

FAUNISTIC INVENTORY OF CLICK BEETLES IN SREM REGION (VOJVODINA PROVINCE, SERBIA)

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Abstract

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A survey was conducted on Elateridae fauna of Srem region, in the south of Vojvodina Province (Serbia) during 2010-2012. As many as 1202 specimens (666 adults and 536 larval forms) were collected from 949 ha on four localities and different types of habitats (crops and open biotops). Totally, 37 species belonging to 15 genera were identified. The most frequently present genus was *Agroites*, with the species *A. ustulaus*.

Key words: Elateiridae, Srem region, faunistic inventory, ecological preferences

Introduction

Most species of Elateridae family are relatively common, and their soil inhabiting larvae (wireworms) are worldwide pests of agricultural and horticultural crops causing significant economic damages in agro-ecosystems. Belowground/aboveground life cycle of these insects imposes need for comprehensive understanding of their ecology and distribution over the various habitats and soil types (Giljarov, 1953; Čerepanov, 1957; Dolin, 1964). Their management is often based on preventive insecticides applied at planting or cultural practices. New data on distribution of Elateridae species, as well as their associations with crop species (host plants) and specific habitats should serve as an additional element in assessing the state of agricultural areas and making forecast for pest management.

Although there were faunistic-ecological studies on Elateridae family in Serbia on arable land (Čamprag et al., 1974; Zabel, 1974; Štrbac, 1979, 1984), no faunistic study has been carried out in natural habitats. However, given the data on Elateridae in neighbouring countries (Central and Southeast Europe and Turkey) (Martin, 1989; Laibner, 2000; Mertlik,

2005; Recalde and Sanchez-ruiz, 2006; Kesdek et al., 2006; Platia, 2004, 2005, 2010; Mertlik and Platia, 2008; Csorba et al., 2006; Landl et al., 2010; Mertlik and Dušanek, 2006; Mahmut and Osman, 2011; Pedroni and Platia, 2010; Sert and Kabalak, 2011; Mahmut et al., 2013; Jarzabek-Müller, 2013), there was hypothesis that some of click beetle species also exist in our region.

Materials and Methods

Larval and adult samples (374 and 285 samples, respectively) were collected during years 2010, 2011 and 2012, in four localities in Srem region (total 949 ha) (Table 1). Collected material of Elateridae family was preserved in 70% ethyl alcohol, a part was stuffed (Mendel, 2002) and subsequently determined in a laboratory. Isolated individuals of this family, separated by location and year of collection, have been determined using a key which included a number of keys published in literature (Peterson, 1951; Čerepanov, 1957; Čerepanov, 1965; Becker, 1991; Dolin, 1960; Dolin, 1964, 1967, 1975, 1978; Giljarov, 1953; Klausnitzer, 1978).

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The procedure for collection the larval samples during the autumn period (late August – mid November) was as following: 1) entomological soil probes according to standard methods were performed (50 x 50 cm, to the depth of the parent layer – 40 cm) and 2) inspection of the rotting plant debris. The procedure for collection of imaginal samples was as following: 1) from the soil surface and from young crops, 2) during the vegetation period using the method of sweep net/cutting: 10 strokes in dense crops with five different places of the same parcel, and 3) plant surface baits were set, prior to sowing or after harvest.

During the processing of the collected material, we used the following terms as quantitative indicators: dominance, constancy and abundance; ecological and phenological grouping as well as diet were determined based on the results of previous studies (Dolin, 1964).

Verification of less known species was carried out in Janus Pannonius Museum (Pécs, Hungary) and in Plantenziektenkundige Dienst (Wageningen, Netherlands). During the processing of collected material, we used following quantitative parameters: dominance, constancy, abundance (Miles, 1942), and some previous studies were used for diet preference, ecological and phenological grouping of species (Dolin, 1964).

Results

Insect species from Elateridae family (larval forms) were registered in 262 samples from 374 inspected samples (70.05%) taken from 949 ha in the region of Srem region over the period 2010-2012 (Table 2). We registered 34 species from 15 genera (larval forms) in specified localities of investigated region (Table 3). In qualitative and quantitative terms, the following genera were represented with the significant number: *Agriotes*, *Adrastus*, *Melanotus*, *Selatosomus* and *Athous*. Some of inventoried species are not typical agrobionts and occur sporadically in investigated areas.

