

# Study on the most important elaterid pests (Coleoptera: Elateridae) in Hungary 2012: species distribution and damage risk

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## SUMMARY

The click beetles and their larvae (wireworms) are dangerous pest of different economically important crops of Hungary. They cause damage mostly in maize, sunflower and wheat. In order to develop the effectiveness of actions against them we need actual distribution and abundance data on the most important species. In 2010 a country wide sampling program was started to collect actual data on six *Agriotes* species. In 2012 26 sampling sites were studied with species specific pheromone traps in Transdanubia (14) and Eastern Hungary (12). We determined the distribution and relative frequency of the six studied species. In this sampling period 72583 individuals of the six sampled species and 1627 individuals of additionally caught elaterid species were trapped. On the basis of distribution of most abundant species we assigned the areas of the country endangered by wireworms.

**Keywords:** click beetle, wireworm, Elateridae, maize, plant protection, pest, pheromone trap

## INTRODUCTION

The family of click beetles (Coleoptera: Elateridae) has approximately 8000 known species, and 131 species of them occur in Hungary (Merkl and Mertlik 2005). Agricultural significance of species depends on the life type of their larva (wireworm), which may be omnivorous, phytophagous, saprophagous or carnivorous. Species of *Agriotes* genus are considered as the most significant elaterid pests in Hungary, because of their phytophagous life form and their outstanding abundance. Species of this genus are the most dominant ones in the elaterid assemblages with approximately 80-90 % relative frequency in the Hungarian arable lands. They can cause significant damage especially in maize, sunflower, and in case of strong infection in winter wheat – and in horticulture (Tóth 1990).

The biology and damage of most noxious click beetle species are extensively studied. Their life cycle, seasonal dynamics and host range are generally well known, and there are numerous data on their distribution. However, protection against wireworm damage must be based on up to date distribution and frequency data, which contribute significantly to effective plant protection (Tóth 1990).

The easiest way to study elaterid pest assemblages is trapping with species specific pheromone traps. These traps are suitable for detection of presence of each species and studying of their seasonal dynamics (Tóth et al. 2002). Furthermore, in case of *A. ustulatus*, an economic threshold was determined by Furlan et al. in 1996 (Internet 1), which is 200-250 individuals/trap/year. The trap effectiveness of this relatively agile species is higher than the less agile ones. In case of parallel damage of *A. lineatus*, *A. obscurus* and *A. sputator* Anon (in Blackshaw et al 2008) recommended economic threshold of 150 individuals/trap/year in the UK. For this reason – in spite of different thresholds and the lack of such estimation for other click beetle species – this value may be reliable for them because of their similar biology, and may be a general threshold for protection against wireworms (Internet 1).

The studied species has different response to their sex pheromone traps: *A. lineatus* traps are more effective than *A. obscurus*, while *A. sputator* is relatively static species with less trap effectiveness (Blackshaw & Vernon 2008, Blackshaw et al. 2008). Considering these results the trap counts could not be simply added, however the damage caused by different species are added in real. In this study counts of different species were summarized separately.

In view of former results, the distribution and frequency of the most important six *Agriotes* species (*A. brevis*, *A. sputator*, *A. obscurus*, *A. lineatus*, *A. rufipalpis*, *A. ustulatus*) of Hungary were studied on maize fields in 2012. This study was a continuation and an extension of a country wide click beetle monitoring started in 2010 (Nagy et al. 2010, 2011). This paper shows the results of the year 2012.

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## MATERIALS AND METHODS

The spatial distribution and the abundance of most dangerous *Agriotes* species (*A. brevis*, *A. sputator*, *A. obscurus*, *A. lineatus*, *A. rufipalpis* and *A. ustulatus*) were studied in different regions of Hungary in 2012. Samplings were carried out on 26 maize fields representing main Hungarian maize producing areas (and completing sampling areas of former two years (Nagy et al. 2010, 2011)). In compliance with it sex pheromone traps were set on maize fields of typical maize producing areas of 14 counties: Hajdú-Bihar (2), Borsod-Abaúj-Zemplén (2), Heves (3), Jász-Nagykun-Szolnok (2), Pest (2), Bács-Kiskun (1), Fejér (2), Tolna (1), Baranya (1),

Komárom-Esztergom (2), Győr-Moson-Sopron (3), Zala (1), Vas (2), Veszprém (2) (Table 1, and Fig. 1 and 2) Pheromone traps were set in edge of maize fields where this crop is produced regularly.

Yatlor type traps were used in case of *A. brevis*, *A. sputator*, *A. obscurus*, *A. lineatus* and *A. rufipalpis*, while Csalomon VarB type traps were used in case of *A. ustulatus*. In the traps commercialized species specific Csalomon type pheromone capsules were used (Internet 2).

Traps were set in four replications in sampling sites in case of each species. The order of replications always was “brevis”, “sputator”, “obscurus/lineatus” combined, “rufipalpis/sordidus” combined. VarB traps of *A. ustulatus* were set approximately two month later between “brevis” and “sputator” traps. The distance between neighbouring traps was 20 metres so the replicated traps were 80 metres far from each other. Yatlor type traps were set in the edge of maize fields and VarB type traps were set in the maize stand near the edge. The destroyed and disappeared traps were recovered or substituted. The traps were emptied every two weeks.

