (H) and relative diversity (Hrel). The Shannon index formula is $H=-\Sigma\ p_i\ ln(p_i)$ where p_i-decimal fraction of the i species individuals (COX, 1996). Using the value of H one can calculate the relative diversity, which reveals how different is the studied community, compared to an ideal equitable community. The relative diversity formula is Hrel=H/Hmax (Hrel value is between 0 – 1), where Hmax =ln(S) or the value of H calculated with the same number of species, but equal p_i values (COX, 1996). Another way to assess diversity was by performing the SHE analysis (S = species richness, H = Shannon index diversity, E = evenness). This technique (BUZAS & HAYEK, 1996; HAYEK & BUZAS, 1998) allows the independent and yet simultaneous evaluation of the species richness and evenness contributions to the community diversity. The diversity measures used in SHE analysis are the above-mentioned S and H together with BUZAS and GIBSON'S evenness (E) which was calculated with the equation $E = e^H/S$,where e is the natural logarithm base. The advantage of this formula is that H can be decomposed as the sum of ln(S)+ln(E) (e^H=SE so H=ln(S)+ln(E)). Furthermore, because E≤1, ln(E) will be a negative number. Therefore, H diversity equals its maximum value, ln(S), minus the amount of evenness, ln(E) (LEPONCE et al., 2004; SMALL & MCCARTHY, 2002).

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

To characterize the coenoses of ground beetles from those crops mentioned above, referring to reproduction season, preferences for moisture, biotopes, food regime, geographical distribution, we used our personal observations in the field and information from the literature, (TURIN et al., 1991), (NECULISEANU, 2003), (ŠUSTEK, 2000). We also used some information and verifications received from ŠUSTEK & NECULISEANU, 2003.

RESULTS OBTAINED

Synthetic results are expressed in tables and figures.

Table 1. General table of Subfamilies of the family Carabidae, their relative abundance and dominance in the maize crop ecosystem, Moldavia, 1984-2000.
Tabel 1. Tabel general al subfamiliilor familiei Carabidae, abundența lor relativă si dominanța în ecosistemul culturii de porumb, Moldova, 1984-2000.

	Name of the subfamilies	Relative abundance	%
1	Cicindelinae	45	0.62
2	**Carabinae**	**506**	**7.02**
3	Nebriinae	3	0.04
4	Loricerinae	1	0.01
5	Scaritinae	26	0.36
6	Broscinae	1	0.01
7	Bembidiine	13	0.18
8	Anisodactylinae	48	0.67
9	**Harpalinae**	**4714**	**65.37**
10	Stenolophinae	5	0.07
11	**Pterostichinae**	**1714**	**23.77**
12	Zabrinae	81	1.12
13	Callistinae	1	0.01
14	Zuphiinae	1	0.01
15	Brachininae	52	0.72
	Total	7211	99.98

From the maize crop ecosystem in Moldavia, 15 subfamilies of Carabidae were found. The well represented subfamilies, as species and individuals, are: Harpalinae (4,714 individuals, that is 65.37%), Pterostichinae (1,714,

23.77%) and Carabinae (506 specimens, 7.02%). 11 subfamilies (73.33%) have percentages below 0. The subfamily Zabrinae had a percentage of 1.12

Table 2. Diversity descriptors of the Carabidae communities from 13 maize crop sites (**H**-Sahnnon diversity index, **Hre**l-relative diversity, **E**-evenness, **S**-species richness.
Tabel 2. Descriptorii diversităţii comunităţilor (cenozelor) de Carabidae din 13 localităţi de culturi cu porumb (H-Indicele de diversitate Shannon, Hrel.-diversitatea relativă, E-echitabilitatea, S-numărul de specii.

Sample	H	Hrel	E	S	Ln(E)	ln(S)
Negreşti, 1997	0.49	0.191	0.12	13	-2.075	2.565
Suceava, 1996	1.15	0.501	0.31	10	-1.150	2.303
Suceava, 1994	1.17	0.445	0.23	14	-1.466	2.639
Cherchezeni, 2000	1.27	0.469	0.23	15	-1.438	2.708
Secuieni, 1990	1.34	0.647	0.48	8	-0.734	2.079
Pogana, 1989	1.51	0.592	0.35	13	-1.047	2.565
Brăila, 1984	1.52	0.501	0.21	21	-1.519	3.045
Săbăoani, 1999	1.60	0.547	0.26	19	-1.335	2.944
Suceava, 1995	1.66	0.692	0.47	11	-0.738	2.398
Osoi, 1989	1.84	0.698	0.45	14	-0.798	2.639
Osoi, 1986	1.91	0.689	0.42	16	-0.863	2.773
Tg. Neamt, 1998	2.01	0.745	0.50	15	-0.690	2.708
Osoi, 1988	2.07	0.865	0.72	11	-0.323	2.398

