European Mosquito Bulletin 30 (2012), 30-65
Journal of the European Mosquito Control Association
ISSN 1460-6127; www.e-m-b.org
First published online 9 March 2012

Revised checklist and distribution maps of mosquitoes (Diptera, Culicidae) of Hungary

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Abstract

A revised checklist, with maps showing the known distribution and local frequency of the 49 species in the Hungarian fauna is presented. A short research history and a bibliography of Hungarian mosquitoes are also included in the paper.

Key words: Hungary, mosquito fauna

Introduction

In Hungary in the last centuries there are numerous reports on the presence of mosquito species and their distribution. Based on this, discussion of the knowledge of the Hungarian mosquito fauna is presented. These results and maps complete the knowledge drawn by several former reviews [e.g. Croatia – Merdic *et al.* (2004), Poland – Kubica-Biemat (1999), Slovakia – Jalili (2000), Országh *et al*. (2001), European Russia – Gomostaeva (2000), Rumania – Nicolescu *et al.* (2002a-b, 2003a-b)] regarding the distribution of Central- and Eastern-European species.

Hydrography, climate and land-use (percentage of natural habitats is high by European comparison) of Hungary are characterized by different requirements and well adapted for habitation by mosquitoes.

Local pattern of the mosquito habitats in the landscape structure are indicated by Somogyi (1997). Most of the rivers of the country (93,000 square-kilometres) are bordered by flood-plains. The length of the two large rivers is over 1,000 kilometres (Danube: 417 km, River Tisza: 600 km – 14.5 and 60 percent of the total lengths). In Hungary a further 2,500 small-rivers and streams exist, the overall length of which is 25,000 km. Danube flood may happen in all months, but at the River Tisza it is unlikely because of the features of that watershed area. Hungarian small streams are characterized by considerable fluctuation in discharge. It means both long dry intervals and short extreme flooded periods (mainly for streams of the plains in rainy early-summers). The total area of potentially flooded land around rivers and streams is 1,500 square-kilometres.

The number of natural and artificial lakes above 0.5 hectares with marginal and contacted habitats is 1,200. Three of them (Lake Balaton, Lake Fertő and Lake Velence) are characterized by large mosquito breeding sites in their marginal zone and the neighbouring areas. Activity of these breeding sites is determined by both the rainfall and water-level of the lakes.

The very first data (*Culex pipiens*) from Hungary (from the settlement of Debrecen) was published by Török (1870). Fászl (1878) also recorded *Cx. pipiens* and a further 3 species: *Cx.*

ciliaris (now *Aedes cinereus*), *Cx. annulipes* (now *Ochlerotatus annulipes*), *Cx. annulata* (now *Culiseta annulata*). Kowarz (1883) added *Anopheles maculipennis* to the known mosquito fauna.

Thalhammer (1900) published records of the first discovery in Hungary of a further 11 species: *An. nigripes* (now *An. plumbeus*), *Cx. vexans* (now *Ae. vexans*), *Cx. cantans* (now *Oc. cantans*), *Cx. dorsalis* (now *Oc. dorsalis*) and *Cx. ornatus* (now *Oc. geniculatus*).

The Hungarian mosquito fauna was summarized for the first time by Kertész (1904) (including 14 species with occurrences). Regarding the first reports of *Cx. richiardii* (now *Coquillettidia richiardii*) and *Cx. modestus,* we have to neglect Kertész' data based on the work of Edwards (1921).

Systematic research of the Hungarian mosquitoes began in the 1930s, mainly related to the epidemiology of malaria. Detection of *An. atroparvus* and *An. messeae* by Lőrincz & Mihályi (1937) was the first result of that project. As a result of frequent examination of Lake Balaton, occurrence data of a further 7 [*An. bifurcatus* (now *An. claviger*), *Ae. caspius* (now *Oc. caspius*), *Ae. cataphylla* (now *Oc. cataphylla*), *Ae. leucomelas* (now *Oc. leucomelas*), *Ae. diversus* (now *Oc. rusticus*), *Ae. lateralis* (now *Oc. sticticus*), *Cx. apicalis* (now *Cx. territans*)] and later, an additional 8 [*Ae. detritus* (*Oc. detritus*), *Ae. excrucians* (now *Oc. excrucians*), *Ae. variegatus* (now *Oc. flavescens*), *Cx. hortensis, Theobaldia longiareolata* (now *Cs. longiareolata*)*, Theobaldia morsitans* (now *Cs. morsitans*), *Orthopodomyia albionensis* (now *Orthopodomyia pulchripalpis*) és *Uranotaenia unguiculata*] species were found for the first time in Hungary (Mihályi 1939, 1941).

After World War II, mosquito research focused on Lake Balaton. In that time Mihályi & Soós (1952) recorded *An. hyrcanus, Ae. pulchritarsis* (now *Oc. pulchritarsis*), *Ae. refiki* (now *Oc. refiki*), *Ae. nemorosus* (now *Oc. communis*), *Cx. torrentium* and *Theobaldia alaskaensis* (now *Cs. alaskaensis*) as species new to the Hungarian fauna.

In the 1950s and 1960s the number of the recorded species continued to increase: *Cx. theileri* – Mihályi *et al.* (1952); *Ae. hungaricus* (now *Oc. hungaricus*) – Mihályi (1955a); *An. algeriensis*, *Ae. punctor* (now *Oc. punctor*)*, Cx. martinii, Theobaldia subochrea* (now *Cs. subochrea*) – Mihályi (1955b); *Theobaldia glaphyroptera* (now *Cs. glaphyroptera*) – Gulyás (1958); *Ae. nigrinus* (now *Oc. nigrinus*) – Mihályi (1959); *Cx. mimeticus* – Mihályi & Gulyás (1963). The first specimens of *Cx. pipiens* biotype *molestus* were collected by Mihályi (1955b).

Detailed mapping of the mosquito species has been carried out from the 1970s to the present time. Most of the results of this work were obtained by the first author of this paper. In the publications relating to mosquitoes (Tóth, 1977, 1981, 1991, 2001a-b, 2003a-b, Tóth & Sáringer, 1997, 2002) several relevant data can be found in his papers about the dipteran taxon (Tóth, 1972, 1975, 1978, 1985, 1990, 1992a-b, 1995a-b, 1999, 2000, 2002). Synthesis by Tóth (2004) of the above mentioned examined the papers of Bartal (1906), Mann (1941), Szilády (1941), Zoltai (1957), Zoltai & Szabó (1968), Gulyás (1958), Gulyás & Zoltai (1959), Sztankay-Gulyás & Zoltai (1959a, 1959b), Zilahi-Sebess (1961), Szabó (1964), Erőss (1988), Sáringer *et al*. (1998), Kuroli (2002), and recorded *Cs. fumipennis, Oc. pullatus* and *Cs. ochroptera* for the first time in Hungary. The presence of *Oc. surcoufi* in the fauna was discovered by Tóth (2009a).

