

## Distribution, Abundance and Dominance of Three *Brachinus* Species (Coleoptera: Carabidae) in Seven Agricultural Crops in Romania, within the Period 1977–2010

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**Abstract.** The present paper is a relevant synthesis of collecting original data on the occurrence, quantitative representation and autecological data of three species of the genus *Brachinus*: *B. crepitans* Linnaeus, 1758, *B. psophia* Audinet-Serville, 1828 and *B. explodens* Duftschmid, 1812 from seven agricultural crops during 19 growing seasons 1977–2010 (wheat, sugar beet, apple orchards, sunflower, maize, potatoes, vineyards). The beetles were pitfall-trapped using predominantly 12 Barber pitfalls in each site, protected against precipitation. 945 specimens of *Brachinus crepitans*, 431 specimens of *B. psophia* and 175 specimens of *B. explodens* were collected.

**Key words:** Carabidae, *Brachinus crepitans*, *B. explodens*, *B. psophia*, abundance, dominance, agricultural crops, ecological requirements.

### INTRODUCTION

Ecological entomology is important in the applied research and the faunistical one in the fundamental research. The papers that reflect the two main faunistical and ecological stages in the knowledge of carabids in Romania, from 1850 to 2002, with the complete bibliography included, are listed in the literature on the Romanian Carabidae (Coleoptera, Carabidae), published by István Máthé jr. (2003–2004).

A number of 31 papers on carabids in agroecosystems were also published in Romania: Andriescu et al. (1983), Cârlan & Varvara (1998–1999), Popescu & Zamfirescu (2004), Turculeț & Varvara (2006), Varvara et al. (1981), Varvara & Brudea (1983, 1999), Varvara et al. (1981, 1984, 1985, 1990, 1991, 1993a, b, 1995, 1999, 2001), Varvara & Andriescu (1986), Varvara & Cârlan (1990), Varvara & Moglan (1993), Varvara & Bulimar (2003), Varvara & Andriescu (2003), Varvara (2005, 2008), Varvara & Gălușcă (2007), Varvara & Zamfirescu (2008), Varvara & Apostol (2008).

In Oltenia, Baniță et al. (1994) mentioned the species of carabids in wheat fields from Șimnic and Dăbuleni. Bobârnac et al. (1981) published the results of observations on the dynamics of terrestrial entomofauna in the fields of sugar beet, wheat and maize in southern Oltenia.

In Banat, Bică (2005), in her PhD thesis, showed the results of quantitative collecting on carabids in the wheat fields. Malschi (2000) mentioned the species of ground beetles found in the cereal fields from the centre of Transylvania.

In the Republic of Moldova, Neculiseanu (2003) published the results of his quantitative research on carabids (1986–1988, 1989, 1992) from seven crops: alfalfa, winter wheat, maize, soybeans, barley, sunflower and peas. Dănilă (2005), in the

same geographical region, published his data on the structure of ground beetles communities in three crops: alfalfa, wheat fields and vineyards in the central and northern parts of this country.

The great variability of results obtained by authors raised the question, what abiotic factors (soil type, temperature and humidity at the soil surface, exposure, etc.) and biotic factors in interaction with the respective crops (wheat, maize, potatoes, sugar beet, sunflower, orchards, vineyards, etc.) are responsible for such variability?

The aim of the present paper is to present a synthesis of data on the distribution, abundance and dominance of *Brachinus crepitans*, *B. psophia* and *B. explodens* in seven types of agroecosystems based on long-termed quantitative collectings, accumulated experience, mainly in Moldavia (Romania), starting from general to particular, in tables.

### MATERIAL AND METHODS

Our material is original. It has been collected for 19 seasons (1977–2010).

The carabids were collected by a 4 % formaldehyde solution pitfall traps in fields of seven crops: wheat in 22 sites and 13 growing seasons (1977–2002), maize in 18 sites and 16 growing seasons (1978–2010), potatoes in 38 sites and 16 growing seasons (1978–1999), sugar beet in 12 sites and 8 growing seasons (1977–2001), sunflower in 11 sites and 8 growing seasons (1981–2010), vineyards in four sites, one growing season (1992) and apple orchards in 6 sites and 4 growing seasons (1979–2000) (Tab. 1).

Altogether during 19 seasons, effectively, between 1977 and 2010, the material was collected in the five regions and 13 counties of Romania: Dobrogea (Tulcea), Oltenia: (Dolj), Muntenia (Brăila), Transylvania (Braşov and Covasna), Moldova (Galaţi, Vrancea, Vaslui, Bacău, Iaşi, Neamţ, Suceava and Botoşani).

The parameters of collecting in individual crops and years (number of traps and length of their exposition, time span of collecting) are generally characterized in table 1, while in details, they are surveyed in table 2.

The beetles were identified by the author. Data for this paper were synthesized from 25 papers of the author and collaborators, mentioned in introduction.

Table 1  
General characteristics of investigation of the three species *Brachinus crepitans*, *B. psophia*, *B. explodens*, from seven types of agricultural crops in Romania.