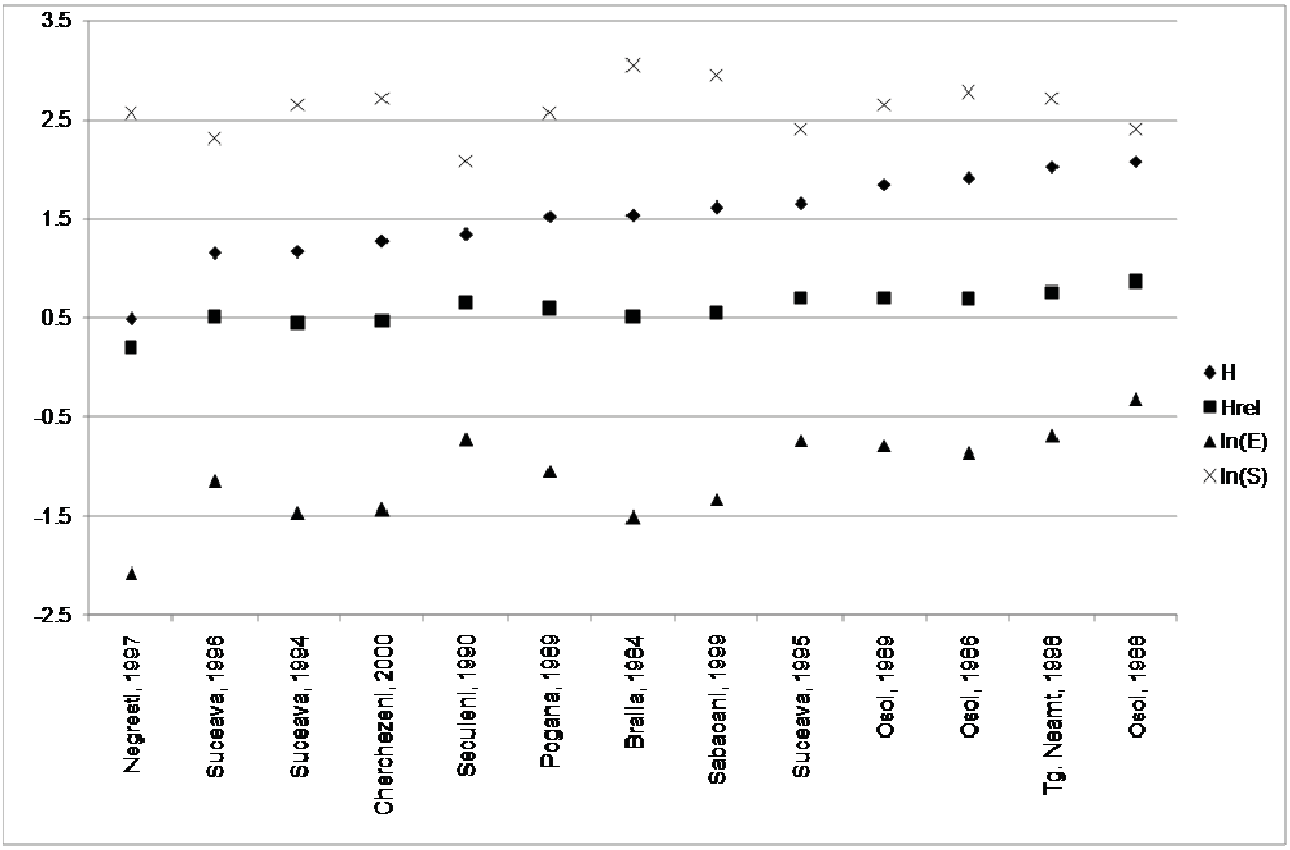

Fig. 1. SHE analysis of the Carabidae communities from 13 maize crop ecosystems (H – Sahnnon index, **Hrel** – relative diversity, **E** – evenness, **S** – species richness).
Fig. 1. Analiza SHE–ului comunităţilor (cenozelor) de Carabidae din 13 localităţi ale ecosistemului culturii de porumb (H – Indice Sahnnon, **Hrel** – diversitatea relativă, **E** – echitabilitate, **S** – numărul de specii (bogăţia de specii).

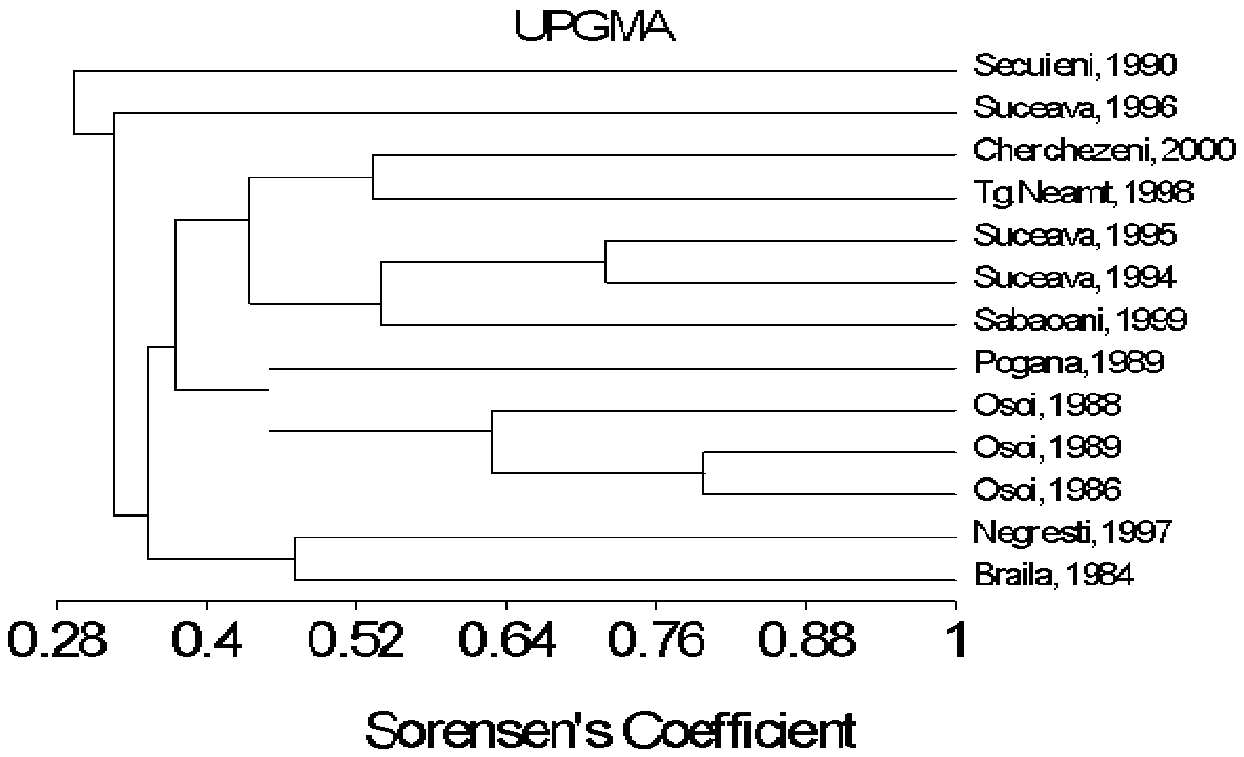

Fig. 2. Similarity of the sampling sites based on carabidae species presence.
Fig. 2. Gradul de asemănare al localităților de colectare pe baza prezenței speciilor de carabide.