The species distribution (larval forms) varied over the localities and over the years (Table 4). Out of total number of inventoried species (34), 19 were present in all investigated years, 4 species were present in two years, and 11 species were present in only one year. Species that were present in each year's samples in all locations are dominant and subdominant (*Agriotes ustulatus* Schall., *Agriotes lineatus* L., *Adrastus limbatus* F. and *Adrastus rathifer* Geoffr.).

Distribution and number of of Elateridae family (larval forms) in regard to crop type showed the highest number of specimens in open biotopes, with population density of

Table 1
Regions and areas of locations (ha) for collection larval and imaginal forms from Elateridae family (L and I, respectively) in Srem region over 2010-2012

Location	Year of sampling											
	2010			2011			2012			2010-2012		
	Area		No of samples	Area		No of samples	Area		No of samples	Area		No of samples
	ha	L	I	ha	L	I	ha	L	I	ha	L	I
Mitrovica	122	33	40	85	28	35	74	31	25	281	92	62
Ruma	97	32	25	66	33	35	71	29	15	254	94	64
Indija	89	34	25	80	37	30	62	26	10	231	97	67
Ugrinovci	63	29	15	60	25	20	60	37	15	183	91	61
Total	371	128	105	311	123	115	267	123	65	949	374	285

Table 2
Average number of family Elateridae larval forms per m² in soil samples of arable land on investigated localities in Srem over the 2010-2012

Location	No of ha	No of samples	No of larvae	larvae/m ²
Sremska Mitrovica	281	92	143	2.31
Ruma	254	94	133	2.08
Indija	231	97	146	2.18
Ugrinovci	183	91	114	1.87
Total	949	374	536	2.11

Table 3

List of registered species of click beetles (Coleoptera, Elateridae) (larval forms), with the appearance in each year of sampling and percentage share in total sample

Species	Year of sampling			Total	%
	2010	2011	2012	2010-2012	
<i>Adrastus limbatus</i> F.	18	9	11	38	7.09
<i>Adrastus montanus</i> Scop.	0	0	0	0	0.00
<i>Adrastus rachifer</i> Geoffr.	21	13	10	44	8.21
ADRASTUS	39	22	21	82	15.30
<i>Agriotes brevis</i> Cand.	3	2	4	9	1.68
<i>Agriotes gurgistanus</i> Fald.	2	4	5	11	2.05
<i>Agriotes lineatus</i> L.	11	10	11	32	5.97
<i>Agriotes medvedevi</i> Dolin	4	5	2	11	2.05
<i>Agriotes obscurus</i> L.	7	6	11	24	4.48
<i>Agriotes piloselus</i> Panz.	6	5	3	14	2.61
<i>Agriotes ponticus</i> Steph.	1	4	4	9	1.68
<i>Agriotes rufipalpis</i> Brulle.	3	3	7	13	2.43
<i>Agriotes sputator</i> L.	15	2	26	43	8.02
<i>Agriotes ustulaus</i> Schall.	76	56	64	196	36.57
AGRIOTES	128	97	137	362	67.54
<i>Betarmon ferrugineum</i> Scop.	0	0	1	1	0.19
BETARMON	0	0	1	1	0.19
<i>Dalopius marginatus</i> L.	0	1	0	1	0.19
DALOPIUS	0	1	0	1	0.19
<i>Ampedus pomorum</i> Hbst.	0	1	0	1	0.19
AMPEDUS	0	1	0	1	0.19
<i>Athous bicolor</i> Goeze	2	0	1	3	0.56
<i>Athous haemorrhoidalis</i> F.	1	0	0	1	0.19
<i>Athous hirtus</i> Herbst.	1	0	1	2	0.37
<i>Athous niger</i> L.	1	0	0	1	0.19
<i>Athous subfuscus</i> Mull.	0	1	0	1	0.19
ATHOUS	5	1	2	8	1.49
<i>Limonius aeruginosus</i> Ol.	1	0	0	1	0.19
<i>Limonius parvulus</i> Panz.	1	0	0	1	0.19
<i>Limonius pilosus</i> Leske.	1	0	0	1	0.19
CIDNOPUS	3	0	0	3	0.56
<i>Cardiophorus cinereus</i> Herbs.	2	1	1	4	0.75
CARDIOPHORUS	2	1	1	4	0.75
<i>Actenicerus siaelandicus</i> Miill.	0	1	0	1	0.19
ACTENICERUS	0	1	0	1	0.19
<i>Ctenicera cuprea</i> F.	1	0	1	2	0.37
CTENICERA	1	0	1	2	0.37
<i>Prosternon tessellatum</i> L.	1	0	0	1	0.19
PROSTERNON	1	0	0	1	0.19
<i>Selatosomus aeneus</i> L.	4	6	1	11	2.05
<i>Selatosomus impressus</i> F.	6	4	1	11	2.05
<i>Selatosomus latus</i> F.	3	3	2	8	1.49
SELATOSOMUS	13	13	4	30	5.60
<i>Melanotus brunnipes</i> Germ.	3	5	3	11	2.05
<i>Melanotus crassicollis</i> Er.	4	6	3	13	2.43
<i>Melanotus rufipes</i> Herbs.	5	2	5	12	2.24
<i>Melanotus tenebrosus</i> Er.	2	2	0	4	0.75
MELANOTUS	14	15	11	40	7.46
	206	152	178	536	100.00