The “brevis” and “rufipalpis/sordidus” Yatlor traps were checked seven times (14-week period) while “sputator” and “obscurus/lineatus” eight times (16-week period) because of different population dynamic of species in the studied year. Pheromone capsules were changed once during this time. The experience given in former years (Nagy et al. 2010, 2011) showed that the adult beetles emerge earlier in Transdanubia (West Hungary), so the traps were set up earlier in this region than in eastern Hungary. Yatlor traps worked from 29 March to 20 July in Transdanubia and from 5 April to 27 July in eastern Hungary. Considering seasonal dynamic of *A. ustulatus* VarB traps were set later. These traps worked from 22 May to 16 August in Transdanubia and from 30 May to 22 August in eastern Hungary. Pheromone capsules were changed two times, after four-week use in this case (Table 2).

Caught adults were killed by moth-killer insecticide, and samples were stored in a refrigerator until count and identification. The sampled individuals were identified after keys of Dolin (1991) and Laibner (2000) and Elateridae collection of University of Debrecen, Plant Protection Institute.

Spatial distribution and relative frequencies of the studied species were evaluated. Besides the specimens of six directly sampled *Agriotes* species the other caught click beetles were also identified. Data of these additional species can be used in further biogeographical or faunistical studies. In order to evaluate the damage risk of different regions we used total number of sampled individuals ( $N_{total} = \text{individuals/year}$ ) and mean number of sampled individuals per traps ( $N_{mean} = \text{individuals/trap/year}$ ) for each studied species in each sampling site.

Table 1

Click beetle (Elateridae: <i>Agriotes</i> sp.) sampling sites in Hungary 2012			
Transdanubia (Western Hungary)		Eastern Hungary	
Code of sites	Sites	Code of sites	Sites
1	Bicske	12	Újszász
2	Kocs	13	Jászberény
3	Kisigmánd	14	Dabas
4	Töltéstava	15	Szabadszállás
5	Kóny	16	Cegléd
6	Szil	17	Fenyőharaszt
7	Zsédény	18	Apc
8	Kám	19	Füzesabony
9	Zalaegerszeg	20	Mezőkövesd
10	Kisszőlős	21	Újcsanáros
11	Nagyacsád	22	Látókép (Debrecen) *
23	Dalmand *	26	Biharkeresztes
24	Bicsérd*	-	-
25	Enying	-	-

\*: sites sampled continuously during 2010-2012

Table 2

Timetable of samplings of click beetle pests (Elateridae: *Agriotes* sp.) in Hungary in 2012 (Yatlor: *A. brevis* (B), *A. sputator* (S), *A. obscurus* + *A. lineatus* (O), *A. rufipalpis* + *A. sordidus* (R); VarB: *A. ustulatus*)

Yatlor	VarB	Eastern Hungary	Transdanubia (Western Hungary)
trap setting		14 <sup>th</sup> week	13 <sup>th</sup> week
1 <sup>st</sup> empty (1)		16 <sup>th</sup> week	15 <sup>th</sup> week
2 <sup>nd</sup> empty (1)		18 <sup>th</sup> week	17 <sup>th</sup> week
3 <sup>rd</sup> empty (1) / change (2)		20 <sup>th</sup> week	19 <sup>th</sup> week
4 <sup>th</sup> empty (1)	trap setting	22 <sup>nd</sup> week	21 <sup>st</sup> week
5 <sup>th</sup> empty (1)	1 <sup>st</sup> empty (1)	24 <sup>th</sup> week	23 <sup>rd</sup> week
6 <sup>th</sup> empty (1)	2 <sup>nd</sup> empty (1) / change (2)	26 <sup>th</sup> week	25 <sup>th</sup> week
7 <sup>th</sup> empty (1) / gather (3): B, R	3 <sup>rd</sup> empty (1)	28 <sup>th</sup> week	27 <sup>th</sup> week
8 <sup>th</sup> empty (1) / gather (3): S, O	4 <sup>th</sup> empty (1) / change (2)	30 <sup>th</sup> week	29 <sup>th</sup> week
	5 <sup>th</sup> empty (1)	32 <sup>nd</sup> week	31 <sup>st</sup> week
	6 <sup>th</sup> empty (1) / gather (3)	34 <sup>th</sup> week	33 <sup>rd</sup> week

emptying traps (1), changing pheromone capsules (2), gathering traps (3)

Figure 1: Location of sampling sites (n=12) of the most common click beetle pests (Elateridae: *Agriotes* sp.) in eastern Hungary in 2012 (Map: GoogleEarth 2012)