Table 3. The variation of the number of species and individuals in the carabids collected from the maize crop ecosystem, Moldavia, 1984- 2000.
Tabel 3. Variația numărului de specii si indivizi la carabidele colectate din ecosistemul culturii de porumb, Moldova, 1984-2000.
Legend: **1**. Braila, 1984; **2**. Osoi, 1986; **3**. Osoi, 1988; **4**. Osoi, 1989; **5**. Pogana, 1989; **6**. Negresti, 1997; **7**. Săbăoani, 1999; **8**. Secuieni, 1990, **9** .Tg. Neamț, 1998; **10**. Suceava, 1994; **11**. Suceava, 1995; **12.** Suceava, 1996; **13**. Cherchezeni, 2000.

Legenda: **1**. Braila, 1984; **2**. Osoi, 1986; **3**. Osoi, 1988; **4**. Osoi, 1989; **5**. Pogana, 1989; **6**. Negresti, 1997; **7**. Săbăoani, 1999; **8**. Secuieni, 1990**, 9**. Tg. Neamț, 1998; **10**. Suceava. 1994; **11**. Suceava, 1995; **12.** Suceava, 1996; **13**. Cherchezeni, 2000.

	Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**T**	**%**
1	*Cicindela germanica*	3	-	-	-	-	20	10	7	-	3	2	-	-	45	0.62
2	*Calosoma auropunctatum*	3	-	1	-	-	-	-	-	-	-	-	-	-	4	0.06
3	*Carabus scabriusculus*	-	-	-	-	1	-	237	-	174	-	-	-	-	412	5.71
4	*C.excelens*	-	-	-	-	-	-	-	-	78	2	-	-	-	80	1.11
5	*C.besseri*	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.01
6	*C.violaceus*	-	-	-	-	-	-	-	-	9	-	-	-	-	9	0.12
7	*Nebria brevicollis*	-	-	-	-	-	-	3	-	-	-	-	-	-	3	0.04
8	*Loricera pilicornis*	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.01
9	*Clivina fossor*	5	-	-	-	-	1	-	-	18	-	-	-	-	24	0.33
10	*C. contracta*	2	-	-	-	-	-	-	-	-	-	-	-	-	2	0.03
11	*Broscus cephalotes*	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.01
12	*Bembidion lampros*	3	-	-	-	-	-	-	2	-	-	-	-	-	5	0.07
13	*B.properans*	4	-	-	-	-	-	-	-	-	-	-	-	-	4	0.06
14	*B.quadrimaculatum*	-	1	-	-	-	-	-	3	-	-	-	-	-	4	0.06
15	*Anisodactylus signatus*	6	5	4	2	1	2	20	-	-	7	-	1	-	48	0.67
16	*Pseudophonus rufipes*	227	134	5	43	60	726	536	104	281	867	48	365	412	3808	52.81
17	*P. griseus*	-	-	-	7	7	-	2	-	-	6	7	-	6	35	0.49
18	*Ophonus sabulicola*	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.01
19	*Metophonus azuresus*	-	-	1	-	-	-	-	-	-	1	-	-	-	2	0.03

	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	T	%
20	*M. punctatulus*	-	-	-	-	4	-	-	-	-	-	-	-	1	5	0.07
21	*M. rupicola*	-	43	4	181	-	-	-	-	-	-	-	-	-	228	3.16
22	*M . rufibarbis*	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.01
23	*Harpalus distinguendus*	7	7	2	29	76	11	163	-	14	-	-	-	47	356	4.94
24	*H. aeneus*	7	28	-	6	2	-	11	-	30	24	2	3	4	117	1.62
25	*H. cupreus*	-	9	-	1	-	-	-	62	-	-	-	61	-	133	1.84
26	*H. calceatus*	-	-	-	-	2	-	5	-	-	-	-	-	-	7	0.10
27	*H. latus*	-	-	-	-	18	-	-	-	-	-	-	-	-	18	0.25
28	*H. tardus*	-	-	-	-	-	2	-	-	-	-	-	-	-	2	0.03
29	*H . rubripes*	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.01
30	*Acupalpus meridianus*	4	-	1	-	-	-	-	-	-	-	-	-	-	5	0.07
31	*Poecilus cupreus*	29	95	1	24	-	7	26	-	117	106	46	-	33	484	6.71
32	*P. versicolor*	-	7	-	-	-	-	1	18	-	-	1	-	-	27	0.37
33	*P. sericeus*	3	-	-	1	-	3	-	-	-	-	-	-	-	7	0.10
34	*P. lepidus*	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.01
35	*P. striatopunctatus*	-	-	-	-	-	-	-	-	-	-	-	-	2	2	0.03
36	*Pterostichus strenuus*	-	3	10	53	-	-	-	-	-	-	-	-	1	67	0.93
37	*Pt. macer*	3	50	6	34	-	5	-	-	-	-	-	-	13	111	1.54
38	*Pt. melanarius*	9	2	-	1	-	-	59	2	188	247	21	138	98	765	10.61
39	*Pt. ovoideus*	-	-	-	-	-	-	-	-	13	-	-	-	-	13	0.18
40	*Pt. anthracinus*	-	-	-	-	-	-	-	-	-	-	-	-	4	4	0.06
41	*Dolichus halensis*	19	-	-	-	-	-	6	12	9	54	10	22	-	132	1.83
42	*Calathus fuscipes*	-	-	-	-	-	4	37	-	29	-	-	1	2	73	1.01
43	*C. ambiguus*	-	-	-	-	-	5	-	-	2	-	-	-	1	8	0.11
44	*Idiochroma dorsalis*	-	-	-	-	5	-	4	-	11	-	-	-	-	20	0.28
45	*Zabrus tenebrioides*	1	-	-	-	-	7	-	-	-	18	2	15	-	43	0.60
46	*Amara equestris*	-	-	-	-	-	3	-	-	-	-	-	-	-	3	0.04
47	*A. aulica*	-	9	1	8	-	-	1	-	-	4	-	-	-	23	0.32
48	*A. apricaria*	-	-	-	-	-	-	-	-	-	4	2	1	-	7	0.10
49	*A. similata*	-	-	-	-	-	-	2	-	-	-	-	1	-	3	0.04
50	*A. aenea*	2	-	-	-	-	-	-	-	-	-	-	-	-	2	0.03
51	*Chlaenius nitidulus*	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.01
52	*Polystichus connexus*	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.01
53	*Brachinus crepitans*	1	-	-	-	-	-	-	-	5	-	-	-	16	22	0.31
54	*B. explodens*	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.01
55	*B. psophia Serv.*	7	3	-	18	1	-	-	-	-	-	-	-	-	29	0.40
	Total species	21	16	11	14	13	13	19	8	15	14	11	10	15		
	Total individuals	346	398	36	408	179	796	1125	210	978	1344	142	608	641	7211	
	% of the total individuals	4.80	5.52	0.50	5.66	2.48	11.04	15.60	2.91	13.56	18.64	1.97	8.43	8.89		