For the compilation of the new distribution maps we took into consideration the recent studies of Bogyó & Szabó (2005), Kenyeres & Tóth (2005), Szepesszentgyörgyi & Rentsendorj (2006), Bogyó (2007), Szabó (2007a-b) and Tóth (2006, 2009b, 2010, 2011). UTM maps (10×10 km grids) have been drawn based on all the known distribution data of the species with the use of BioTér software (Dévai *et al*., 2000).

Species recorded in Hungary

A total of 49 mosquito species have been recorded in Hungary, belonging to 8 genera, as follows: *Anopheles* (7), *Aedes* (3), *Ochlerotatus* (20), *Coquillettidia* (1), *Culex* (8), *Culiseta* (8), *Orthopodomyia* (1) and *Uranotaenia* (1).

The checklist was compiled according to the current list of Snow & Ramsdale (2003).

Culicidae

Subfamily Anophelinae
- Genus Anopheles Meigen, 1818
  - Subgenus Anopheles Meigen, 1818
  - (1) *Anopheles algeriensis* Theobald, 1903
  - (2) *Anopheles atroparvus* Thiel, 1927
  - (3) *Anopheles claviger* (Meigen, 1804)
  - (4) *Anopheles hyrcanus* (Pallas, 1771)
  - (5) *Anopheles maculipennis* Meigen, 1818
  - (6) *Anopheles messeae* Falleroni, 1926
  - (7) *Anopheles plumbeus* Stephens, 1828

Subfamily Culicinae
- Genus Aedes Meigen, 1818
  - Subgenus Aedes Meigen, 1818
  - (8) *Aedes cinereus* Meigen, 1818
  - (9) *Aedes rossicus* Dolbeshkin, Goritzkaja & Mitrofanova, 1930
  - Subgenus Aedimorphus Theobald, 1903
  - (10) *Aedes vexans* (Meigen, 1830)
- Genus Ochlerotatus Lynch-Arribálzaga, 1891
  - Subgenus Finlaya Theobald, 1903
  - (11) *Ochlerotatus geniculatus* (Olivier, 1791)
  - Subgenus Ochlerotatus Lynch-Arribálzaga, 1891
  - (12) *Ochlerotatus annulipes* (Meigen, 1830)
  - (13) *Ochlerotatus cantans* (Meigen, 1818)
  - (14) *Ochlerotatus caspius* (Pallas, 1771)
  - (15) *Ochlerotatus cataphylla* (Dyar, 1916)
  - (16) *Ochlerotatus communis* (De Geer, 1776)
  - (17) *Ochlerotatus detritus* (Haliday, 1833)
  - (18) *Ochlerotatus dorsalis* (Meigen, 1830)
  - (19) *Ochlerotatus excrucians* (Walker, 1856)
  - (20) *Ochlerotatus flavescens* (Müller, 1764)
  - (21) *Ochlerotatus hungaricus* (Mihályi, 1955)
  - (22) *Ochlerotatus leucomelas* (Meigen, 1804)
  - (23) *Ochlerotatus nigrinus* (Eckstein, 1918)
  - (24) *Ochlerotatus pulcritarsis* (Rondani, 1872)

(25) *Ochlerotatus pullatus* (Coquillett, 1904)
(26) *Ochlerotatus punctor* (Kirby, 1837)
(27) *Ochlerotatus sticticus* (Meigen, 1838)
(28) *Ochlerotatus surcoufi* (Theobald, 1912)
Subgenus Rusticoidus Shevchenko & Prudkina, 1973
(29) *Ochlerotatus refiki* (Medschid, 1928)
(30) *Ochlerotatus rusticus* (Rossi, 1790)
Genus Coquillettidia Dyar, 1905
Subgenus Coquillettidia Dyar, 1905
(31) *Coquillettidia (Coquillettidia) richiardii* (Ficalbi, 1889)
Genus Culex Linnaeus, 1758
Subgenus Barraudius Edwards, 1921
(32) *Culex modestus* Ficalbi, 1890
Subgenus Culex Linnaeus, 1758
(33) *Culex mimeticus* Noé, 1899
(34) *Culex pipiens pipiens* Linnaeus, 1758
Culex pipiens pipiens biotype *molestus* Forskal, 1775
(35) *Culex theileri* Theobald, 1903
(36) *Culex torrentium* Martini, 1925
Subgenus Maillotia Theobald, 1907
(37) *Culex hortensis* Ficalbi, 1890
Subgenus Neoculex Dyar, 1905
(38) *Culex martinii* Medschid, 1930
(39) *Culex territans* Walker, 1856
Genus Culiseta Felt, 1904
Subgenus Allotheobaldia Broelemann, 1919
(40) *Culiseta longiareolata* (Macquart, 1838)
Subgenus Culicella Felt, 1904
(41) *Culiseta fumipennis* (Stephens, 1825)
(42) *Culiseta morsitans* (Theobald, 1901)
(43) *Culiseta ochroptera* (Peus, 1935)
Subgenus Culiseta Felt, 1904
(44) *Culiseta alaskaensis* (Ludlow, 1906)
(45) *Culiseta annulata* (Schrank, 1776)
(46) *Culiseta glaphyroptera* (Schiner, 1864)
(47) *Culiseta subochrea* (Edwards, 1921)
Genus Orthopodomyia Theobald, 1904
(48) *Orthopodomyia pulcripalpis* (Rondani, 1872)
Genus Uranotaenia Lynch-Arribálzaga, 1891
Subgenus Pseudoficalbia Theobald, 1912
(49) *Uranotaenia unguiculata* Edwards, 1913

Distribution of the species

We have presented the local frequencies of the recorded species to give the most accurate picture of the Hungarian mosquito fauna (Table 1). Values were determined with the use of the data of 194,898 larvae, 145,332 biting-females and 358,124 imagos collected by light trap, carbon-dioxide baited trap and netting (over than 50,000 samples). Frequencies of the species in the studied UTM-quadrates (591 from the overall 1,052) were also calculated. See distribution maps in Appendix.

Table 1. Frequencies of the mosquito species in Hungary

[**F-La** = relative frequency in the samples of larvae; **S-La** = number of the samples with the larvae of the species; **F-B** = relative frequency of females in the samples of biting; **S-B** = positive cases in the samples of biting**; F-I** = relative frequency in the samples of imagos (included males and females) collected by light trap, carbon-dioxide baited trap and netting; **UTM%** = percentile frequency in the studied UTM-quadrates, top 10 species are bold in each column]