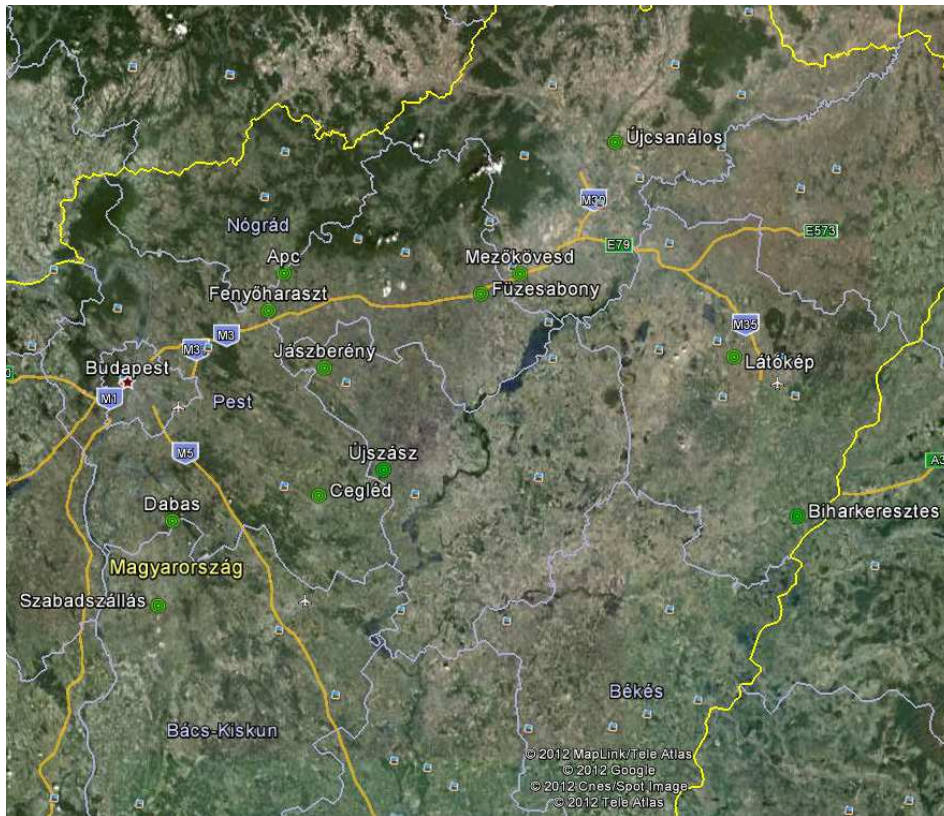
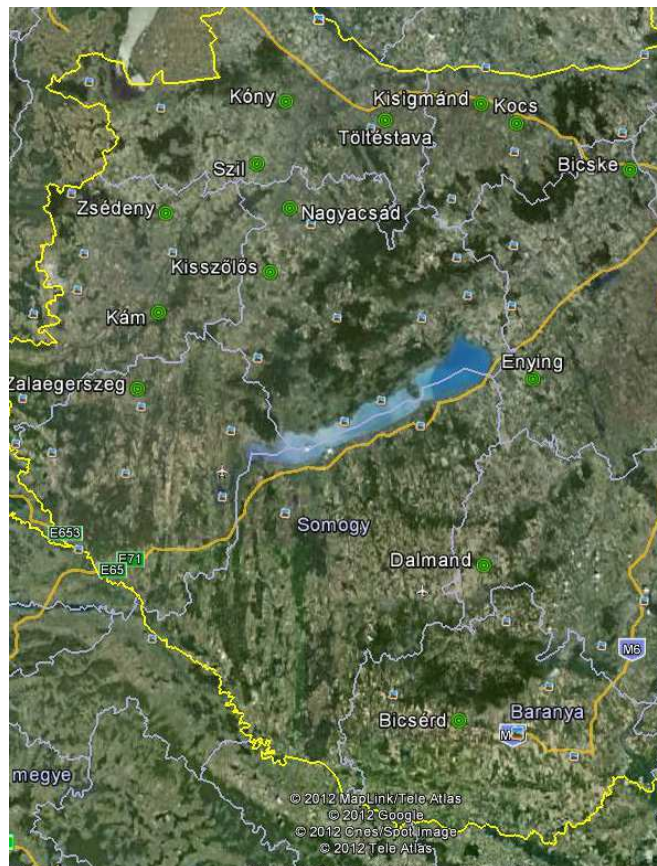


Figure 2: Location of sampling sites (n=14) of the most common click beetle pests (Elateridae: *Agriotes* sp.) in Transdanubia (western Hungary) in 2012 (Map: GoogleEarth 2012)



## RESULTS AND DISCUSSION

During the study 3744 samples (Yatlor: 3120, VarB: 624) were evaluated. Only *A. sordidus* were not caught of directly sampled species. Considering our results and former distribution data of this species we can assume that *A. sordidus* do not occur in Hungary. The total number of individuals sampled by Yatlor traps was 37990, while VarB traps caught 34593 specimens of *A. ustulatus* which was the most abundant one among six studied species. It was followed by *A. sputator* with 27858 individuals while the other four species were much less abundant. Altogether 72583 individuals of the studied species and additionally 1627 individuals of 24 other elaterid species were caught in 2012 (Table 3). During the three-year study (2010-2012) the mean number of sampled individuals per site varied between small intervals (Nagy et al. 2010, 2011).