Table 4
Zoogeographical distribution of Elateridae family (larval forms) on investigated location in three years of investigation (I -2010, II-2011, III-2012)

Species	Location											
	Sremska Mitrovica			Ruma			Indija			Ugrinovci		
	I	II	III	I	II	III	I	II	III	I	II	III
<i>Adrastus limbatus</i> F.	3	2	2	5	3	1	5	2	3	5	2	5
<i>Adrastus rachifer</i> Geoffr.	4	4	4	7	5	1	6	3	2	4	1	3
ADRASTUS	7	6	6	12	8	2	11	5	5	9	3	8
<i>Agriotes brevis</i> Cand.		1		2		1	1	1	1			2
<i>Agriotes gurgistanus</i> Fald.		2	1		1	2	1	1	1	1		1
<i>Agriotes lineatus</i> L.	6	4	4	2	1	1	2	4	2	1	1	4
<i>Agriotes medvedevi</i> Dolin		1			1	1	2	2	1	2	1	
<i>Agriotes obscurus</i> L.	2	1	4			1	1	2	4	4	3	2
<i>Agriotes piloselus</i> Panz.		2		4	1			2	1	2		2
<i>Agriotes ponticus</i> Steph.		1		1		1		2	1		1	2
<i>Agriotes rufipalpis</i> Brulle.		1	1	2		2		1	1	1	1	3
<i>Agriotes sputator</i> L.	8		7	2		8	5		5		2	6
<i>Agriotes ustulatus</i> Schall.	23	15	20	18	14	15	18	15	17	17	12	12
AGRIOTES	39	28	37	31	18	32	30	30	34	28	21	34
<i>Betarmon ferrugineum</i> Scop.						1						
BETARMON	0	0	0	0	0	1	0	0	0	0	0	0
<i>Dalopius marginatus</i> L.								1				
DALOPIUS	0	0	0	0	0	0	0	1	0	0	0	0
<i>Ampedus pomorum</i> Hbst.								1				
AMPEDUS	0	0	0	0	0	0	0	1	0	0	0	0
<i>Athous bicolor</i> Goeze	1			1		1						
<i>Athous haemorrhoidalis</i> F.	1											
<i>Athous hirtus</i> Herbst.				1		1						
<i>Athous niger</i> L.										1		
<i>Athous subfuscus</i> Mull.	1				1							
ATHOUS	2	0	0	2	1	2	0	0	0	1	0	0
<i>Limonius aeruginosus</i> Ol.							1					
<i>Limonius parvulus</i> Panz.				1								
<i>Limonius pilosus</i> Leske.										1		
CIDNOPUS	0	0	0	1	0	0	1	0	0	1	0	0
<i>Cardiophorus cinereus</i> Herbs.				1			1	1	1			
CARDIOPHORUS	0	0	0	1	0	0	1	1	1	0	0	0
<i>Actenicerus siaelandicus</i> Miill.								1				
ACTENICERUS	0	0	0	0	0	0	0	1	0	0	0	0
<i>Ctenicera cuprea</i> F.	1								1			
CTENICERA	1	0	0	0	0	0	0	0	1	0	0	0
<i>Prosternon tessellatum</i> L.				1								
PROSTERNON	0	0	0	1	0	0	0	0	0	0	0	0
<i>Selatosomus aeneus</i> L.	1	1		1	3		1	1	1	1	1	
<i>Selatosomus impressus</i> F.	2	1	1	2	2		2	1				
<i>Selatosomus latus</i> F.		1		2	2	1	1		1			
SELATOSOMUS	3	3	1	5	7	1	4	2	2	1	1	0
<i>Melanotus brunnipes</i> Germ.	1	1		2				2	2		2	1
<i>Melanotus crassicollis</i> Er.		1	1	1	2		2	2	1	1	1	1
<i>Melanotus rufipes</i> Herbs.	2	1	1	1		1	2	1	2			1
<i>Melanotus tenebrosus</i> Er.	1	1		1				1				
MELANOTUS	4	4	2	5	2	1	4	6	5	1	3	3
	56	41	46	58	36	39	51	47	48	41	28	45