Species	F-La	S-La	F-B	S-B	F-I	UTM%
Culex pipiens	**0.3427**	2926	0.0001	2	**0.0647**	**65.82**
Culex pipiens molestus	<0.0001	2	0.0002	18	0.0001	5.08
Aedes vexans	**0.1297**	1757	**0.3168**	4630	**0.1796**	**70.90**
Culiseta annulata	**0.0834**	1849	0.0002	22	**0.0150**	**49.24**
Anopheles maculipennis	**0.0698**	2513	0.0015	140	**0.0083**	**53.13**
Ochlerotatus sticticus	**0.0468**	1070	**0.0828**	1428	**0.0436**	**52.96**
Culex modestus	**0.0435**	1161	**0.0552**	933	**0.0287**	**44.67**
Aedes cinereus	**0.0363**	1369	**0.0249**	172	**0.0157**	**48.05**
Ochlerotatus cantans	**0.0322**	660	**0.0136**	407	**0.0139**	33.33
Ochlerotatus cataphylla	**0.0319**	525	0.0011	59	0.0036	23.01
Anopheles claviger	**0.0296**	1465	**0.0107**	508	0.0068	30.46
Ochlerotatus annulipes	0.0274	560	**0.1782**	2913	**0.2053**	**34.69**
Ochlerotatus rusticus	0.0268	662	0.0011	48	0.0032	24.70
Culex territans	0.0161	633	<0.0001	1	0.0006	29.61
Ochlerotatus caspius	0.0137	420	**0.0095**	134	0.0080	**42.47**
Culiseta morsitans	0.0111	542	–	–	0.0003	23.18
Ochlerotatus geniculatus	0.0092	245	0.0026	157	0.0015	23.86
Ochlerotatus excrucians	0.0088	469	0.0028	176	0.0027	26.57
Ochlerotatus flavescens	0.0079	290	0.0034	131	0.0037	30.80
Ochlerotatus refiki	0.0076	117	<0.0001	1	0.0007	9.98
Coquillettidia richiardii	0.0074	204	**0.2759**	2363	**0.3816**	26.06
Anopheles messeae	0.0052	351	0.0004	12	0.0023	**38.41**
Uranotaenia unguiculata	0.0043	171	0.0004	31	0.0004	11.17
Anopheles plumbeus	0.0026	148	0.0019	145	0.0010	20.47
Aedes rossicus	0.0009	61	**0.0158**	218	0.0069	18.44
Culex hortensis	0.0009	71	–	–	0.0001	12.01
Anopheles algeriensis	0.0007	71	<0.0001	5	<0.0001	3.89
Ochlerotatus punctor	0.0006	31	<0.0001	2	<0.0001	5.08
Anopheles hyrcanus	0.0006	62	0.0001	7	0.0002	9.98
Anopheles atroparvus	0.0003	8	0.0001	13	0.0007	16.07
Ochlerotatus communis	0.0003	21	<0.0001	1	<0.0001	4.40
Ochlerotatus dorsalis	0.0002	17	0.0001	5	0.0002	13.03
Culex mimeticus	0.0002	8	–	–	–	1.35
Ochlerotatus hungaricus	0.0002	7	0.0002	9	0.0001	1.86
Ochlerotatus leucomelas	0.0002	12	–	–	0.0002	6.60
Culex martinii	0.0002	20	–	–	<0.0001	3.72
Ochlerotatus surcoufi	0.0001	4	<0.0001	2	<0.0001	1.02
Culiseta longiareolata	0.0001	5	–	–	<0.0001	1.18
Ochlerotatus nigrinus	0.0001	10	–	–	<0.0001	2.88
Orthopodomyia pulchripalpis	0.0001	5	–	–	<0.0001	0.68
Culiseta subochrea	0.0001	4	–	–	<0.0001	1.02
Culex torrentium	0.0001	4	–	–	–	4.74
Culiseta fumipennis	0.0001	3	–	–	–	0.51
Culiseta alaskaensis	0.0001	4	<0.0001	3	<0.0001	2.88
Culiseta ochroptera	0.0001	3	–	–	–	0.68
Culex theileri	0.0001	5	<0.0001	1	<0.0001	3.55
Ochlerotatus pulchritarsis	<0.0001	3	0.0001	3	<0.0001	2.37
Culiseta glaphyroptera	<0.0001	3	–	–	<0.0001	0.51
Ochlerotatus pullatus	<0.0001	1	–	–	–	0.68
Ochlerotatus detritus	–	–	–	–	<0.0001	0.34

Notes

Published Hungarian occurrences of *Oc. communis* must be considered doubtful, because it is confirmed that several of them are based on misidentifications. Recording by Mihályi & Soós (1952) is the first valid report of presence in the Hungarian fauna.

Oc. detritus has been collected in Hungary just as adults.

Oc. pullatus, Cx. mimeticus, Cs. fumipennis, Cs. ochroptera have been collected in Hungary just as larvae.

Anopheles labranchiae Falleroni, 1926 may occur in Hungary (Mihályi & Gulyás, 1963) but this needs confirmation. The same is also true for *An. sacharovi* Favre, 1903, another member of the Anopheles Maculipennis Complex.

Aedes albopictus (Skuse 1894) and *Ae. aegypti* (Linnaeus 1762) are absent from the Hungarian mosquito fauna according to our actual knowledge. Based on the climatic and dispersion prognoses they may appear in Hungary due to global warming and/or introduction.

The Hungarian mosquito checklist may be still incomplete. It is important to note that *Ae. geminus* Peus, 1970 handled by Kenyeres & Tóth (2008) as a provisional element of the fauna has recently been collected in Hungary by Zoltán Soltész (personal communication) but has not yet been published. Species which are presumably present in the country but have not been discovered are *Oc. behningi* (Martini, 1926), *Oc. riparius* (Dyar & Knab, 1907) and *Oc. intrudens* (Dyar, 1919). In addition to the above mentioned species, the discovery of *Oc. cyprius* (Ludlow, 1919), *Oc. diantaeus* (Howard, Dyar & Knab, 1912), *Cx. laticinctus* Edwards, 1913 and *Coquillettidia buxtoni* (Edwards, 1923) is also possible.