Crop type	Wheat	Maize	Potatoes	Sugar beet	Sunflower	Vineyards	Apple orchards
Interval of sampling	1977–2002	1978–2010	1986–1993	1977–2001	1981–2010	1992	1979–2000
Total years of sampling	10	12	3	6	7	1	3
Total number of traps	209	131	49	84	82	36	36
Average of pitfalls per site	12	11	12	12	10	12	12
Minimum–maximum of traps	12	5–12	12–13	12	5–12	12	12
Total days of trap exposition	1,314	1,662	270	910	884	429	470
Average days/year	73	134	67	130	88	143	156
Minim–maxim days/season	25–121	101–161	21–137	97–153	92–176	142–145	129–184
Number of analysed samples	1,458	1,311	534	900	707	408	384
Average of analysed samples	81	109	133	128	88	136	128
Minim–maxim of analysed samples	24–108	36–180	24–390	84–180	45–108	120–144	96–184

Table 2

Localities and parameters of sampling of the three species of the genus *Brachinus* in fields of seven agricultural crops.

County	Sites, years	Traps exposition	Days	Pitfalls	Collectings	Samples
	<i>Wheat (sum)</i>		1,314	209	125	1,458
Brăila	Lacul Sărat, 1981	May 25 – July 15	51	12	3	36
Brăila	Lacul Sărat, 1982	May 28 – July 15	48	12	7	84
Brăila	Lacul Sărat, 1983	April 27 – July 12	77	12	7	84
Brăila	Lacul Sărat, 1984	May 8 – July 17	70	12	6	72
Brăila	Terasă, 1982	May 28 – Aug. 30	95	12	9	108
Brăila	Terasă, 1983	May 10 – July 20	71	12	7	84
Brăila	Terasă, 1984	May 10 – July 11	63	12	6	72
Tulcea	Uzlina, 1986	June 10 – July 5	25	12	2	24
Tulcea	Uzlina, ecoton, 1986	June 10 – July 5	25	12	2	24
Vrancea	Adjud, 1978	April 15 – July 30	106	12	8	96
Bacău	Hemeiuși, 1980	May 1 – Aug. 29	121	12	12	144
Iași	Iași, 1981	May 1 – July 20	81	12	9	108
Iași	Chirița, 1999	May 1 – July 7	69	5	6	30
Iași	Lețcani, 1981	May 10 – July 17	68	12	7	84
Iași	Lețcani, 1982	May 13 – July 19	69	12	9	108
Iași	Miroslava, 1981	April 20 – July 15	86	12	8	96
Vaslui	Perieni, 1989	April 24 – July 28	96	12	8	96
Suceava	Zvoriștea, 1993	May 1 – Aug. 1	93	12	9	108
	<i>Maize (sum)</i>		1,662	131	119	1,311
Brăila	Brăila, 1978	April 4 – July 29	116	10	6	60
Brăila	Brăila, 1985	May 10 – Sept. 15	128	10	12	120
Brăila	Lacul Sărat, 1981	May 25 – Sept. 3	155	12	10	120
Brăila	Lacul Sărat, 1984	May 15 – Sept. 10	118	12	10	120
Brăila	Terasă, 1984	May 10 – Sept. 30	144	12	15	180
Tulcea	Uzlina, 1986	June 26 – Oct. 10	106	12	3	36
Iași	Osoi, 1986	April 15 – Sept. 23	161	5	9	45
Vaslui	Pogana, 1989	May 10 – Sept. 30	143	10	9	90
Neamț	Târgul Neamț, 1998	May 1 – Sept. 30	153	12	14	168
Neamț	Săbăoani, 1999	May 5 – Sept. 30	148	12	12	144
Botoșani	Cherchejeni, 2000	May 5 – Sept. 19	137	12	9	108
Botoșani	Trușești, 2010	May 1 – Sept. 30	153	12	10	120
	<i>Sugar beet (sum)</i>		910	84	75	900
Dolj	Dobridor, 1977	May 17 – Sept. 30	136	12	7	84
Iași	Lețcani, 1981	May 10 – Sept. 30	144	12	14	168
Iași	Lețcani, 1982	May 5 – Sept. 30	149	12	14	168
Iași	Roman, 1992	May 15 – Aug. 20	97	12	9	108

Table 2 (continued)

County	Sites, years	Traps exposition	Days	Pitfalls	Collectings	Samples
Iași	Pașcani, 1981	May 1 – Sept. 30	142	12	15	180
Botoșani	Trușești, 2001	May 1 – Aug. 30	123	12	8	96
Botoșani	Botoșani, 2001	May 20 – Sept. 15	119	12	8	96
	<i>Potatoes (sum)</i>		270	49	52	534
Brașov	Brașov, 1986	April 29 – Oct. 12	137	13	30	390
Brașov	Brașov, 1997	May 24 – June 13	21	12	2	24
Covasna	Târgul Secuiesc, 1986	May 24 – June 13	21	12	2	24
Suceava	Zvorișteea, 1993	April 26 – July 25	91	12	8	96
	<i>Sunflower (sum)</i>		884	70	55	707
Brăila	Terasă, 1982	May 28 – Aug. 31	95	12	9	108
Brăila	Lacul Sărat, 1981	May 25 – Sep. 3	102	12	9	108
Brăila	Lacul Sărat, 1982	May 28 – Aug. 31	96	12	9	108
Brăila	Lacul Sărat, 1983	May 27 – Aug. 29	95	12	9	108
Iași	Osoi, 1986	April 15 – Sept. 23	176	5	9	45
Iași	Osoi, 1989	May 10 – Aug. 18	100	5	10	50
Botoșani	Broscăuți, 1999	May 10 – Sept. 15	128	12	9	108
Botoșani	Broscăuți, 2010	June 1 – Aug. 31	92	12	6	72
	<i>Apple orchards (sum)</i>		470	36	32	384
Iași	Chicerea, 1979 (County)	May 1 – Oct. 2	155	12	8	96
Iași	Breazu, 1980	April 23 – Aug. 30	132	12	12	144
Iași	Botanical Garden, Iași, 2000	April 1 – Oct. 1	183	12	12	144
	<i>Vineyards (sum)</i>		429	36	34	408
Iași	Cotnari, 1992	June 5 – Oct. 25	142	12	10	120
Iași	Iași, 1992	June 1 – Oct. 20	142	12	12	144
Vaslui	Huși, 1992	June 7 – Oct. 27	145	12	12	144