7.11 individuals per m². Then come wheat, row crops, fodder crops and vegetables (Table 5). Distribution and number of Elateridae family (larval forms) in regard to soil type showed the highest number of specimens in chernozem and black soil, with population density of 3.22 and 3.14 individuals per m², respectively. Then come alluvium, brown soil, and other soil types (Table 6).

The presence of insects of Elateridae family (imaginal forms) was registered in 214 out of 285 samples, or 75.08% (Table 7). The appearance of listed species (imaginal forms) in

each year of sampling and percentage share in total sample indicates the frequency of registered genera and species in total sample (Table 8). The most frequent genus was Agriotes (species *A. ustulaus*, *A. lineatus*, *A. sputator*), then Adrastus, Melanotus, Selatosomus.

According to number of registered species (larval and imaginal forms) and their percentage share in total sample the most frequent is genus Agriotes which comprises with 67.89% in total sample. The second frequent genus was Adrastus (14.64%) and other genera with less of 10%

Table 5
Average number of family Elateridae (larval forms) per m² in Srem region in relation to type of crop over the period 2010-2012

Crop	Area (ha)	No of samples	No of larvae	larvae/m ²
Wheat	432	95	288	3.03
Row crops	279	76	68	0.89
Vegetables	66	31	12	0.39
Fodder crops	136	34	40	1.18
Open biotopes	36	18	128	7.11
Total	949	254	536	2.11

Table 6
Average number of family Elateridae (larval forms) per m² in Srem region in relation to soil type over the period 2010-2012

Soil type	Area (ha)	No of samples	No of larvae	larvae/m ²
Chernozem	224	46	148	3.22
Brown soil (smonica)	88	12	18	1.50
Brown soil (gajnjača)	68	24	21	0.88
Parapodzol	59	31	19	0.61
Red soil	47	19	6	0.32
Black soil (marsh soil)	233	84	266	3.17
Saline soil	12	14	7	0.50
Alluvium	122	14	38	2.71
Sand	96	10	13	1.30
Total	949	254	536	2.11

Table 7
Average number of family Elateridae (imaginal forms) per m² in soil samples of arable land on investigated localities in Srem region over the 2010-2012

Location	No of ha	No of samples	No of larvae	larvae/m ²
Sremska Mitrovica	281	100	186	1.86
Ruma	254	70	200	2.86
Indija	231	65	155	2.38
Ugrinovci	183	50	125	2.50
Total	949	285	666	2.34

Table 8

List of registered species of click beetles (Coleoptera, Elateridae) over the 2010-2012 in soil samples on investigated localities in Srem region (imaginal forms), with the appearance in each year of sampling and percentage share in total sample