In total, 7,211 individuals were collected, belonging to 15 subfamilies, 24 genera and 55 species of Carabidae. Of these 43 species (78.18%) have their relative abundance below 0. Comparatively, the total percentage of the collected carabids in each site as compared to the total number of carabids collected varied between 0.50% (Osoi, 1988) and 18.64% (Suceava, 1994) (Table 3).

Table 4. Main ecological requirements of the species of Carabidae in the maize crop ecosystem, in Moldavia.
Tabel 4. Principalele cerințe ecologice ale speciilor de Carabidae în ecosistemul culturii de porumb in Moldova.
Legend: **1.** Reproduction type; **2.** Moisture preference; **3.** Biotope preference; **4.** Food regime; **5.** Zoogeographical distribution. **Sp.** Spring; **A**. Autumnal; **S**. Summer; **M**. Mesophilous; **X.** Xerophilous; **H.** Hygrophilous; **h.** halophilous; **F**. Forest; **St.** Steppe; **Eu.** Eurytopic; **Cr** Crops; **Ols.** Open landscape; **Rip**. Riparian **Z.** Zoophagous; **P**. Pantophagous; **Fit** Phytophagous; **Hl**. Holarctic; **WP**. West-Palaearctic; **Pl**. Palaearctic; **E.** European**; EstE**. East European; Emd. Euro- mediterranian; Ec Euro-caucasian; Es. Euro-siberian; Cirmd. Circum-mediterranean.
Legenda: **1.** Tipul de reproducere; **2.** Preferința față de umiditate; **3.** Preferința față de biotop; **4**. Regimul de hrană; **5**. Distribuția (răspândirea) zoogeografică. **Sp.** Primăvara; **A**. Toamna; **S**. Vara; **M**. Mezofilă; **X.** Xerofilă; **H.** Hygrofilă; **h.** halofilă; **F**.Pădure; **St.** Stepă; **Eu.** Eurytopic; **Cr** Culturi; **Ols**.Peisaj deschis; **Rip**. Ripicol **Z.** Zoofag; **P**. Pantofag; **Fit** Fitofag; **Hl**. Holarctic; **WP**. Vest-Palaearctic; **Pl**. Palaearctic; **E.** European**; EstE**. Est european; Emd. Euro- mediteranian; Ec Euro-caucasian; Es. Euro-siberian; Cirmd. Circum-mediteranean.