The beetles were identified by the author, using mainly the work of Freude et al. (1976). A part of the material was collected by the four former students of the Faculty of Biology, Iași, during their B.Sc. Thesis: Ștețel Maria (1997), Gălușcă Simona (2002), Herghelegiu Simona (2000), Marcu Coca (2001) and three teachers in education for preparing their papers for obtaining the first degree in education: Proca Constanța (1984), Comșa Rozalia (1992), Apostol (Cercel) Elena (2010). All of them were methodologically guided by the author.

### *Characteristics of studied regions*

#### *Dobrogea*

The Danube Delta is a unique territory in Europe, in the geographical, floristic and faunal aspects. Its relief formed of fluvial and fluvio-maritime banks (Letea, Caraorman) as well as the sandy soil cause peculiarities on the fauna. Climate is temperate–continental, influenced by the Delta and maritime littoral. The annual

average temperature is 11.1°C. and precipitations 450 mm, having the highest value of the overall solar radiation.

Agricultural plants are grown on alluvial and fluvio-maritime unflooded fields: maize, wheat, rye, sunflower etc.

#### *Oltenia*

Târgu Jiu basin comprises flood plain meadows and terraces. 80% of the basin surface has a temperate-continental climate. The annual average temperature is 10.5°C at Târgu Jiu. Annual average rain fall is 753 mm. The brown alluvial soils predominate on the extensive Jiu River flood plain. The crop plants occupy large surfaces in the centre and south of the county: cereals, potatoes and vegetables. The average yields are below the Romanian average.

#### *Transylvania*

Țara Bârsei from the region of Transylvania has an area of 2,406 km<sup>2</sup> and altitude between 504 m (Feldioara zone) and 723 m (Brașov zone). Due to its geographical position within the framework of Romania, the climate is temperate continental, moderately humid-mesophilous, with annual average temperature of 7.8°C; the annual average rainfall varies between 548–782 mm, reaching a maximum in Brașov area. In this region, summers are cool because of the mountain influence. The warmest months are July and August, when the temperature rises to 25°C.

#### *Moldova*

Moldova is characterized by a continental climate, with the annual average temperature between 7.0 and 9.0°C, annual average precipitations of 450–650 mm (Kiss, 1970). According to the altitudinal gradient two zones can be distinguished here. The cooler western zone of Moldavia with an annual average temperature of 8.5°C and precipitations of 600–700 mm, and the eastern zone with the annual average temperature of 9.5°C and precipitations of 450–550 mm.

Within the eastern zone three climatic districts are differentiated. The northern zone with the southern boundary of Iasi, the central zone with the southern boundary of the Huși town and the southern one. They differ from one another by annual average temperature and precipitations.

## RESULTS

The results of this paper are concretized in 12 tables and seven histograms, concerning the variation of total number of specimens and percentages of the species *Brachinus crepitans*, *B. psophia* and *B. explodens* within the framework of seven crops.

Altogether 1533 individuals of those three species were collected during the whole investigation period, 1977–2010, 19 seasons effectively (in which the material was collected), 5702 samples.

In descending order, the collected specimens belong to three species: *Brachinus crepitans* 945 (61.64%), *B. psophia* 431 (28.11%), *B. explodens* 157 (10.24%).

The species and specimens were very unequally distributed in number of individuals, distribution and seasons activity. In many places, they were absent.

Details about those 1533 individuals within framework of crops, species, total numbers per crop, are shown in table 3.

The cumulative influence of ecological features of each agricultural crops, from where the species were collected, on those three species is shown in percentages in figures 1, 2, 3.

Table 3

The number of specimens of three *Brachinus* species collected in seven crops.