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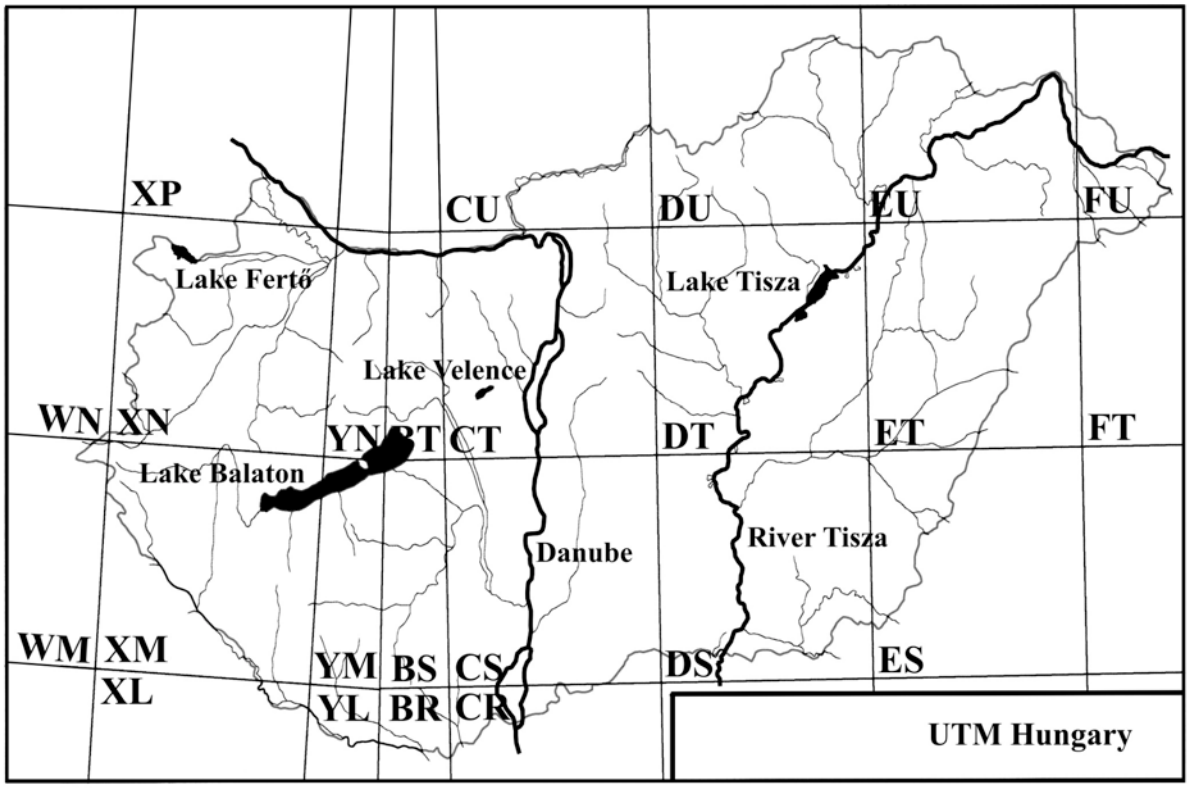
Appendix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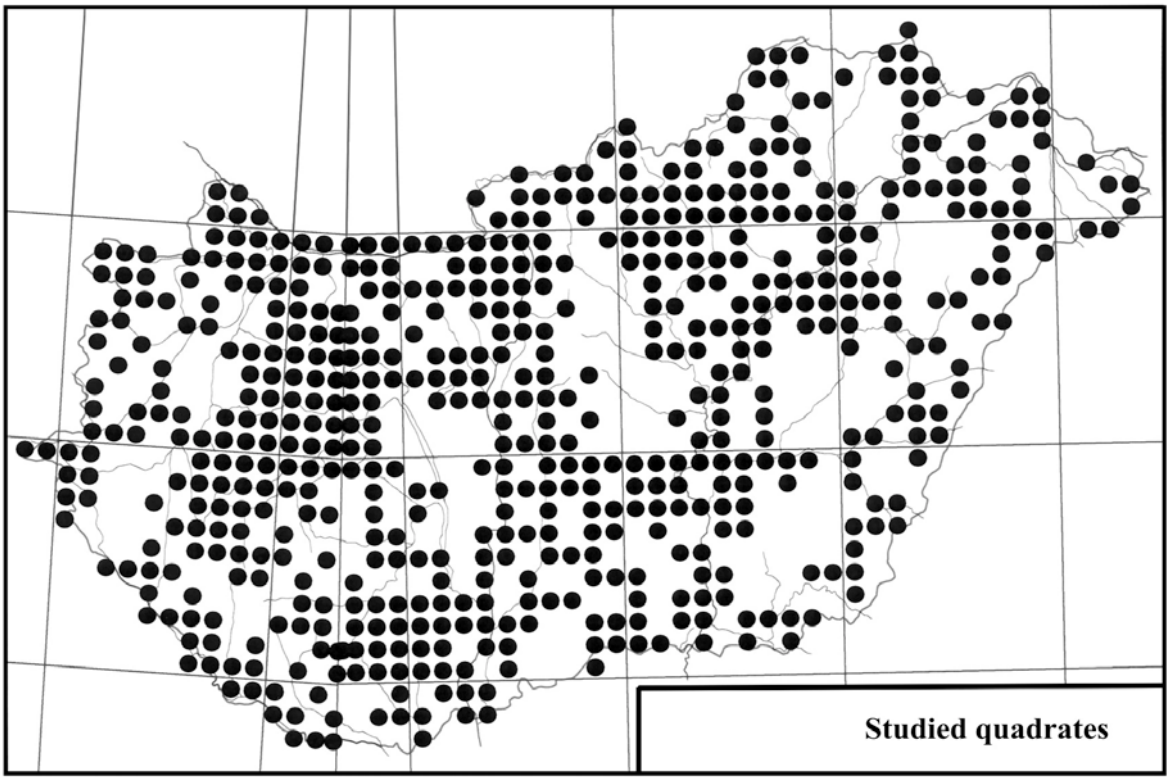
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