	Species	1	2	3	4	5
1	*Cicindela germanic*a (LINNE, 1758)	Sp	M	St, Cr	Z	Wp
2	*Calosoma auropunctatum* (HERBST, 1784)	Sp	M	St, Cr	Z	Wp
3	*Carabus scabriusculus* (OLIVIER, 1795)	Sp	M-X	St, Cr	Z	EstE
4	*C. excellens* (FABRICIUS, 1798)	Sp	M-X	F, Cr	Z	EstE
5	*C. besseri* (FISCHER von WALDHEIM, 1822)	A	M-X	St, Cr	Z	EstE
6	*C. violaceus andrzejuscii* (FISCHER, 1823)	A	M-X	St, Cr	Z	Wp
7	*Nebria brevicollis* (FABRICIUS, 1792)	A	M	Eu	Z	Ec
8	*Loricera pilicornis* (FABRICIUS, 1775)	Sp	H	F	Z	Hl
9	*Clivina fossor* (LINNE, 1758)	Sp	M	Rip.	Z	Pl
10	*C. contracta* (FOURCROY, 1785)	Sp	M	St	Z	Ec
11	*Broscus cephalotes* (LINNE, 1758)	Sp	X	St, Cr	Z	E
12	*Bembidion lampros* (HERBST, 1784)	Sp	M	Cr	Z	Hl
13	*B. properans* (STEPHENS, 1829)	Sp	M	Cr	Z	Hl
14	*B. quadrimaculatum* (LINNE, 1761)	Sp	M	Cr	Z	Hl
15	*Anisodactylus signatus* (PANZER, 1797)	Sp	M	Cr	P	Pl
16	*Pseudophonus rufipes* (DE GEER, 1774)	A	M-X	Ols	P	Wp
17	*P. griseus* (PANZER, 1797)	A	M-X	Ols	P	Pl
!8	*Ophonus sabulicola* (PANZER, 1796)	A	M	St,Cr	P	Es
19	*Metophonus azureus* (FABRICIUS, 1775)	A	M	St,Cr	Fit	Wp
20	*M. punctatulus* (DUFTSCHMID,1812)	A	X	St	Fit	Wp
21	*M. rupicola* (STURM, 1818)	Sp	M	Cr	Fit	Emd.
22	*M. rufibarbis* (FABRICIUS,1792)	Sp	M	Cr	Fit	Pl
23	*Harpalus distinguendus* (DUFTSCHMID, 1812)	Sp-S	M	Ols	P	Pl
24	*H. aeneus* (FABRICIUS, 1775)	Sp	M-X	Cr	P	Pl
25	*H. cupreus* (DEJEAN, 1829)	Sp	M	Cr	P	Wp
26	*H. calceatus* (DUFTSCHMID, 1812)	A	M-X	St	P	Pl
27	*H. latus* (LINNE, 1758)	A	M	F, St	P	Pl
28	*H. tardus* (PANZER, 1797)	Sp	M-X	St	P	Es
29	*H. rubripes* (DUFTSCHMID, 1812)	A	X	F, Cr	P	Wp
30	*Acupalpus meridianus* (LINNE, 1767)	Sp	M	Cr	P	E
31	*Poecilus cupreus* (LINNE, 1758)	Sp	M	Cr	Z	Wp
32	*P. versicolor* (STURM, 1824)	Sp	M	Cr	Z	Wp
33	*P. sericeus* (F. DE WALD,1823)	Sp	M	St,Cr	Z	Wp
34	*P. lepidus* (LESKE, 1785)	A	M-X	Cr	Z	Es
35	*P. striatopunctatus* (DUFTSCHMID, 1812)	Sp	H	Cr	Z	Wp
36	*Pterostichus strenuus* (PANZER, 1797)	Sp	M	Eu	Z	Es
37	*Pt. macer* (MARSCHAM, 1802)	Sp	M	Cr	Z	Wp
38	*Pt. melanarius* (ILLIGER, 1798)	Sp	M	F, Cr	Z	Wp
39	*Pt. ovoideus* (STURM, 1824)	Sp	M	F	Z	Ec
40	*Pt. anthracinus* (ILLIGER, 1798)	Sp	H	F, St	Z	Es
41	*Dolichus halensis* (SCHALLER, 1783)	A	M	Cr	P	Pl
42	*Calathus fuscipes* (GOEZE, 1777)	A	M	Eu	P	Wp
43	*C. ambiguus* (PAYKULL, 1790)	A	M-X	St, Cr	P	Wp
44	*Idiochroma dorsalis* (PONTOPIDAN, 1763)	Sp	H-M	St, Cr	Z	Wp
45	*Amara equestris* (DUFTSCHMID, 1812)	Sp	M	Cr	P	Wp
46	*A. aulica* (PANZER, 1797)	Sp	M	Cr	P	Wp
47	*A. apricaria* (PAYKULL, 1790)	Sp	M	Cr	P	Pl
48	*A. similata* (GYLLENHALL, 1810)	Sp	M	F, St	P	Pl
49	*A. aenea* (DE GEER, 1774)	Sp	M	Cr	P	Pl
50	*Chlaenius nitidulus* (SCHRANK, 1781)	Sp	H	Rip	P	Wp
51	*Zabrus tenebrioides* (GOEZE, 1777)	A	M	Cr	Fit	Ec
52	*Polystichus connexus* (FOURCROY, 1785)	Sp	M	St, Cr	Z	cirmd
53	*Brachinus crepitans* (LLINNE, 1758)	Sp	M-X	St, Cr	Z	Wp
54	*B. explodens* (DUFTSCHMID, 1812)	Sp	M-X	St, Cr	Z	Emd
55	*B. psophia* (SERVILLE, 1821)	Sp	M-h	St. Cr	Z	Es

Table 5. Types of reproduction of the carabids in the maize crop ecosystem, Moldavia.
Legend**: A**. Spring; **B**. Autumnal; **C**. Spring- Summer, **D** = Total species.
Tabel 5. Tipuri de reproducere ale carabidelor în ecosistemul culturii de porumb, Moldova.
Legenda**: A**. Primavara; **B**. Toamna; **C**. Primăvară-Vară, **D** = Total speciii.

	A	B	C	D
No. of species	38	16	1	55
% of total	69.09	29.09	1.82	100.00

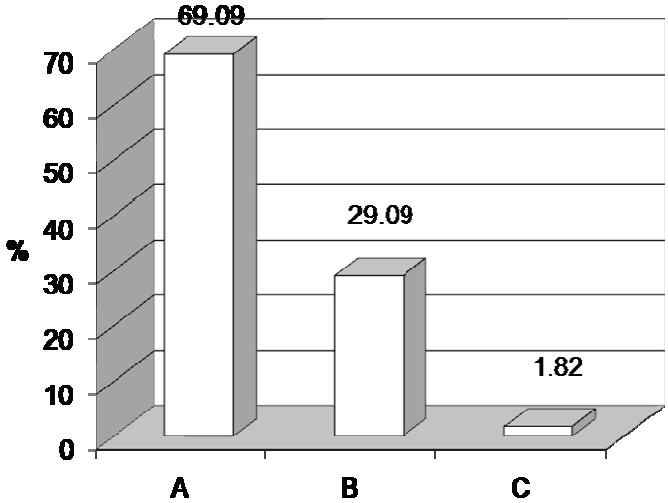

Fig. 3. Types of reproduction of the carabids in the maize crop ecosystem, Moldavia
(A. Spring; B. Autumnal; C. Spring - Summer).
Fig. 3. Tipuri de reproducere ale carabidelor în ecosistemul culturii de porumb, Moldova
(A . Primăvara; B. Toamna; C. Primăvara - Vara).