	Name of crops	Species			Total specimens
		<i>Brachinus crepitans</i>	<i>B. psophia</i>	<i>B. explodens</i>	
1	Wheat	364	334	11	709
2	Sugar beet	238	11	9	258
3	Apple orchards	122	–	117	239
4	Sunflower	127	28	9	164
5	Maize	85	48	4	137
6	Potatoes	–	7	6	13
7	Vineyards	9	3	1	13
	<i>Total</i>	<i>945</i>	<i>431</i>	<i>157</i>	<i>1,533</i>

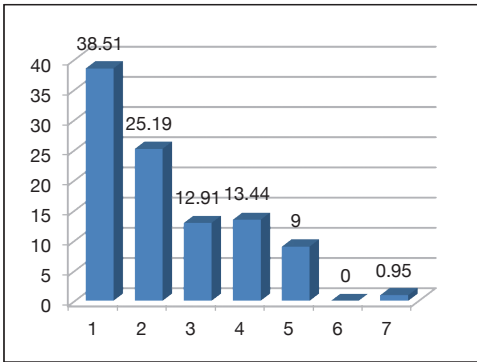


Fig. 1 – *Brachinus crepitans*

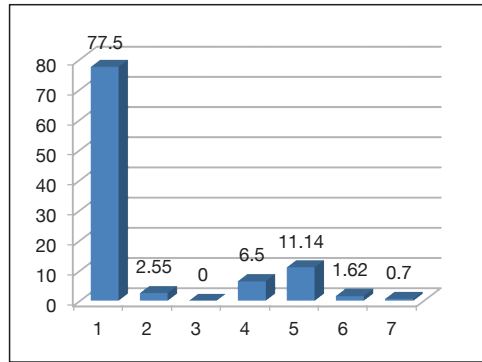


Fig. 2 – *Brachinus psophia*

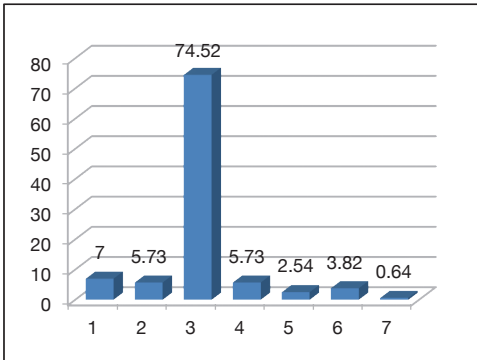


Fig. 3 – *Brachinus explodens*

**Legend**

1. Wheat
2. Sugar beet
3. Apple orchards
4. Sunflower
5. Maize
6. Potatoes
7. Vineyards

*Brachinus crepitans* Linnaeus, 1758

A total of 945 individuals of the *Brachinus crepitans* were collected from six crops (Tab. 3, 4, fig. 1). Average number of specimens per crop was 79 (9 specimens in vineyards) and 364 in wheat, limits of specimens per crop 1 (eight localities) – 179

Table 4

Position of the species *Brachinus crepitans* in the dominance classes within framework of investigated crops (number of sites).

	Classes	Wheat	Maize	S. beet	S. flower	Potatoes	Ap. orchards	V. yards
1	Subrecedent	3	3	4	3	–	–	3
2	Recedent	2	1	–	–	–	–	–
3	Subdominant	3	2	1	–	–	1	–
4	Dominant	2	–	1	–	–	1	–
5	Eudominant	2	–	–	1	–	1	–
	Total localities	12	6	6	4	–	3	3

(sugar beet, one locality (Table 5)). The species was collected from 12 wheat crops of those 22 investigated. In maize crop, *B. crepitans* totalized 85 specimens and was found in six sites of 18 investigated (33 %) ones. 127 specimens were collected in four sunflower crops of 9 researched sites. 238 specimens were collected in six sugar beet crops of 12 investigated sites.

Only 9 specimens were collected in three vineyards of 6 researched ones (Tab. 5).

The species prevalence in biocoenosis in individual localities and years, varied between 0.05% (subrecedent, Zvoriștea, 1993) and 12.83% (eudominant, Lețcani, 1981) wheat (Iași County) (Fig. 4).

Table 5

Distribution, activity abundance (A) and dominance (D) of *Brachinus crepitans* in the investigated agricultural ecosystems in Romania.

Crop, locality, year	A	D (%)	Crop, locality, year	A	D (%)
<i>Wheat</i>			<i>Sugar beet</i>		
Lacul Sărat, 1984	24	7.43	Dobridor, 1977	1	0.04
Uzlina, Danube Delta, 1986	5	7.94	Lețcani, 1981	179	3.49
Uzlina – ecoton	4	2.11	Lețcani, 1982	2	0.18
Adjud, 1978	5	1.95	Pașcani, 1981	9	0.13
Hemeiuși, 1980	3	0.26	Trușești, 2001	19	0.80
Iași, 1981	14	3.84	Botoșani, 2001	28	7
Chirița (Iași), 1999	5	1.72	<i>Number of specimens</i>	238	
Lețcani, 1981	134	12.83	<i>Sunflower</i>		
Lețcani, 1982	154	12.75	Terasă, 1982	1	0.17
Miroslava, 1981	14	3.84	Lacul Sărat, 1983	1	0.34
Perieni, 1989	1	0.40	Broscăuți, 1999	2	0.06
Zvoriștea, 1993	1	0.05	Broscăuți, 2010	123	13.44
<i>Number of specimens</i>	364		<i>Number of specimens</i>	127	

Table 5 (continued)