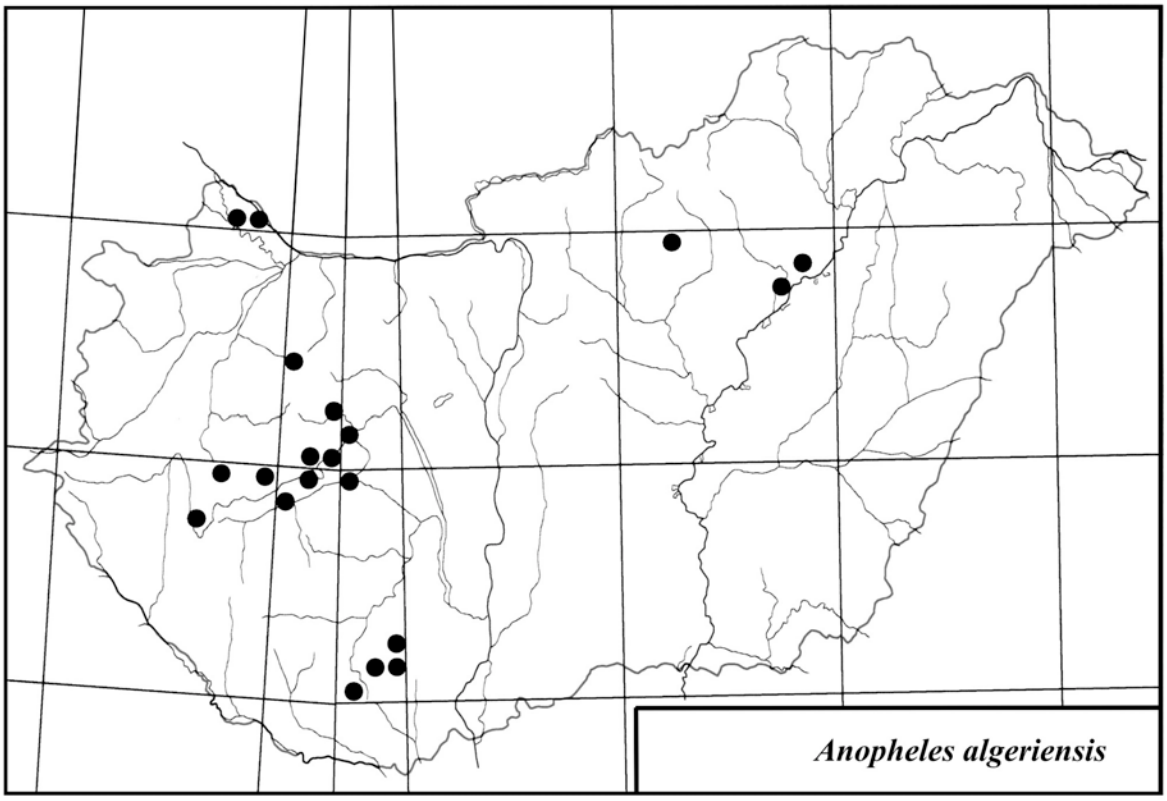
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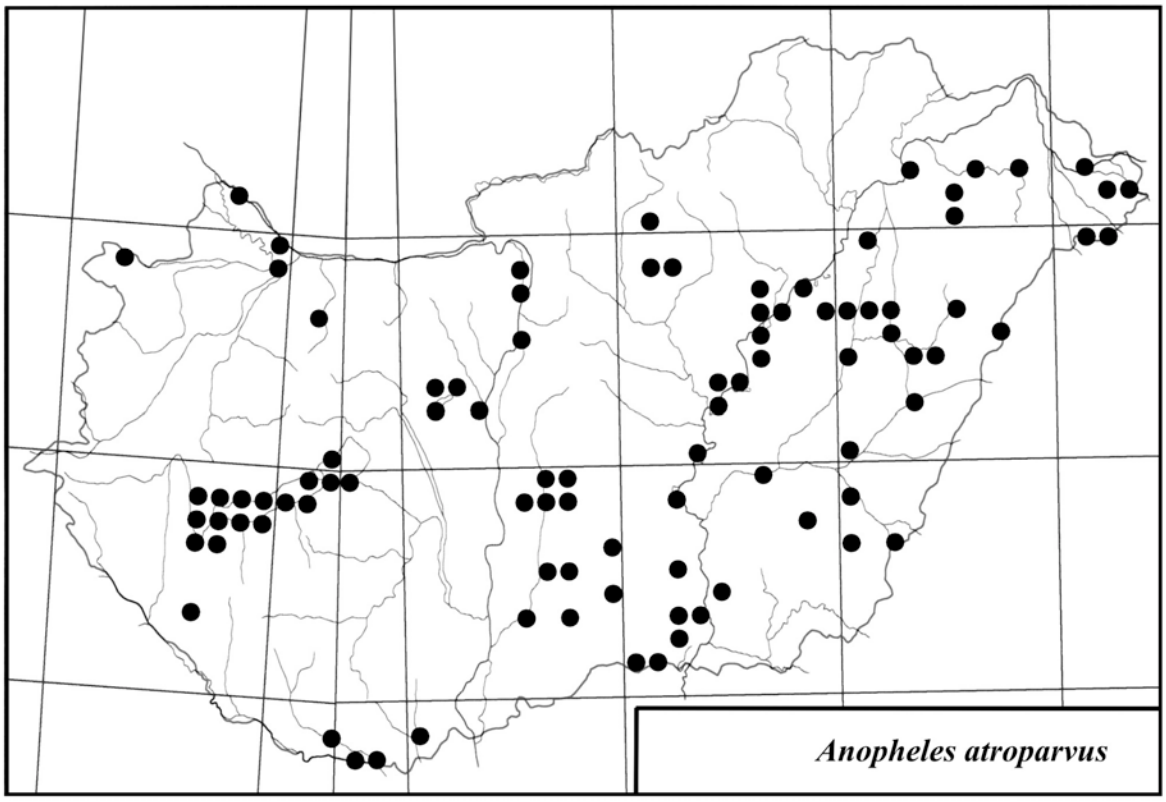
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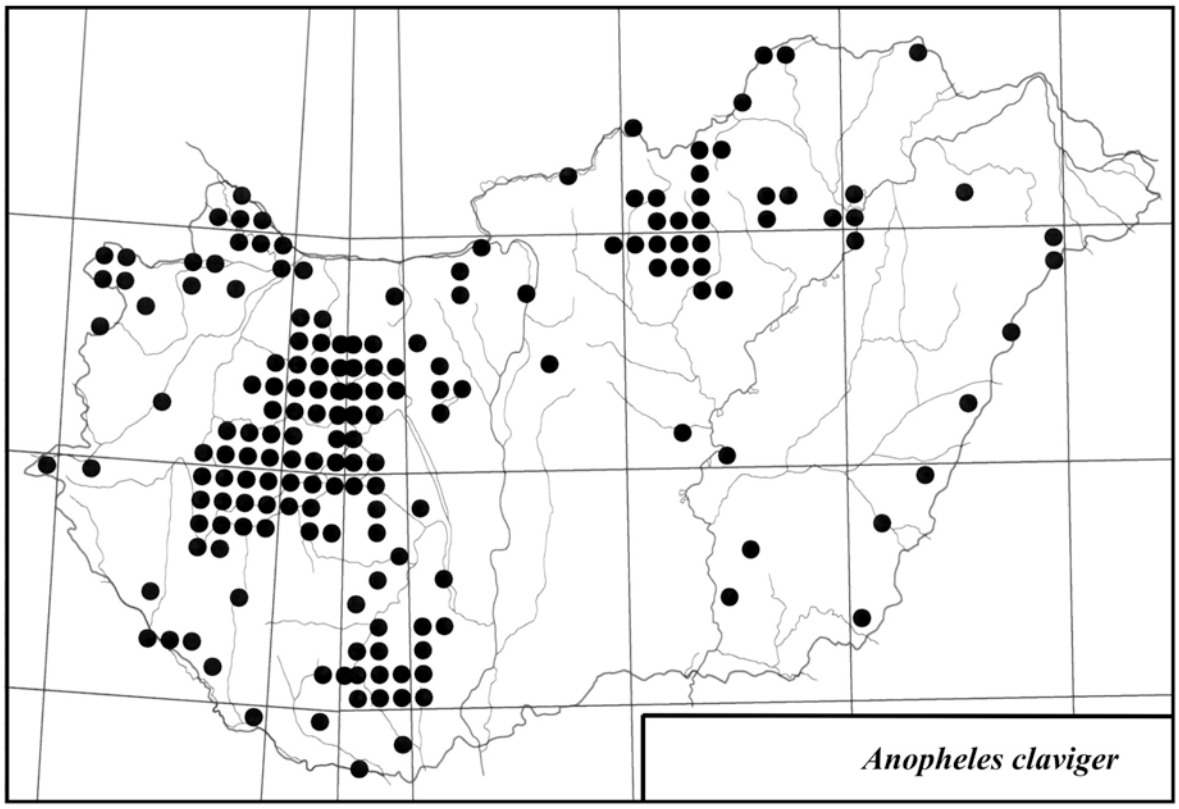