Table 6. General moisture preferences of the species of carabids in the maize crop ecosystem, Moldavia.
Legend: **A**. Higrophilous; **B**. Higro-mesophilous; **C**. Mesophilous; **D**. Meso-xerophilous; **E**. Meso-halophilous; **D**. Xerophilous; **G**. Total species.
Tabel 6. Preferinţele generale faţă de umiditate ale carabidelor în ecosistemul culturii de porumb, Moldova.
Legenda: **A**. Higrofilă; **B**. Higro-mezofilă; **C**. Mezofilă; **D**. Mezo-xerofilă; **E**. Mezo-halofilă; **D**. Xerofilă; **G**. Total specii.

	A	B	C	D	E	F	G
No. of species	4	1	33	13	1	3	55
% of total	7.27	1.82	60.00	23.64	1.82	5.45	100.00

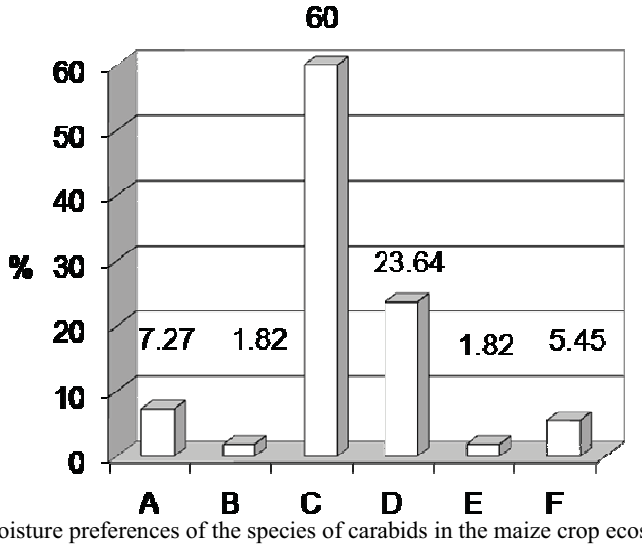

Fig. 4. General moisture preferences of the species of carabids in the maize crop ecosystem, Moldavia
(A – F see the legend above).
Fig. 4. Preferinţele generale faţă de umiditate ale speciilor de carabide în ecosistemul culturii de porumb, Moldova
(A – F vezi legenda din tab. nr. 6).

Table 7. General biotope preferences of the species of carabids in the maize crop ecosystem, Moldavia.
Legend: **A**. Forest; **B**. Forest, Steppe; **C**. Forest, Crops; **D**. Steppe; **E**. Steppe, Crops; **F**. Crops; **G**. Eurytopic; **H**. Open landscape; **I**. Riparian; **J**. Total species.

Tabel 7. Preferințele generale față de biotop ale speciilor de carabide în ecosistemul culturii de porumb, Moldova.
Legenda: **A**. Pădure; **B**. Pădure, stepă; **C**. Pădure, culturi; **D**. Stepă; **E**. Stepă, culturi; **F**. Culturi; **G**. Eurytopic; **H**. Peisaj deschis; **I**. Ripicol; **J**. Total specii.

	A	B	C	D	E	F	G	H	I	J
No. of species	2	3	3	4	15	20	3	3	2	55
%	3.64	5.45	5.45	7.27	27.27	36.36	5.45	5.45	3.64	99.98

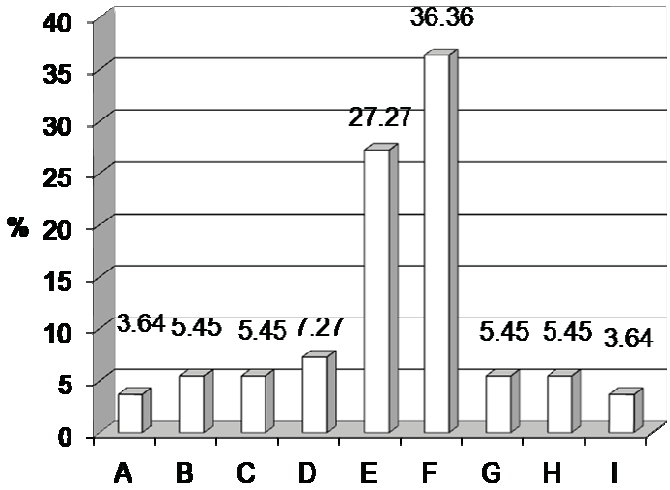

Fig. 5. General biotope preferences of the species of carabids in the maize crop ecosystem, Moldavia (A–I see the legend above).
Fig. 5. Preferințele generale față de biotop ale speciilor de carabide în ecosistemul culturii de porumb (A–I vezi legenda tab. n. 7).

Table 8. General trophic regime of the species of carabids in the maize crop ecosystem, Moldavia.
Legend: **A**. Zoophagous; **B**. Pantophagous; **C**. Phytophagous; **D**. Total species.

Tabel 8. Regimul trofic general al speciilor de carabide în ecosistemul culturii de porumb, Moldova.
Legenda: **A**. Zoofag; **B**. Pantofag; **C**. Fitofag; **D**. Total specii.