Crop, locality, year	A	D (%)	Crop, locality, year	A	D (%)
<i>Maize</i>			<i>Vineyards</i>		
Lacul Sărat, 1984	1	0.20	Cotnari, 1992	5	0.51
Terasă, 1984	1	0.28	Iași, 1992	3	0.57
Uzlina, Danube Delta, 1986	37	1.32	Huși, 1992	1	0.04
Târgul Neamț, 1998	5	0.51	<i>Number of specimens</i>	9	
Cherchejeni, 2000	16	2.49			
Trușești, 2010	25	2.52			
<i>Number of specimens</i>	85				
<i>Apple orchards</i>					
Chicerea, 1979	19	5.01			
Breazu, 1980	83	14.43			
Botanical Garden, Iași, 2000	20	4.13			
<i>Number of specimens</i>	122				

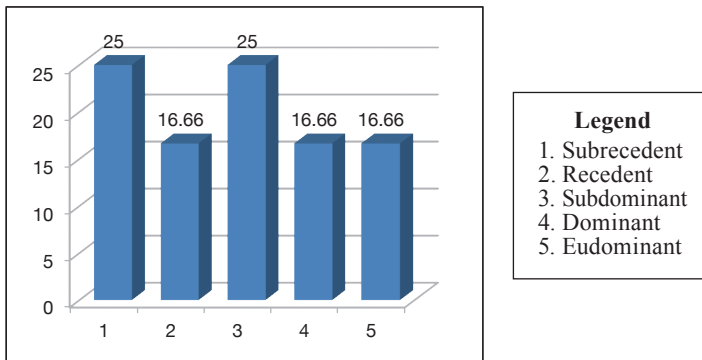


Fig. 4 – The percentage plotting in the dominance classes of the species *Brachinus crepitans* in the wheat crops, Moldova.

### *Brachinus psophia* Audinet-Serville, 1828

A total of 431 specimens were captured (Tab. 3, fig. 2). The average of specimens was 18 individuals per locality (431:24 localities) with a percentage variation between 0.15 % Brașov, potatoes (Brașov County) and 70.89% wheat crop (Lacul Sărat, 1984 – Brăila County). The crops are formed as follows: wheat, maize, sunflower, sugar beet, potatoes, vineyards (Tab. 6).

The species was collected from seven localities of wheat crops, in comparison to 18 investigated localities (38.88%), on average 47.28 % per locality and a variation between one individual (Lacul Sărat, 1981, Terasă, 1982 (Brăila County) and 229 specimens, Lacul Sărat, 1984 (Brăila County) (Tab. 7).

The dominance within frame work of coenoses varied between 0.38% (subrecedent) and 70.89% (eudominant, Lacul Sarat, 1984).



Table 6

Position of the species *Brachinus psophia* in the dominance classes within framework of investigated crops.

	Classes	Wheat	Maize	S. beet	S. flower	Potatoes	Apple orchards	Vineyards
1	Subrecedent	3	2	2	4	2	–	1
2	Recedent	1	–	–	–	–	–	–
3	Subdominant	3	3	–	–	–	–	–
4	Dominant	–	–	–	1	–	–	–
5	Eudominant	1	–	–	–	–	–	–
	Total localities	8	5	2	5	2	–	1

A total of 48 specimens were collected in maize crops and was found in 5 localities (38.46 %).

The prevalence of the species within the maize crop varied between 0.55 % (subrecedent, Pogana, 1989, (Vaslui County) and 3.95 % (subdominant, Lacul Sărat, Braila, 1984).

A total of 28 specimens were collected in sunflower crops (6.50 %) with an average of 5.5 per locality, and a variation between one individual Lacul Sărat, 1981, 1983 (Brăila County) and 21 individuals, Osoi, 1989 (Iași County).

The dominance varied between 0.34% (subrecedent) Lacul Sărat, 1983 (Brăila County) and 6.25 % (dominant) (Osoi, 1989) Iași County.

A total of 11 individuals were collected in only two localities with sugar beet crops. 2 individuals in Roman, 1992 (Neamț County) and 9 individuals, Trușești, 2001 (Botoșani County)

*Brachinus psophia* is the only species which was found in the potatoes crop, in seven specimens, with a variation between one individual (Brașov, 1986, 1987 – Brașov County) and 5 (Zvoriște, 1993 – Suceava County). In vineyards, in 1992, using 12 pitfalls in each locality, there were collected only 3 specimens in total, one locality, Cotnari, 1992, (Tâlmăciu, 1995). The dominance varied between 0.15 % (subrecedent, Brasov, 1986) and 5.25 % (dominant, Brasov, 1997) (Fig. 5).

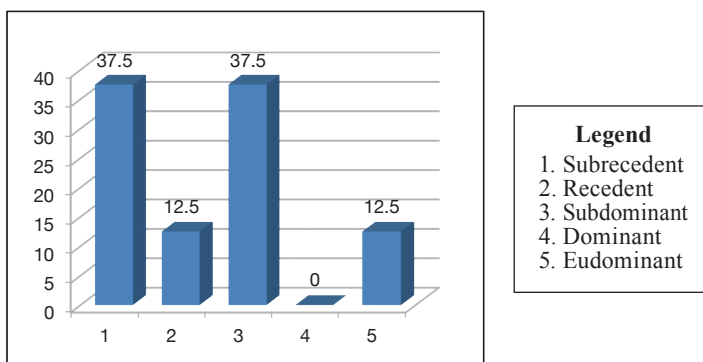


Fig. 5 – The percentage plotting in the dominance classes of the species *Brachinus psophia* in the wheat crops, Moldavia.