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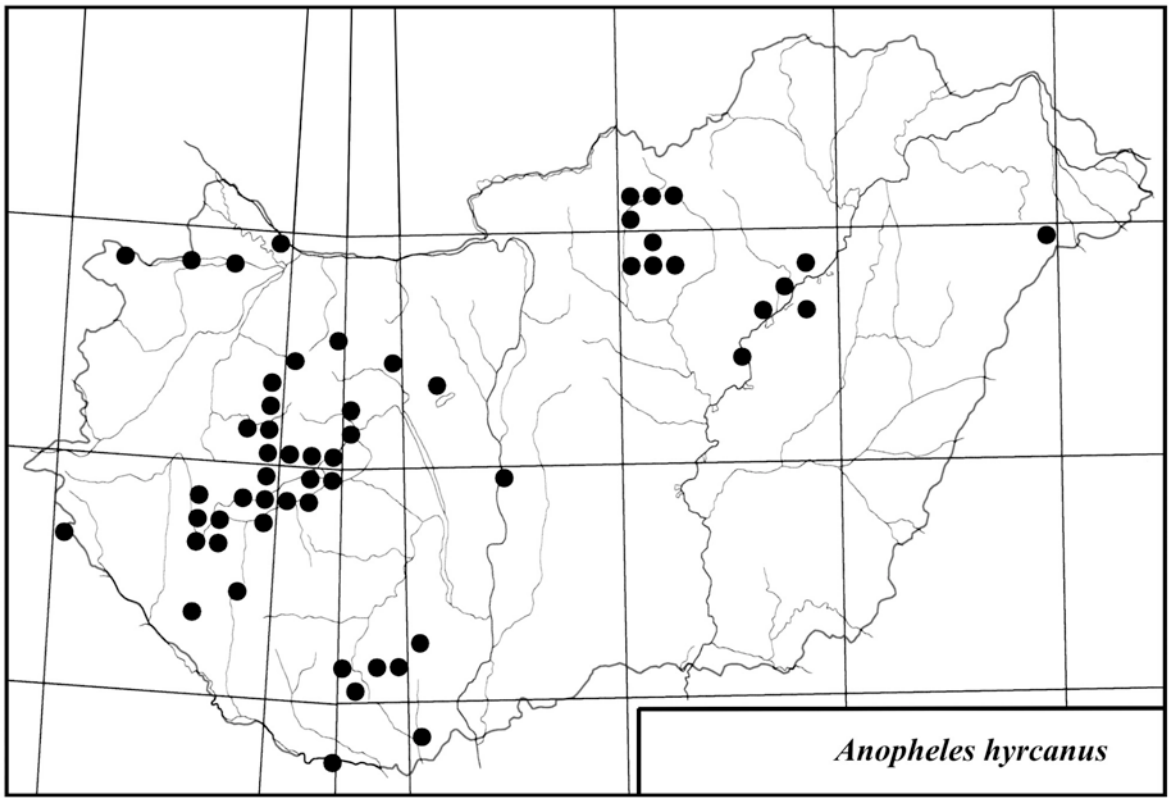
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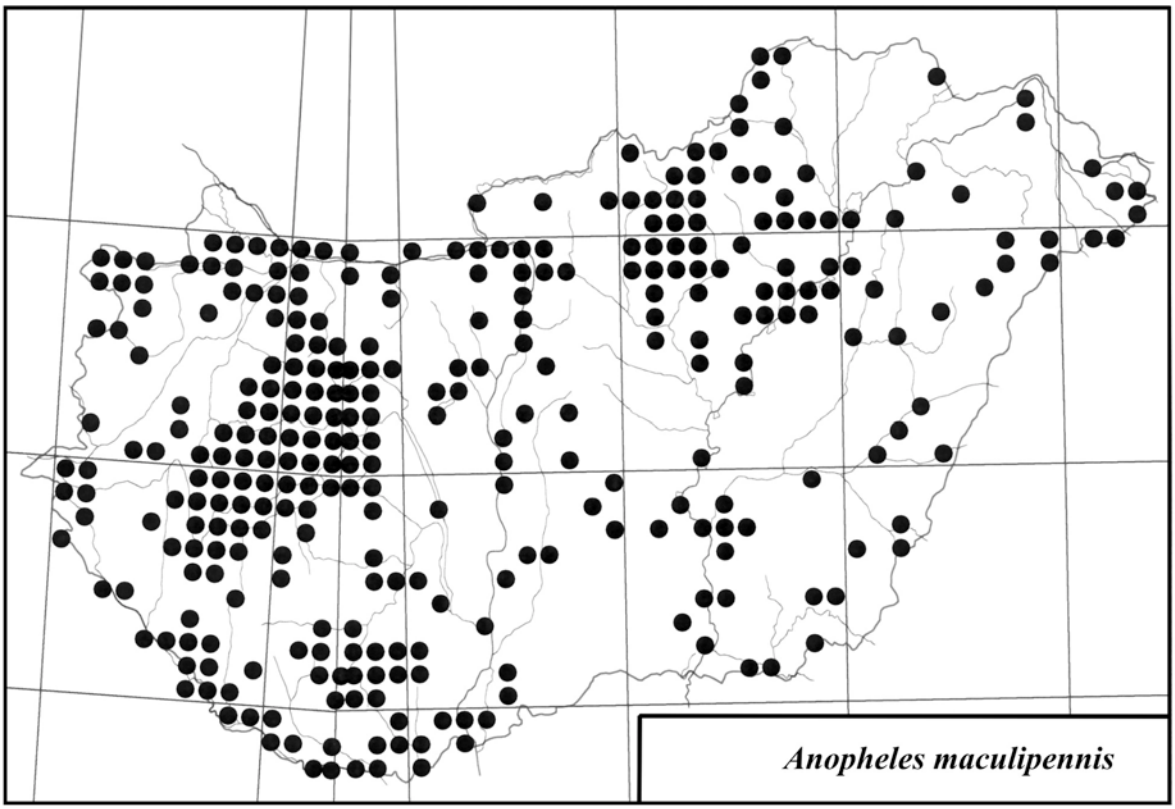
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