Table 3

**Total number of individuals of the directly sampled six *Agriotes* (Coleoptera: Elateridae) species and of the additionally caught 24 species in Hungary in 2012**

Species	Total number of sampled individuals
<i>Agriotes brevis</i>	2336
<i>Agriotes sputator</i>	27858
<i>Agriotes obscurus</i>	624
<i>Agriotes lineatus</i>	4170
<i>Agriotes rufipalpis</i>	3002
<i>Agriotes ustulatus</i>	34593
Total number of sampled individuals	<b>72583</b>
Total number of individuals of additionally caught species	1627

*A. sputator*, *A. lineatus* and *A. ustulatus* occurred in all studied sites in 2012. Distribution of *A. rufipalpis* was sporadic in Transdanubia while it was characteristic for eastern Hungarian sites. *A. obscurus* occurred mostly in Transdanubia with lower abundances and only there specimens could be sampled in a hilly area of East Hungary (21. – Újcsanáros, Fig. 1, Table 4). In 2012 distribution of species were similar than former studied years (2010 and 2011) (Nagy et al. 201, 2011)

Between 2010 and 2012 *A. ustulatus* and *A. sputator* were the most abundant regardless the spatial distribution of sampling sites. *A. lineatus* and *A. rufipalpis* reached economically significant abundance only in some areas. *A. brevis* was a wide-ranging species in through the sampled areas but generally showed small abundances, while *A. obscurus* were sparsely distributed. In former studies *A. ustulatus*, *A. sputator*, *A. lineatus*, *A. brevis* and *A. obscurus* were the most dominant species, although the rank of them belonged to the geographical location of studied sites (Bognár 1958, Szarukán 1973, 1977, Tóth 1990). The first really precise identification key for elaterid larvae was published by Dolin in 1964 (Dolin 1964). Because of the problematic identification of *A. obscurus* and *A. ustulatus* larvae, data on *A. obscurus* published before 1964 are unreliable. First and last our data showed that *A. ustulatus* and *A. sputator* has being kept their dominance, while abundance of *A. brevis* has being decreased during the last decades. Henceforward *A. lineatus* and *A. rufipalpis* may be dominant in some areas (Table 4).

Traps caught additionally 24 elaterid species in 2012, accordingly the total species number was 30, which is almost one fourth of the Hungarian elaterid fauna (131 species, Merkl & Mertlik 2005). During the tree-year study altogether 34 species were found in 68 sapling sites (Nagy et al. 2010, 2011). Among additional species *A. modestus*, *B. megerlei* and *M. brunneus* occurred only in eastern Hungary while *A. acuminatus*, *A. elongatus*, *A. sanquinolentus*, *A. sinuatus*, *D. marginatus*, *D. cinereus* and *P. tessellatus* could be found only in Transdanubia (Table 4). The mean species richness of the Tarnsdanubian sites was 10.9 (species/site) while the eastern Hungarian ones showed value of 8.42.

Considering the directly sampled six species the largest elaterid abundances (individuals/site) were found in Kisigmánd (N=6154), Dalmand (N=5776), Jászberény (N=5580), Fenyőharaszt (N=4624) and Újszász (N=4458). The first two of them are located in Transdanubia and the others are in Eastern Hungary, but among the first ten sites only three Transdanubian sites could be found. The mean number of elaterid pests per site was higher in eastern Hungary (3417 individuals/site) than in Transdanubia (2372 individuals/site). This showed that the mean infestation is higher in the eastern part of the country. In 13 sampling sites (7 Tansdanubian and 6 East Hungarian) *A. ustulatus*, in 11 sites (7 Tansdanubian and 4 East Hungarian) *A. sputator*, while in 2 sites (1 Tansdanubian and 1 East Hungarian) *A. lineatus* were dominant (Table 4).

The economic threshold determined by Furlan et al. (1996) (250 individual/trap/year) were exceeded by *A. ustulatus* in 11 areas, *A. sputator* in 10 areas and *A. lineatus* in one area. Furthermore abundances of *A. ustulatus*, *A. sputator* and *A. rufipalpis* were between 200 and 250 individuals/trap/year in two, two and one areas respectively. Economically significant damage may be expected in case of five of the fourteen Transdanubian and in case of eleven of twenty East Hungarian areas. In Transdanubia *A. sputator* could be seen as a dangerous species in Kisigmánd (3) and Bicsérd (24) and *A. ustulatus* exceeded economic threshold in Zsédény (7) and

Enying (25) while in Dalmand (23) both of them occurred with economically significant abundance. Beyond that in Kocs (2) and Kisszölös (10) *A. ustulatus*, while in Bicske (1) *A. sputator* approximated the economic threshold ( $N_{\text{mean}}=200\text{-}250$  individuals/trap/year) (Table 5).

The damage risk was higher in Eastern Hungary, the abundance of species did not overstep the economic threshold only in Füzesabony (19). In case of Dabas (14) and Cegléd (16) *A. sputator* and in case of Újcsanáros (21), Debrecen-Látókép (22) and Biharkeresztes (26) *A. ustulatus* showed larger abundances than the economic threshold. In four sites (Újszász 12, Pusztamonostor 13, Fenyőharaszt17 and Mezőkövesd 20) abundance of both *A. ustulatus* and *A. sputator* while in Szabadszállás (15) three species (*A. sputator*, *A. ustulatus*, *A. lineatus*) collectively exceeded the 250 individuals/trap/year threshold. The last five sites were extremely infected. Additionally in Apc (18) the abundance of *A. sputator* approached the economic threshold by seven individuals. Despite the damage risk caused by different species could not be simply added in case of the sites where two or even three species together exceeded the economic threshold, especially high damage can be predicted (Table 5).