Table 7

Distribution, activity abundance (A) and dominance (D) of *Brachinus psophia* in the investigated agricultural ecosystems in Romania.

Crop, locality, year	A	D (%)	Crop, locality, year	A	D (%)
<i>Wheat</i>			<i>Sugar beet</i>		
Lacul Sărat, 1981	1	0.38	Roman, 1992	2	0.22
Lacul Sărat, 1982	14	3.85	Trușești, 2001	9	0.38
Lacul Sărat, 1983	79	2.15	<i>Number of specimens</i>	11	
Lacul Sărat, 1984	229	70.89	<i>Sunflower</i>		
Terasă, 1982	1	0.39	Lacul Sărat, 1981	1	0.38
Terasă, 1983	3	0.90	Lacul Sărat, 1982	2	0.29
Terasă, 1984	4	2.05	Lacul Sărat, 1983	1	0.34
Chirița (Iași), 1999	3	1.03	Osoi, 1989	21	6.25
<i>Number of specimens</i>	334		Broscauți, 1999	3	0.09
<i>Maize</i>			<i>Number of specimens</i>		
Lacul Sărat, 1984	19	3.95	<i>Vineyards</i>		
Terasă, 1984	7	2.02	Cotnari, 1992	3	0.31
Osoi, 1986	3	0.74	<i>Number of specimens</i>		
Osoi, 1989	18	4.36			
Pogana, 1989	1	0.55			
<i>Number of specimens</i>	48				
<i>Potatoes</i>					
Brașov, 1986	1	0.15			
Brașov, 1997	1	5.25			
Zvorișteea, 1993	5	0.43			
<i>Number of specimens</i>	7				

### *Brachinus explodens* Duftschmid, 1812

The average of specimens per locality was 9 specimens (157:18) with a variation between one (Terasă, 1984 – Brăila County; Zvorișteea, 1993 – Suceava County), in wheat crop and 89 specimens (Breazu, 1980, Iași County) in apple orchard. The crops are formed as follows: apple orchard, wheat, sugar beet, sunflower, potatoes, maize, vineyards (Tab. 8).

A total of 117 specimens were collected in apple orchards. The species was collected in three localities, in comparison to 6 investigated localities (50%), on average 39 individuals per locality and a variation between three individuals, Chicerea, 1979 (Iași County) and 89 specimens, Breazu, 1980 (Iași County) (Tab. 9).

The dominance within coenoses varied between 0.79 % (subprecedent) Chicerea, 1979 (Iași County) and 15.48 % (eudominant) (Breazu, 1980, Iași County) (Tab. 9).

Only 9 specimens were collected in the sugar beet crop and it was found in a single locality, Trușești, 2001 (Botoșani County)

Regarding potatoes crops the species was found in two localities: Zvorișteea, 1993 (Suceava) – 5 specimens and Secuieni, one specimen, 1997 (Neamț) (Fig. 6).

Table 8

Position of the species *Brachinus explodens* in the dominance classes within framework of investigated crops.

	Classes	Wheat	Maize	S. beet	S. flower	Potatoes	App. orchards	V. yards
1	Subrecedent	3	3	1	3	2	1	1
2	Recedent	–	–	–	–	–	–	–
3	Subdominant	1	–	–	–	–	–	–
4	Dominant	–	–	–	–	–	1	–
5	Eudominant	–	–	–	–	–	1	–
	Total localities	4	3	1	3	2	3	1

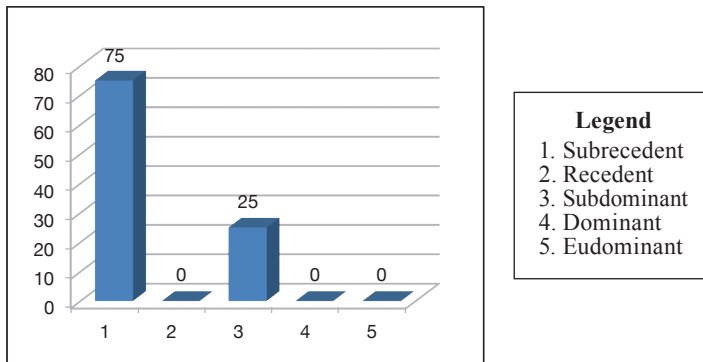


Fig. 6 – The percentage plotting in the dominance classes of the species *Brachinus explodens* in the wheat crops, Moldova.

Table 9

Distribution, activity abundance (A) and dominance (D) of *Brachinus explodens* in the investigated agricultural ecosystems from Romania.