Species	Year of sampling			Total	%
	2010	2011	2012	2010-2012	
<i>Adrastus limbatus</i> F.	21	16	3	40	6.01
<i>Adrastus rachifer</i> Geoffr.	27	18	9	54	8.11
ADRASTUS	48	34	12	94	14.11
<i>Agriotes brevis</i> Cand.	3	4	3	10	1.50
<i>Agriotes gurgistanus</i> Fald.	4	3	1	8	1.20
<i>Agriotes lineatus</i> L.	15	21	4	40	6.01
<i>Agriotes medvedevi</i> Dolin	3	2	6	11	1.65
<i>Agriotes obscurus</i> L.	17	13	6	36	5.41
<i>Agriotes piloselus</i> Panz.	1	5	3	9	1.35
<i>Agriotes ponticus</i> Steph.	2	4	4	10	1.50
<i>Agriotes rufipalpis</i> Brulle.	5	3	3	11	1.65
<i>Agriotes sputator</i> L.	30	27	8	65	9.76
<i>Agriotes ustulaus</i> Schall.	103	115	36	254	38.14
AGRIOTES	183	197	74	454	68.17
<i>Betarmon ferrugineum</i> Scop.	0	0	1	1	0.15
BETARMON	0	0	1	1	0.15
<i>Dalopius marginatus</i> L.	0	1	0	1	0.15
DALOPIUS	0	1	0	1	0.15
<i>Idolus picipenis</i> Schr.	0	1	0	1	0.15
IDOLUS	0	1	0	1	0.15
<i>Lacon murinus</i> L.	0	1	0	1	0.15
AGRYPNUS	0	1	0	1	0.15
<i>Ampedus pomorum</i> Hbst.	0	1	0	1	0.15
AMPEDUS	0	1	0	1	0.15
<i>Athous bicolor</i> Goeze	2	0	1	3	0.45
<i>Athous haemorrhoidalis</i> F.	2	0	0	2	0.30
<i>Athous hirtus</i> Herbst.	1	0	1	2	0.30
<i>Athous niger</i> L.	1	0	0	1	0.15
<i>Athous subfuscus</i> Mull.	0	1	0	1	0.15
ATHOUS	6	1	2	9	1.35
<i>Limonius aeruginosus</i> Ol.	1	0	0	1	0.15
<i>Limonius parvulus</i> Panz.	1	0	0	1	0.15
<i>Limonius pilosus</i> Leske.	1	0	0	1	0.15
CIDNOPUS	3	0	0	3	0.45
<i>Cardiophorus cinereus</i> Herbs.	2	1	0	3	0.45
CARDIOPHORUS	2	1	0	3	0.45
<i>Actenicerus siaelandicus</i> Miill.	0	1	0	1	0.15
ACTENICERUS	0	1	0	1	0.15
<i>Ctenicera cuprea</i> F.	1	0	0	1	0.15
<i>Ctenicera pectinicornis</i> L.	1	0	0	1	0.15
CTENICERA	2	0	0	2	0.30
<i>Prosternon tessellatum</i> L.	1	0	0	1	0.15
PROSTERNON	1	0	0	1	0.15
<i>Selatosomus aeneus</i> L.	7	7	1	15	2.25
<i>Selatosomus impressus</i> F.	6	13	1	20	3.00
<i>Selatosomus latus</i> F.	5	3	1	9	1.35
SELATOSOMUS	18	23	3	44	6.61
<i>Melanotus brunniipes</i> Germ.	6	12	0	18	2.70
<i>Melanotus crassicolis</i> Er.	6	7	0	13	1.95
<i>Melanotus rufipes</i> Herbs.	6	3	1	10	1.50
<i>Melanotus tenebrosus</i> Er.	2	7	0	9	1.35
MELANOTUS	20	29	1	50	7.51
	283	290	93	666	100.00

Table 9

List of registered genera of family Elateridae (larval and imaginal forms) in investigated areas of Srem region over the period 2010-2012, with number and percentage