Table 4

**Distribution, abundances and spatial constancy (c [%]) of the sampled six *Agriotes* (\*) and additionally caught elaterid species (Coleoptera: Elateridae) in the 26 sampling sites in 2012**

	Transdanubia														
	1	2	3	4	5	6	7	8	9	10	11	23	24	25	
<i>Agriotes brevis</i> (Candeze, 1863) *	7	71	91	224	41	83	414	133	113	282	177	4	234	3	
<i>Agriotes sputator</i> (Linnaeus, 1758) *	955	520	5929	385	310	30	482	623	531	206	692	2379	1433	275	
<i>Agriotes obscurus</i> (Linnaeus, 1758) *	289	0	0	1	0	5	1	296	17	8	1	3	0	0	
<i>Agriotes lineatus</i> (Linnaeus, 1767) *	76	239	64	68	658	7	2	56	28	235	88	188	109	107	
<i>Agriotes rufipalpis</i> (Brullé, 1832) *	11	8	0	7	0	0	0	0	0	0	0	0	0	7	
<i>Agriotes ustulatus</i> (Schaller, 1783) *	210	853	70	548	196	607	3521	16	343	844	423	3202	293	1566	
<i>Adrastus rachifer</i> (Geoffroy, 1875)	60	212	157	292	60	10	2	0	14	1	7	118	0	24	
<i>Agriotes acuminatus</i> (Stephens, 1830)	0	0	0	0	0	14	4	7	0	0	2	1	2	0	
<i>Agriotes modestus</i> Kiesenwetter, 1858	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Agriotes proximus</i> Schwarz, 1891	1	0	1	0	0	1	0	0	0	0	0	0	0	1	
<i>Agrypnus murinus</i> (Linnaeus, 1758)	0	0	1	0	1	0	0	1	0	2	0	0	0	0	
<i>Ampedus elongatus</i> (Schönherr, 1817)	0	0	0	0	0	0	0	3	0	2	0	0	0	0	
<i>Ampedus sanquinolentus</i> (Schrank, 1776)	0	0	0	0	1	0	0	3	0	0	0	0	0	0	
<i>Ampedus sinuatus</i> (Germar, 1844)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
<i>Athous haemorrhoidalis</i> (Fabricius, 1801)	4	0	5	6	17	9	0	11	0	5	0	0	0	3	
<i>Athous bicolor</i> (Goeze, 1777)	1	0	1	1	1	2	0	0	0	0	0	0	0	0	
<i>Brachygonus megerlei</i> (Lacordaire, 1835)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Cidnopus pilosus</i> (Leske, 1785)	0	0	0	0	0	0	1	0	1	0	0	0	0	0	
<i>Dalopius marginatus</i> (Linnaeus, 1785)	0	0	0	0	0	0	0	37	0	0	0	0	0	0	
<i>Dicronychus cinereus</i> (Herbst, 1784)	0	0	0	0	0	0	0	5	0	3	0	0	0	0	
<i>Dicronychus rubripes</i> (Germar, 1824)	0	0	7	2	0	0	0	0	0	0	0	0	0	0	
<i>Drasterius bimaculatus</i> (Rossi, 1790)	17	0	9	2	0	0	2	0	0	6	8	10	1	0	
<i>Hemicrepidius hirtus</i> (Herbst, 1784)	0	0	0	1	0	0	0	0	0	0	0	1	0	0	
<i>Limonius minutus</i> (Linnaeus, 1758)	0	0	3	0	5	14	16	14	15	5	0	13	13	0	
<i>Melanotus brunneipes</i> (Germar, 1824)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Melanotus crassicolis</i> (Erichson, 1841)	0	0	0	3	0	0	0	0	0	0	0	1	0	0	
<i>Melanotus punctolineatus</i> (Pelerin, 1829)	0	0	5	0	0	0	0	3	0	1	0	0	3	0	
<i>Melanotus villosus</i> (Geoffroy, 1785)	0	0	0	0	0	1	0	0	0	2	0	0	0	0	
<i>Prosternon tessellatum</i> (Linnaeus, 1758)	0	0	3	0	0	1	0	1	0	3	0	0	0	0	
<i>Synaptus filiformis</i> (Fabricius, 1781)	2	0	0	0	1	0	0	0	0	0	0	0	0	0	
Number of Species	12	6	14	13	12	13	10	15	8	15	8	11	8	8	
Number of individuals of six studied species	1548	1691	6154	1233	1205	732	4420	1124	1032	1575	1381	5776	2069	1958	
Total number of individuals	1633	1903	6346	1540	1292	784	4445	1209	1062	1605	1398	5920	2088	1986	