Crop, locality, year	A	D (%)	Crop, locality, year	A	D (%)
<i>Wheat</i>			<i>Maize</i>		
Lacul Sărat, 1981	2	0.74	Brăila, 1978	2	0.18
Terasă, 1984	1	0.51	Brăila, 1985	1	0.08
Chirița (Iași), 1999	7	2.41	Săbăoani, 1999	1	0.08
Zvoriștea, 1993	1	0.05	<i>Number of specimens</i>	4	
<i>Number of specimens</i>	11		<i>Sunflower</i>		
<i>Sugar beet</i>			Lacul Sărat, 1983	1	0.34
Trușești, 2001	9	0.38	Broscăuți, 1999	3	0.09
<i>Number of specimens</i>	9		Broscăuți, 2010	5	0.54
<i>Apple orchards</i>			<i>Number of specimens</i>		
Chicerea, 1979	3	0.79	<i>Potatoes</i>		
Breazu, 1980	89	15.48	Zvoriștea, 1993	5	0.43
Botanical Garden, Iași, 2000	25	5.17	Secuieni, 1997	1	0.09
<i>Number of specimens</i>	117		<i>Number of specimens</i>		
<i>Vineyards</i>					
Iași, 1992	1	0.19			
<i>Number of specimens</i>	1				

Both in the sunflower and maize crops, 4 specimens were collected each.

In vineyards, in 1992, using 12 pitfalls in Iași locality, only one specimen was collected.

### *Outecological data*

#### *Brachinus crepitans*

*Reproduction.* It is a spring breeding species (Neculiseanu, 2003). According to our observations, the higher number of individuals 179 (75.21 %) was obtained in the sugar beet crop (Lețcani, 1981), and wheat crop, 154 (42.30 %), Lețcani, 1981, Iași County). (Tab. 5).

In the sugar beet crop 56.98 % of individuals was captured in June (1981). No individual was captured in August, September, October. Adults are active between May and July.

Bică (2005) found the species in all the wheat crops investigated, in the west plain (Banat, 1999–2002).

According to Neculiseanu (2003) females of *Brachinus crepitans* lay eggs in May – June, and the young adults appear in June and July.

*Preference for moisture.* It is a mezo-xerophilous species.

*Preference for habitat.* According to Gâdei & Popescu (2012), the individuals occur on sunny calcareous and marshy lands, under stones (for protection during the day).

More specifically, the species can live in three types of ecosystems: forest, steppe and crops. Conformable to our observations, the species was found in six crops, wheat, sugar beet, apple orchards, sunflower, maize, and vineyards. The number of specimens is quite variable within the framework of crops.

In the Republic of Moldova, Neculiseanu (2003) found the species in four agricultural crops: wheat, maize, soy bean, barley. Dănilă (2005) found it only in the lucerne crops in the north of the Republic of Moldova.

*Food regime.* Zoophagous species.

*Dynamics.* In the year 1981, sugar beet crop, Lețcani, 1981 (Iași County), 15 km away north of the city of Iași, in the sugar beet material (Tab. 10). The species was collected in May, June and July, most specimens were in June (Fig. 7).

*World distribution.* It is a west Palaearctic species.

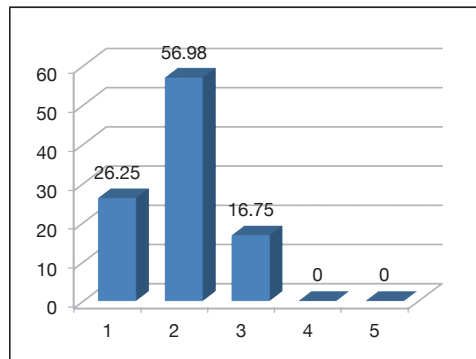


Fig. 7 – The monthly percentage dynamics of the species *Brachinus crepitans* in the sugar beet crop, Lețcani, 1981 (Iasi County).

Table 10

Monthly numerical and percentage dynamics of *Brachinus crepitans* in the sugar beet crop, Lețcani, 1981.

	1	2	3	4	5
Name of species	May	June	July	August	Sept.
<i>Brachinus crepitans</i>	47	102	30	–	–
%	26.25	56.98	16.75	–	–

### *Brachinus psophia*

*Reproduction.* It is a spring breeding species.

*Preference for moisture.* It is a mezo-halophilous species.

*Preference for habitat.* The species can live in steppe, crops. According to our collecting the species is more spread numerically in the wheat crops on chernozem salinated in the county of Brăila, the locality Lacul Sărat. For four seasons (1981–1984) in that locality 323 individuals were collected, while in the same county, but in locality Terasă, wheat, with black chernozem, only 8 individuals were collected for three seasons (1982–1984) (Tab. 7).

*Food regime.* Parasitoid, mixo-zoophagous species.

*Dynamics.* The annual variation of specimens of *Brachinus psophia* in the Lacul Sarat locality, wheat crops, comparatively with the Terasă locality is shown in tables 11 and 12.

*World distribution.* West-Palaeartic species.

Table 11

Annual numerical variation of individuals of *Brachinus psophia* in the locality Lacul Sărat (Brăila County) (wheat)

Locality	Years of collecting				Total
	1981	1982	1983	1984	
Lacul Sărat	1981	1982	1983	1984	Total
Number of specimens	1	14	79	229	323
%	0.31	4.33	24.46	70.90	100

Table 12

The annual numerical variation of individuals of *Brachinus psophia* in the locality Terasă (Brăila County) (wheat)

Locality	Years of collecting				Total
	1981	1982	1983	1984	
Terasă	1981	1982	1983	1984	Total
Number of specimens	–	1	3	4	8
%	–	12.50	37.50	50	100

### *Brachinus explodens*

*Reproduction.* It is a spring-breeding species.

*Preference for moisture.* It is a mezo-xerophilous species.