	A	B	C	D
No. of species	29	21	5	55
%	52.73	38.18	9.09	100.00

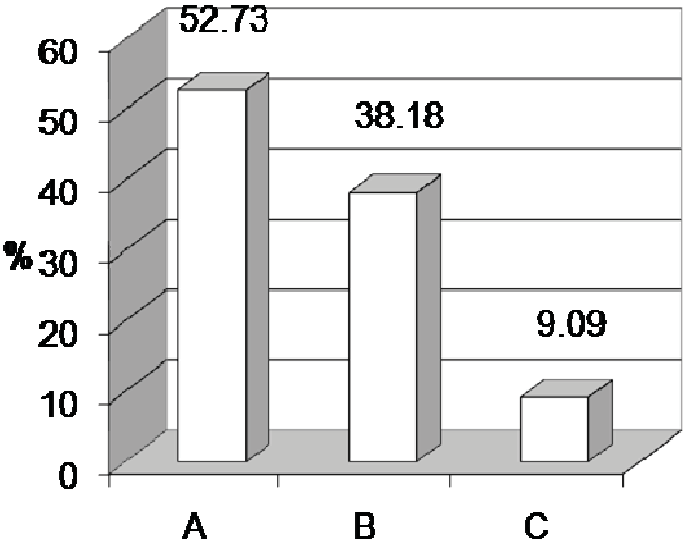

Fig. 6. General trophic regime of the species of carabids in the maize rop ecosystem, Moldavia.
Legend: **A**. Zoophagous; **B**. Pantophagous; **C**. Phytophagous; **D**. Total species.
Fig. 6. Regimul trofic general al speciilor de carabide în ecosistemul culturii de porumb, Moldova.
Legenda: **A**. Zoofag; **B**. Pantofag; **C**. Fitofag; **D**. Total specii.

Table 9. General geographical distribution of the species of carabids in the maize crop ecosystem, Moldavia.
Legend: **A**. Holarctic; **B**. Palaearctic; **C**. West-Palaearctic; **D**. European; **E**. East-European; **F**. Euro-Mediterranean **G**. Circum-Mediterranean; **H**. Euro-Siberian; **I**. Euro-Caucasian; **J**. Total species.
Tabel 9. Distribuţia geografică generală a speciilor de carabide în ecosistemul culturii de porumb, Moldova.
Legenda: **A**. Holarctic; **B**. Palaearctic; **C**. Vest-Palaearctic; **D**. European; **E**. Est-european; **F**. Euro-mediteranean **G**. Circum-mediteranean; **H**. Euro-siberian; **I**. Euro-caucasian; **J**. Total specii.

	A	B	C	D	E	F	G	H	I	J
No. of species	4	12	21	2	3	2	1	6	4	55
%	7.27	21.82	38.18	3.64	5.45	3.64	1.82	10.91	7.27	100.00

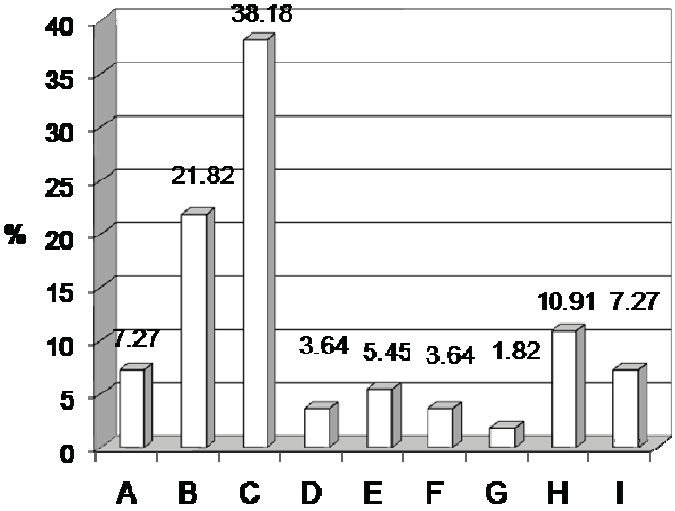

Fig. 7. General geographical distribution of the species of carabids in the maize crop ecosystem, Moldavia (A – I see the legend above).
Fig. 7. Distribuţia zoogeografică generală a speciilor de carabide în ecosistemul culturii de porumb, Moldova (Legenda: **A**. Holarctic; **B**. Palaearctic; **C**. Vest-Palaearctic; **D**. European; **E**. Est-european; **F**. Euro-mediteranean; **G**. Circum-mediteranean; **H**. Euro-siberian; **I**. Euro-caucasian; **J**. Total specii.

DISCUSSIONS

Variation and adaptation are two expressions of the law of unity and interaction between organisms and environment.

Annual and local variations of the number of species (alfa diversity) in the maize crop ecosystem from 13 sites of Moldavia (1984–2000) was between 8 species (Secuieni, 1999) and 21 species (Brăila, 1984). According to other researches of ours, sugar beet crops from Moldavia showed limits between 7 and 25 species (VARVARA, 2008, in press) and in the wheat crop between 8 and 25 species (VARVARA & BULIMAR, 2002).

Analysing the dendrogram one can observe that five localities are separated from one another and eight localities are grouped two by two. The degree of resembles of the separated localities with other sites varies between 29% and 62%, that is: Secuieni, 1990, (29%) (Fig. 2), Suceava, 1996, (32%), Pogana 1989, (45%), Sabaoani, (53%) Osoi, 1988, (62%).

The biggest similarity between localities was 80% (Osoi 1986 and Osoi 1989) followed by Suceava 1994 and Suceava 1995 (72%), Târgul Neamţ, 1998 and Cherchezeni 2000 (53%). Brăila, 1984, Negreşti, 1997 (47%).

According to THIENEMANN'S principles, between ecodiversity and biodiversity, correlation is positive, but between the number of species and the number of individuals the correlation is negative: Few species with many individuals (eudominant and dominant species), and many species with few individuals: subrecedent (subsporadic) and recedent (sporadic) species.