	No of imago	%	No of larvae	%	No of imago + larvae	%
AGRIOTES	454	68.17	362	67.54	816	67.89
ADRASTUS	94	14.11	82	15.30	176	14.64
MELANOTUS	50	7.51	40	7.46	90	7.49
SELATOSOMUS	44	6.61	30	5.60	74	6.16
ATHOUS	9	1.35	8	1.49	17	1.41
CIDNOPUS	3	0.45	3	0.56	6	0.50
CARDIOPHORUS	3	0.45	4	0.75	7	0.58
CTENICERA	2	0.30	2	0.37	4	0.33
BETARMON	1	0.15	1	0.19	2	0.17
IDOLUS	1	0.15	0	0.00	1	0.08
AGRYPNUS	1	0.15	0	0.00	1	0.08
AMPEDUS	1	0.15	1	0.19	2	0.17
DALOPIUS	1	0.15	1	0.19	2	0.17
ACTENICERUS	1	0.15	1	0.19	2	0.17
PROSTERNON	1	0.15	1	0.19	2	0.17
SYNAPTUS	0	0.00	0	0.00	0	0.00
ELATER	0	0.00	0	0.00	0	0.00
	666	100.00	536	100.00	1202	100.00

(Table 9). The most frequent species was *Agriotes ustulatus*, then *A. sputator*, *Adrastus rachfieri*, *A. limbatus*.

Discussion

Four localities comprising different crops and soil types (total 949 ha) in Srem region have been inspected during the 2010-2012. Totally, 37 species belonging to 15 genera were registered, and based on their frequency of occurrence they can be considered as residents at the Srem region.

The most frequently present was genus *Agriotes* (67.89% in total sample), then come genera *Adrastus* (the most frequent species *A. ustulatus*), *Melanotus*, *Selatosomus* and *Athous*. According to findings of Manole et al. (1999) from similar geographical conditions in Romania, *Agrotinae* and genus *Agriotes* were also dominant, with the most common and economically important species *A. obscurus*. Genera with less of 10 specimens (imago+larvae) were represented with less of 1% in total sample.

Insects of family Elateridae occur in meadows, pastures and fields, mostly in weedy environment with regular irrigation and without extensive usage of pesticides. Distribution of adults and wireworms is important because of relatively long life cycle in Elaterids, which comprises feeding periods and

periods of dormancy (Kulash and Monroe, 1955). Many species spend one or more winters in the larval stage, although a few species with shorter life cycles may overwinter as pupa or adults (Fisher et al., 1975). Their habitat preferences are directed toward open biotopes, as shown in our study. Wireworms have specific moisture and temperature preferences, as documented by Campbell in 1937. They prefer soil moisture content of 9-12%, and experience fatality in soil that is desiccated or saturated (Campbell, 1937; Lefko et al., 1998), while preferred temperature range is 10-24°C (Campbell, 1937; Fisher et al., 1975).

Twice a year, migration of wireworms vertically through the soil happens. In spring, they migrate up into shallower soil as the surface temperature increases, and in mid-summer they move back down as the soil temperature increases. In fall, the second migration happens when the wireworms again move upwards as temperatures begin to cool then again return to deeper soil in late October to overwinter (Fisher et al., 1975). All this ecological demands determine habitat and soil preference towards open biotopes and soils with moderate humidity (Benfer, 2011), which is also confirmed by our results. In relation to crop preference, they mostly inhabit wheat and other small grains (Manole et al., 1999) and also fodder crops (Štrbac, 1984).

Conclusions

Entomological sampling in Srem region during 2010-2012 resulted in inventory of Elateridae family with new data on species presence, distribution and ecological performance. Constant presence of Elaterids was verified with frequency of occurrence of their representatives (70.05% for larvae and 75.08% for adults, respectively). Average population density of Elaterids in Srem region was 2.10 larvae and 2.34 adults per m². Totally, 34 species (15 genera) were inventoried and these are arranged according to their frequency of occurrence: *Agriotes ustulatus*, *A. sputator*, *A. lineatus*, *A. obscurus*, *A. brevis*, *Adrastus rachifer*, *A. limbatus*, and others.

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