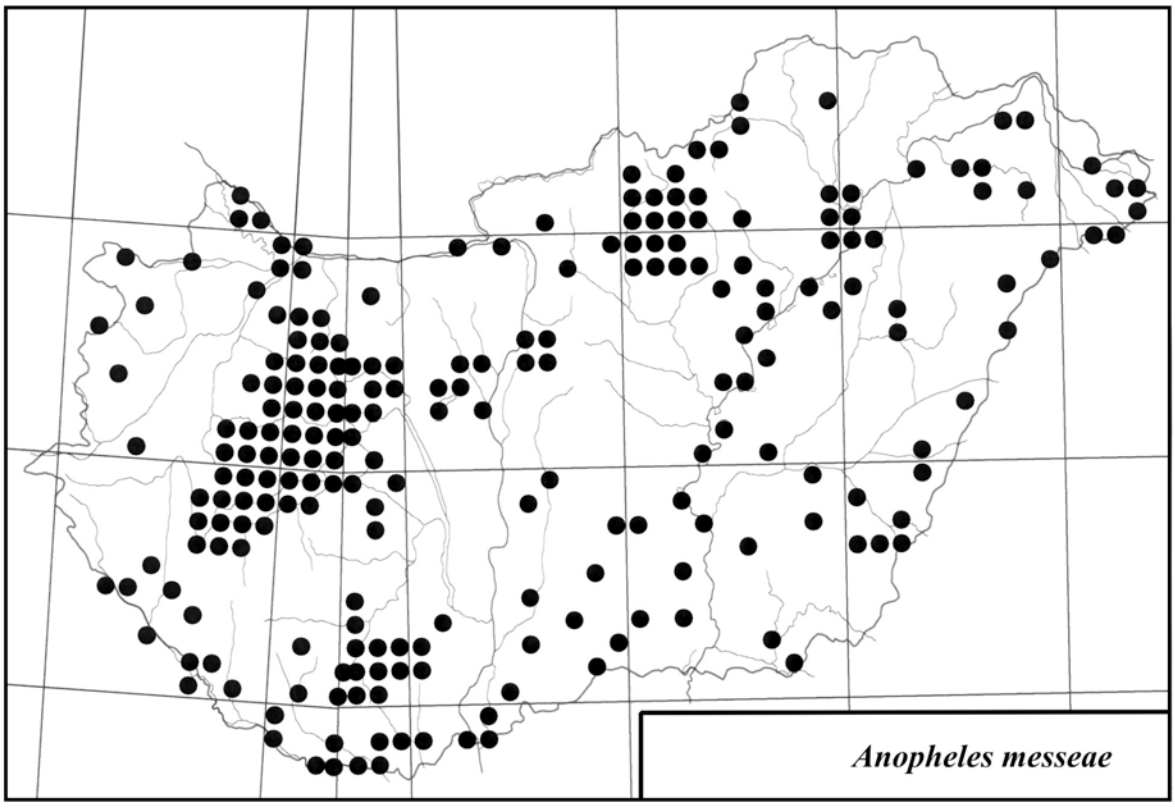
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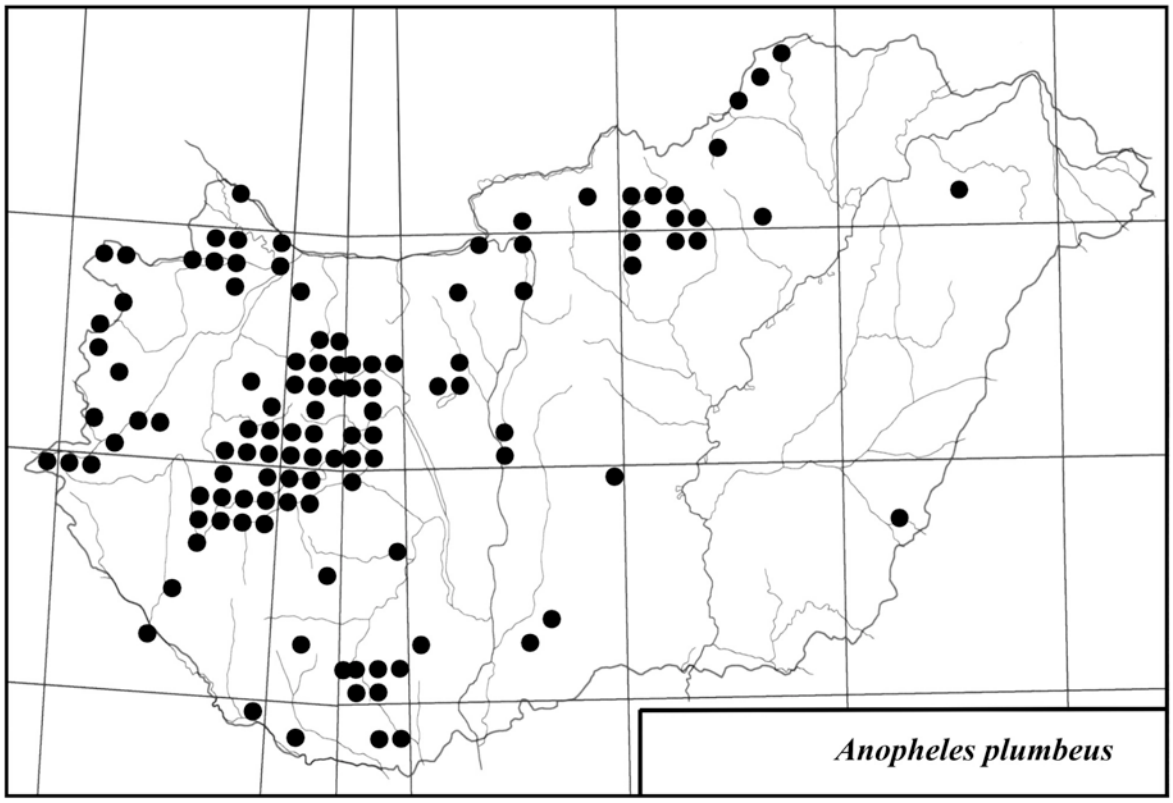
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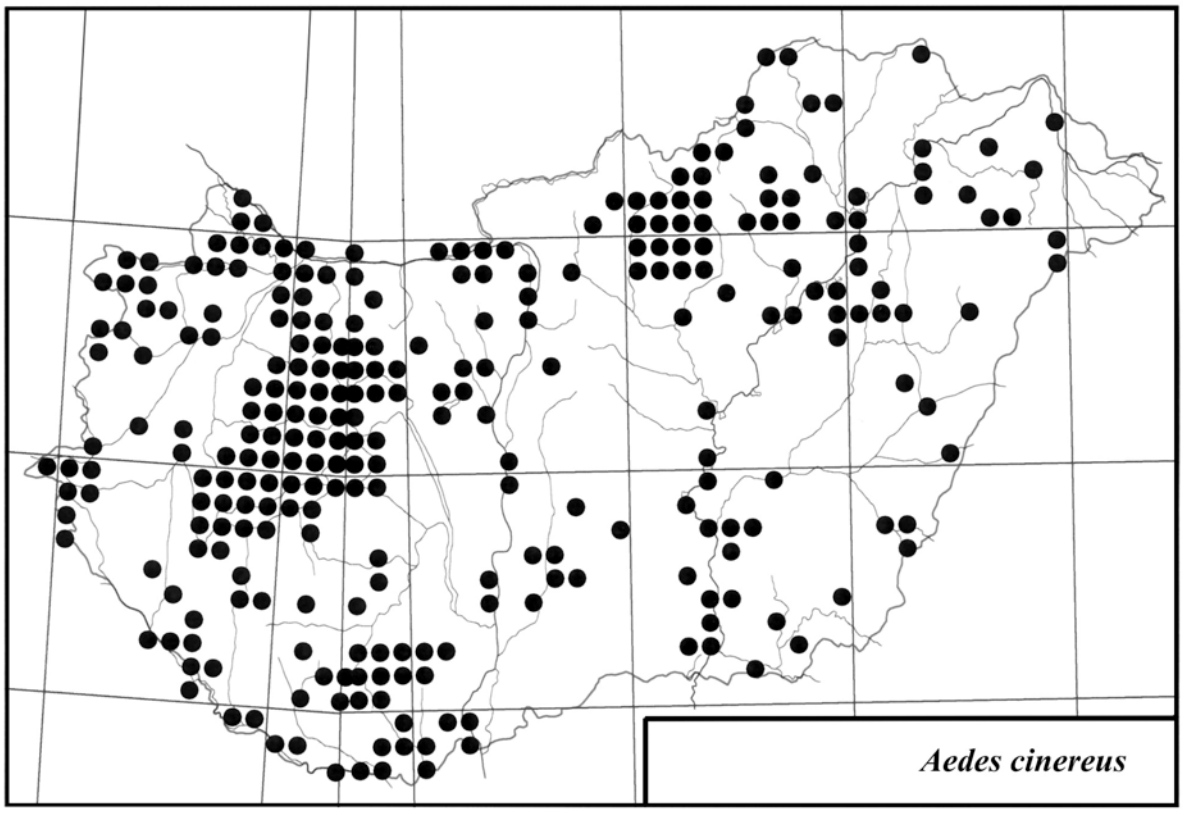