*Preference for habitat.* The species can live in steppe, crops. Conformable to our collecting, the species was collected in all investigated crops. There were collected

157 specimens; of which 117 specimens were collected in three apple orchards, 80.69 % of total individuals (Tab. 8).

*Food regime.* Zoophagous species

*World distribution.* It is an East Mediteranean species.

### DISCUSSIONS

Conformable to our data, contained in this ample and relevant synthesis paper, *Brachinus explodens* was collected in all seven crops: wheat, sugar beet, apple orchards, sun flower maize, potatoes, and vineyards.

*Brachinus crepitans* was collected in six crops, excepting potatoes.

*Brachinus psophia* was collected in six crops excepting apple orchards.

In Banat (1999–2002), Bică (2005) found *Brachinus crepitans* only in wheat fields. No specimen was found in barley and maize fields.

In the Republic of Moldova, Neculiseanu (2003) collected this species in five crops: wheat, soy bean, sunflower, peas and alfalfa, while Dănilă (2005) in only two crops of three: lucerne, and vineyards. No individual was found in the wheat crop, in 1996 and 1997.

The presence of these three species is very variable in the researched ecosystems, due to concrete particular ecological features of crops:

*Brachinus crepitans*, six agricultural ecosystems: vineyards 75% (3 of 4 sites investigated), apple orchards 50% (3 of 6 sites), sugar beet 50% (6 of 12 sites), wheat 45.45%, (present in 10 sites of 22); sunflower 44.44% (4 of 9 sites, Moldova); maize 27.77% (5 of 18 sites).

No individual of this species was found in the potatoes crops, though the material was collected in 38 localities from seven counties (Tulcea, Dolj, Braşov, Covasna, Iaşi, Suceava, Botoşani). As in case of the species of *Calosoma auropunctatum* (Varvara et al., 2012), which was found in only one field with potatoes, the presence of a pesticide or the smell of the leaves of potatoes could be the two suppositions which explain the absence of this species in various and climatic favourable regions for potatoe crops. (Ţara Bârsei and Northern Moldova).

In those seven agricultural crops, the percentage presence of the species and dominance is variable according to the characteristics of investigated agricultural ecosystems. The paper of the authors (Stan & Gâdei, 2015) demonstrates that *Brachinus crepitans* is the most distributed species in Romania, based on studied collections.

*Brachinus psophia* was found in six agricultural crops, in variable percentage: wheat 27.27% (that is present in 6 sites of 22 investigated), sugar beet 16.66 % (2 of 12), maize 27.77 % (5 of 18), sunflower 55.55% (5 of 9), potatoes 7.89% (3 of 38), apple orchards no individuals, vineyards 25% (1 of 4).

It is obvious the influence of a factor on the abundance, in 1984, on the population of *Brachinus psophia* in the same crop, wheat (Tab. 7) on chernozem with weak salinity (Braila, Lacul Sarat), and Brăila Terasă, with chernozem soil (Tabs 11, 12). During four years of collecting on chernozem soil there were collected only 8 individuals in total, with a very small variation among years, while on chernozem with weak salinity there were collected 323 individuals, in total, that is 40 times more than on chernozem soil.

On chernozem with weakly salinity, the variation of total material collected among years was very great, in 1982, it was 14 times more compared to 1981, in 1983, 23 times more than in 1982, and in 1984, only four times more than in 1983.

I think that weak salinity of the soil and food regime of the species (parasitoid and mixo-zoophagous) could be the interpretation of these differences.

*Brachinus explorens*: wheat 13.63% (3 of 22 localities), maize 16.66% (3 of 18 localities), sugar beet 8.33 % (1 of 12), sunflower 22.22% (2 of 9), potatoes 5.26%, (2 of 38), apple orchards 50% (3 of 6), vineyards 25 % (1 of 4).

All those three species are spring breeding species.

### Conclusions

On the basis of the analysis of 5,702 samples taken from seven crops during a period of 19 years, (favourable seasons) from 1977 to 2010, we conclude:

*Brachinus crepitans* is present in vineyards in proportion of 75 %, of the researched sites, wheat 54.54%, apple orchards 50%, sugar beet 50%, sunflower 36.35 %, maize 33.33 %.

It was recorded in all positions of classes of dominance, in wheat, as subrecedent, recedent and dominant; in maize as subrecedent, subdominant; sunflower, subrecedent and eudominant; in vineyards, as subrecedent; in apple orchards, as subdominant, dominant and eudominant) (Tab. 5, fig. 4).

*Brachinus psophia* is present in sunflower 45%, wheat 36 %, maize 27 %, vineyards 25 %, sugar beet 16%, potatoes 7% from one individual (wheat, maize, sunflower, potatoes) to 229 individuals (wheat) and dominance from 0.09 % (sunflower, Broscăuți 1999–Moldova) to 70.89 % (Lacul Sărat, 1984).

*Brachinus psophia* was recorded in wheat crop, as recedent and subdominant, in maize, as, subdominant; in sunflower, as dominant, eudominant (in wheat with saline chernozem) (Tab. 7).

*Brachinus explorens* is present in apple orchards 50%, sunflower 27%, vineyards 25%, wheat 18%, maize 16%, sugar beet 8%, potatoes 5%. It was recorded as subrecedent in all seven crops, and as subdominant in wheat crop.

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