	Eastern Hungary											N <sub>total</sub>	c [%]	
	12	13	14	15	16	17	18	19	20	21	22			26
<i>Agriotes brevis</i> (Candeze, 1863) *	60	5	57	116	0	8	3	109	17	22	20	42	2336	96.2
<i>Agriotes sputator</i> (Linnaeus, 1758) *	1498	1207	1474	1116	1638	1542	972	539	1159	746	746	471	27858	100.0
<i>Agriotes obscurus</i> (Linnaeus, 1758) *	0	0	0	0	0	0	0	0	0	3	0	0	624	38.5
<i>Agriotes lineatus</i> (Linnaeus, 1767) *	49	28	87	1589	7	43	3	72	103	28	100	136	4170	100.0
<i>Agriotes rufipalpis</i> (Brullé, 1832) *	703	92	604	262	46	53	4	97	74	31	67	936	3002	61.5
<i>Agriotes ustulatus</i> (Schaller, 1783) *	2148	4248	361	1053	511	2978	373	532	1979	2423	2907	2388	34593	100.0
<i>Adrastus rachifer</i> (Geoffroy, 1875)	12	8	3	0	11	2	0	0	14	0	1	0	1008	73.1
<i>Agriotes acuminatus</i> (Stephens, 1830)	0	0	0	0	0	0	0	0	0	0	0	0	30	23.1
<i>Agriotes modestus</i> Kiesenwetter, 1858	0	0	9	0	0	0	0	0	0	0	0	0	9	3.8
<i>Agriotes proximus</i> Schwarz, 1891	0	0	0	0	0	0	0	0	0	1	0	0	5	19.2
<i>Agrypnus murinus</i> (Linnaeus, 1758)	0	0	3	0	0	0	0	0	0	0	0	0	8	19.2
<i>Ampedus elongatus</i> (Schönherr, 1817)	0	0	0	0	0	0	0	0	0	0	0	0	5	7.7
<i>Ampedus sanquinolentus</i> (Schrank, 1776)	0	0	0	0	0	0	0	0	0	0	0	0	4	7.7
<i>Ampedus sinuatus</i> (Germar, 1844)	0	0	0	0	0	0	0	0	0	0	0	0	1	3.8
<i>Athous haemorrhoidalis</i> (Fabricius, 1801)	0	0	1	0	0	0	1	0	0	0	0	0	62	38.5
<i>Athous bicolor</i> (Goeze, 1777)	0	0	0	0	0	0	1	1	0	0	0	0	8	26.9
<i>Brachygonus megerlei</i> (Lacordaire, 1835)	0	0	0	0	0	0	0	0	0	1	0	0	1	3.8
<i>Cidnopus pilosus</i> (Leske, 1785)	0	0	0	0	0	0	0	0	0	0	0	1	3	11.5
<i>Dalopius marginatus</i> (Linnaeus, 1785)	0	0	0	0	0	0	0	0	0	0	0	0	37	3.8
<i>Dicronychus cinereus</i> (Herbst, 1784)	0	0	0	0	0	0	0	0	0	0	0	0	8	7.7
<i>Dicronychus rubripes</i> (Germar, 1824)	0	0	2	0	0	0	0	0	0	0	0	0	11	11.5
<i>Drasterius bimaculatus</i> (Rossi, 1790)	2	0	140	51	0	0	0	6	0	0	0	6	260	50.0
<i>Hemicrepidius hirtus</i> (Herbst, 1784)	1	0	0	0	0	0	0	0	1	0	0	1	5	19.2
<i>Limonius minutus</i> (Linnaeus, 1758)	1	1	0	0	0	3	2	0	4	0	0	1	110	57.7
<i>Melanotus brunneipes</i> (Germar, 1824)	0	0	0	0	0	0	1	0	0	0	0	0	1	3.8
<i>Melanotus crassicolis</i> (Erichson, 1841)	6	4	0	0	0	2	2	0	3	0	0	0	21	26.9
<i>Melanotus punctolineatus</i> (Pelerin, 1829)	0	0	1	0	0	1	0	0	0	0	0	0	14	23.1
<i>Melanotus villosus</i> (Geoffroy, 1785)	0	0	0	0	0	0	0	0	1	0	0	0	4	11.5
<i>Prosternon tessellatum</i> (Linnaeus, 1758)	0	0	0	0	0	0	0	0	0	0	0	0	8	15.4
<i>Synaptus filiformis</i> (Fabricius, 1781)	0	0	0	0	0	0	0	1	0	0	0	0	4	11.5
Number of Species	10	8	12	6	5	9	10	8	10	8	6	9		
Number of individuals of six studied species	4458	5580	2583	4136	2202	4624	1355	1349	3332	3253	3840	3973		
Total number of individuals	4480	5593	2742	4187	2213	4632	1362	1357	3355	3255	3841	3982		