The total number of specimens collected was 7,211 with strong variation among sites. The average number was 554, with limits between 36 specimens (Osoi, 1988 (0.50%) in comparison with the total number of individuals collected in 13 years) and 1,344 (18.64%), (Suceava, 1995). (Tables 1,3). The subfamilies of Carabidae well represented in the maize crop ecosystem are: Harpalinae and Pterostichinae. The predominance of the Harpalinae subfamily is in accordance with the humidity of soil of the maize crop. Maize crops are dryer.

The composition of species and the number of individuals of the Carabidae in agroecosystems is influenced by the interaction of the type of soil, the crop plant, the humidity of the soil, all these factors in interaction create microhabitats used by species. In total, the number of the collected individuals in the maize crop is less in comparison with wheat, potatoes and sugar beet crop ecosystems (VARVARA, 2005).

Three species were particularly abundant: *Pseudophonus rufipes,* (DE GEER,1774), *Pterostichus melanarius* (ILLIGER, 1798) and *Poecilus cupreus* (LINNE, 1758). These species show ample variation in the number of individuals in sites and years (Table 3). For example, in *Pseudophonus rufipes* (DE GEER,1774), the limits of the number of

individuals was between 5 (Osoi, 1986 and 867 (Suceava, 1994). The situation is similar in other crops, too. In Moldavia, wheat crops (3 and 390 individuals); potato crops (3 and 309 individuals) (VARVARA, 2005) *Pseudophonus rufipes* is very frequent in agrocoenoses (TIETZE, 1973). We confirm that this species is also widely distributed in vineyards (Talmaciu, 1996), wheat, potato crops, sugar beet crop (VARVARA et al. 1991), VARVARA et al. 1999), sugar beet crop (VARVARA, 2008, in press).

Notion of diversity help us to compare the general results obtained from sites. The highest diversity was found in the maize crop at Osoi) 1988 (S = 11 species, H = 2.07, E = 0.72), while the lowest diversity was found in the maize crop at Negreşti (1997) (S = 13 species, H = 0.49, E = 0.12). The same thing is also valid for the relative diversities, comprised between 0.86 and 0.19 respectively (Table no. 2). The values of these indexa do not vary direct proportionally with the specific richness. Thus, in the localities in which the biggest number of species was found (Brăila, 1984, S = 21) Săbăoani, 1999 (S = 19), did not have the highest diversity. These results are explained by the fact that evenness of the abundance of species in these localities was lower than in the localities with high diversity. The specific richness at Negresti (1997) was higher (S = 13) than at Osoi 1998 (S = 11), but the evenness is higher at Osoi (E = 0.86) which determines finally a higher diversity in this site. (Osoi, 1988 H = 2.07) Negresti, 1997, H = 0.49) The explanation is that the total number of individuals belonging to the species *Pseudophonus rufipes* (DE GEER, 1774) represented 91.21% in the coenosis at Negresti, (1997), while the same species represented only 13.89% in the coenosis at Osoi, 1988.

In open biotopes, specific diversity is higher than in forests, but the number of individuals and their fluctuation is higher in forests (MOUSSON & LEBRUN 1996, p 85). These variations are a synthetic result of the action of abiotic factors which have effect in the ecological context in unity with ecological valences of species: Soil type, the content in humus, temperature and soil humidity variation, the pH, vegetation character and the shade degree of soil (HŮRCA, ŠUSTEK 1995, p. 350, ŠUSTEK 2000, p. 2, ŠUSTEK 2001, NECULISEANU 1995, p. 48, HOLLAND & LUFF 2000, p. 112, VARVARA 2005).

Species have their dominant ecological characteristics related to reproduction, humidity requirements, preference for biotops and habitat, food, geographical distribution in accordance with the unity between their valences and the offer of the environment.

On our observation, as for the reproduction seasons of carabids and the requirement of the species for moisture more than 50% of the species in forests and agroecosystems of Moldavia (wheat, sugar beet, potato, maize crops, clover crop) reproduce in spring, followed by autumnal species. The majority of species in the mentioned ecosystems are mesophilous (VARVARA, 2005, TURCULET & VARVARA, 2006, VARVARA, 2008) In the maize crop ecosystem from Moldavia, 69.09% of species (38 species of 55) are spring species, they lay their eggs in spring and are active in summer as larvae, 29.09% are autumnal species. As concerns moisture, 60% (33 species) are mesophilous followed by meso-xerophiluis species (Tables 5,6 Fig. 3,4)

Preference of individuals of a species for a particular range of an environmental factor is according to their preferendum. The preferendum limits the distribution of individuals to biotope or habitat.

Referring to preferred biotopes, the coenosis of *Carabidae* living in the maize crops from Moldavia is formed of a mixture of species. (Table 7, Fig. 5). Of these classes, 36.36% (20 species) are crop species and 27.27% are, (15 species) steppe-crop species.

The food regime of the species of carabids in the maize crop is predominantly represented by zoophagous species (52.73% (29 species) and 38.18% (21 species) pantophagous species (Table 8, Fig. 6).

As concerns the geographical distribution of the species of carabids, the West Palaearctic and Palearctic species are predominant, that is 38.18% (21 species) and 21.82% (12 species) (Table 9, Fig. 7).

CONCLUSIONS

The Alpha diversity of epigeic ground beetles in the maize crop ecosystem from Moldavia varied between 8 and 24 species with an average of 13 species.

The specific diversity varied between 0.49 and 2.07 and evenness between 0.12 and 0.72.

69.09% of the species have their reproduction in spring, followed by autumnal species (29.09%) 60% of the species are mesophilous.

36.36% of the species are crop species, 27.27% are steppe-crop species.

The food regime of the species is zoophagous and pantophagous. The West-Palaearctic and Palaearctic are predominant, representing in total 60%.

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