Table 5

Mean numbers of sampled individuals ( $N_{\text{mean}}$ =individuals/trap/year) of six studied <i>Agriotes</i> species in the 26 sampling sites in 2012								
Species	Sampling site	n	$N_{\text{mean}}$	$\pm$ SD	Sampling site	n	$N_{\text{mean}}$	$\pm$ SD
<i>A. brevis</i>	1 Bicske	6	1.8	2.1	14 Dabas	19	14.3	2.6
<i>A. sputator</i>		32	238.8 *	76.9		32	368.5 **	152.8
<i>A. obscurus</i>		21	72.3	60.0		0	0.0	0.0
<i>A. lineatus</i>		22	19.0	16.5		21	21.8	26.6
<i>A. rufipalpis</i>		5	2.8	3.2		28	151.0	127.1
<i>A. ustulatus</i>		14	52.5	34.7		13	90.3	24.3
<i>A. brevis</i>	2 Kocs	21	17.8	4.6	15 Szabadszállás	16	29.0	26.5
<i>A. sputator</i>		31	130.0	68.1		30	279.0 **	45.2
<i>A. obscurus</i>		0	0.0	0.0		0	0.0	0.0
<i>A. lineatus</i>		23	59.8	42.4		27	397.3 **	71.5
<i>A. rufipalpis</i>		6	2.0	0.8		26	65.5	25.6
<i>A. ustulatus</i>		16	213.3 *	103.6		11	263.3 **	52.0
<i>A. brevis</i>	3 Kisigmánd	16	22.8	6.4	16 Cegléd	0	0.0	0.0
<i>A. sputator</i>		32	1482.3 **	742.4		32	409.5 **	118.5
<i>A. obscurus</i>		0	0.0	0.0		0	0.0	0.0
<i>A. lineatus</i>		16	16.0	13.5		5	1.8	1.0
<i>A. rufipalpis</i>		0	0.0	0.0		10	11.5	10.8
<i>A. ustulatus</i>		10	17.5	15.1		15	127.8	47.0
<i>A. brevis</i>	4 Töltéstava	24	56.0	26.8	17 Fenyőharaszt	8	2.0	0.0
<i>A. sputator</i>		29	96.3	18.4		31	385.5 **	113.6
<i>A. obscurus</i>		1	0.3	0.5		0	0.0	0.0
<i>A. lineatus</i>		23	17.0	6.8		10	10.8	12.2
<i>A. rufipalpis</i>		6	1.8	1.7		15	13.3	13.2
<i>A. ustulatus</i>		16	137.0	58.3		19	744.5 **	388.2
<i>A. brevis</i>	5 Kóny	13	10.3	10.3	18 Apc	3	0.8	1.0
<i>A. sputator</i>		26	77.5	22.0		31	243.0 *	83.4
<i>A. obscurus</i>		0	0.0	0.0		0	0.0	0.0
<i>A. lineatus</i>		24	164.5	167.1		2	0.8	1.5
<i>A. rufipalpis</i>		0	0.0	0.0		4	1.0	0.8
<i>A. ustulatus</i>		13	49.0	18.4		14	93.3	38.2
<i>A. brevis</i>	6 Szil	20	20.8	11.7	19 Füzesabony	22	27.3	24.2
<i>A. sputator</i>		12	7.5	6.2		31	134.8	42.1
<i>A. obscurus</i>		4	1.3	1.3		0	0.0	0.0
<i>A. lineatus</i>		6	1.8	1.0		13	18.0	2.2
<i>A. rufipalpis</i>		0	0.0	0.0		15	24.3	20.5
<i>A. ustulatus</i>		14	151.8	26.6		15	133.0	39.4
<i>A. brevis</i>	7 Zsédény	23	103.5	24.0	20 Mezőkövesd	10	4.3	1.7
<i>A. sputator</i>		27	120.5	48.1		32	289.8 **	170.9
<i>A. obscurus</i>		1	0.3	0.5		0	0.0	0.0
<i>A. lineatus</i>		2	0.5	0.6		21	25.8	15.9
<i>A. rufipalpis</i>		0	0.0	0.0		15	18.5	7.0
<i>A. ustulatus</i>		17	880.3 **	374.6		19	494.8 **	227.9
<i>A. brevis</i>	8 Kám	23	33.3	21.5	21 Újcsanáros	8	5.5	4.8
<i>A. sputator</i>		30	155.8	110.1		32	186.5	93.2
<i>A. obscurus</i>		21	74.0	72.1		2	0.8	1.5
<i>A. lineatus</i>		18	14.0	10.8		9	7.0	9.4
<i>A. rufipalpis</i>		0	0.0	0.0		10	7.8	3.3
<i>A. ustulatus</i>		6	4.0	2.9		19	605.8 **	252.3
<i>A. brevis</i>	9 Zalaegerszeg	23	28.3	17.6	22 Debrecen-Látókép	12	5.0	2.7
<i>A. sputator</i>		32	132.8	24.4		29	186.5	143.1
<i>A. obscurus</i>		9	4.3	1.7		0	0.0	0.0
<i>A. lineatus</i>		11	7.0	8.0		15	25.0	20.6
<i>A. rufipalpis</i>		0	0.0	0.0		18	16.8	9.6
<i>A. ustulatus</i>		10	85.8	40.5		15	726.8 **	232.9
<i>A. brevis</i>	10 Kisszőlős	28	70.5	30.3	23 Dalmand	3	1.0	1.2
<i>A. sputator</i>		30	51.5	21.9		29	594.8 **	34.5
<i>A. obscurus</i>		5	2.0	1.8		1	0.8	1.5
<i>A. lineatus</i>		25	58.8	49.3		23	47.0	3.2
<i>A. rufipalpis</i>		0	0.0	0.0		0	0.0	0.0
<i>A. ustulatus</i>		20	211.0 *	62.8		24	800.5 **	207.8
<i>A. brevis</i>	11 Nagyacsád	23	44.3	17.6	24 Bicsérd	26	58.5	25.5
<i>A. sputator</i>		31	173.0	17.1		32	358.3 **	136.2
<i>A. obscurus</i>		1	0.3	0.5		0	0.0	0.0
<i>A. lineatus</i>		22	22.0	9.5		18	27.3	21.6
<i>A. rufipalpis</i>		0	0.0	0.0		0	0.0	0.0
<i>A. ustulatus</i>		12	105.8	31.8		18	73.3	61.3
<i>A. brevis</i>	12 Újszász	21	15.0	4.8	25 Enying	2	0.8	1.5
<i>A. sputator</i>		32	374.5 **	107.2		26	68.8	10.8
<i>A. obscurus</i>		0	0.0	0.0		0	0.0	0.0
<i>A. lineatus</i>		19	12.3	1.0		18	26.8	12.7
<i>A. rufipalpis</i>		28	175.8	39.2		6	1.8	1.0
<i>A. ustulatus</i>		18	537.0 **	78.1		18	391.5 **	158.4
<i>A. brevis</i>	13 Pusztamonostor	4	1.3	1.3	26 Biharkeresztes	11	10.5	8.8
<i>A. sputator</i>		32	301.8 **	59.1		31	117.8	19.7
<i>A. obscurus</i>		0	0.0	0.0		0	0.0	0.0
<i>A. lineatus</i>		10	7.0	2.9		22	34.0	13.7
<i>A. rufipalpis</i>		20	23.0	7.4		26	234.0 *	108.1
<i>A. ustulatus</i>		20	1062.0 **	231.6		20	597.0 **	78.6

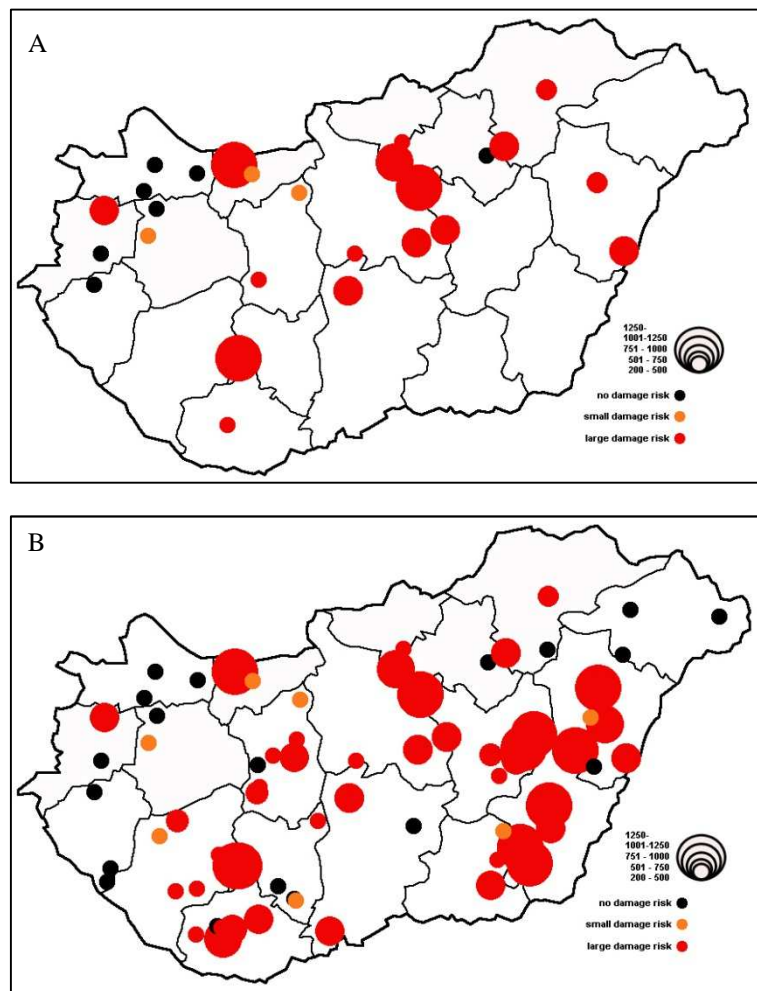
n: number of positive samples,  $\pm$ SD: standard deviation, \*\* $N_{\text{mean}} > 250$  individuals/trap/year (economic threshold), \*  $N_{\text{mean}} = 200-250$  individuals/trap/year.

Although the composition of the studied elaterid pest assemblages showed large spatial differences, the formerly detected differences between Transdanubian and eastern Hungarian areas decreased in 2012. The abundances of the two dominant species *A. sputator* and *A. ustulatus* were more balanced in this year than in former two years (Nagy et al. 2010, 2011). Mostly these two dominant species can cause significant economic risk, but the less abundant *A. lineatus*, *A. rufipalis* and *A. brevis* increase this danger in case of many areas. On the basis of geographic distribution of the most abundant species areas infected by click beetles or wireworms are easily determine (Fig. 3)

On the basis of three-year study we determined the distribution and actual relative abundances of the most dangerous elaterid pests in Hungary. The most infected and endangered areas are the eastern and south-eastern part of the Alföld (Great Hungarian Plain; Hajdú-Bihar, Jász-Nagykun-Szolnok, Békés and Csongrád counties), the hillfoot of the North Hungarian Hilly Area (Heves and Pest counties), the Mezőség (Fejér and Tolna counties) and the Transdanubian Hilly Area (Somogy and Baranya counties). In the sandy area of Szabolcs-Szatmár-Bereg county (northeast Hungary) and in the western part of the country (Győr-Moson-Sopron, Vas, Veszprém and Zala counties) we could not expect significant economic damage caused by wireworms of *Agriotes* species.

In order to more effective use of monitoring data we should understand the mechanisms underlying dynamic of species and pest assemblages. The analysis of connection among species distribution, composition of assemblages and background parameters (e.g. soil type, geographic situation, habitat diversity etc.) is in process.

Figure 3: Abundance of the most dominant *Agriotes* species in the 26 sites sampled in 2012 (A) and in the 68 sampling sites studied during 2010-2012 (B)



Size of circles proportional with mean number of species (individuals/trap/year) reached the economic threshold ( $N_{\text{mean}} > 250$  individuals/trap/year), and colours show the probability of economic damage considering the number of species exceeded the economic threshold.

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