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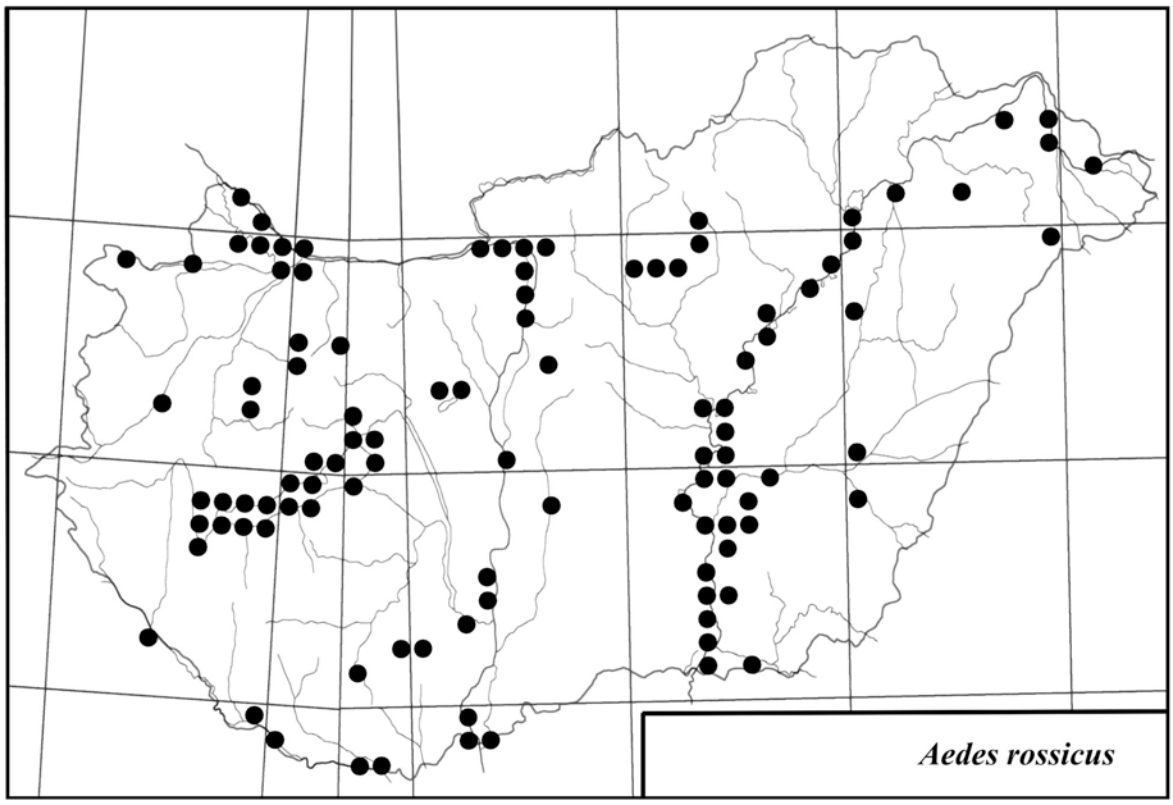
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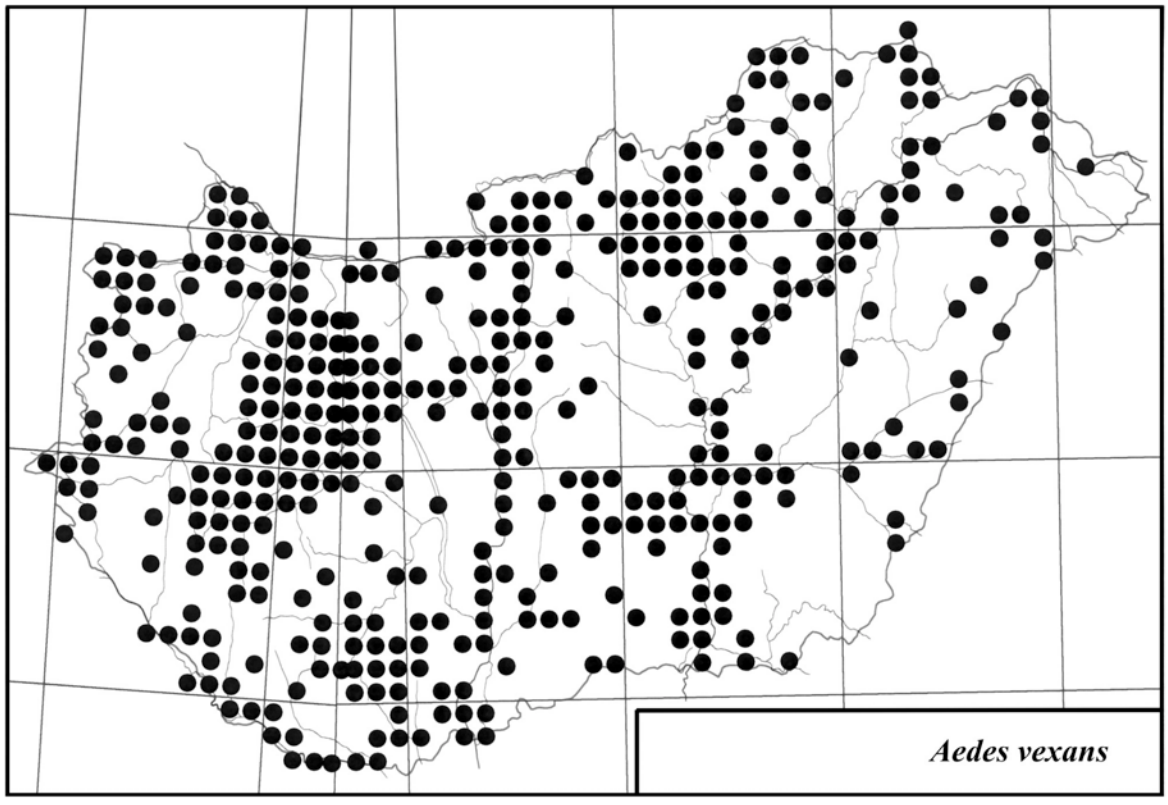
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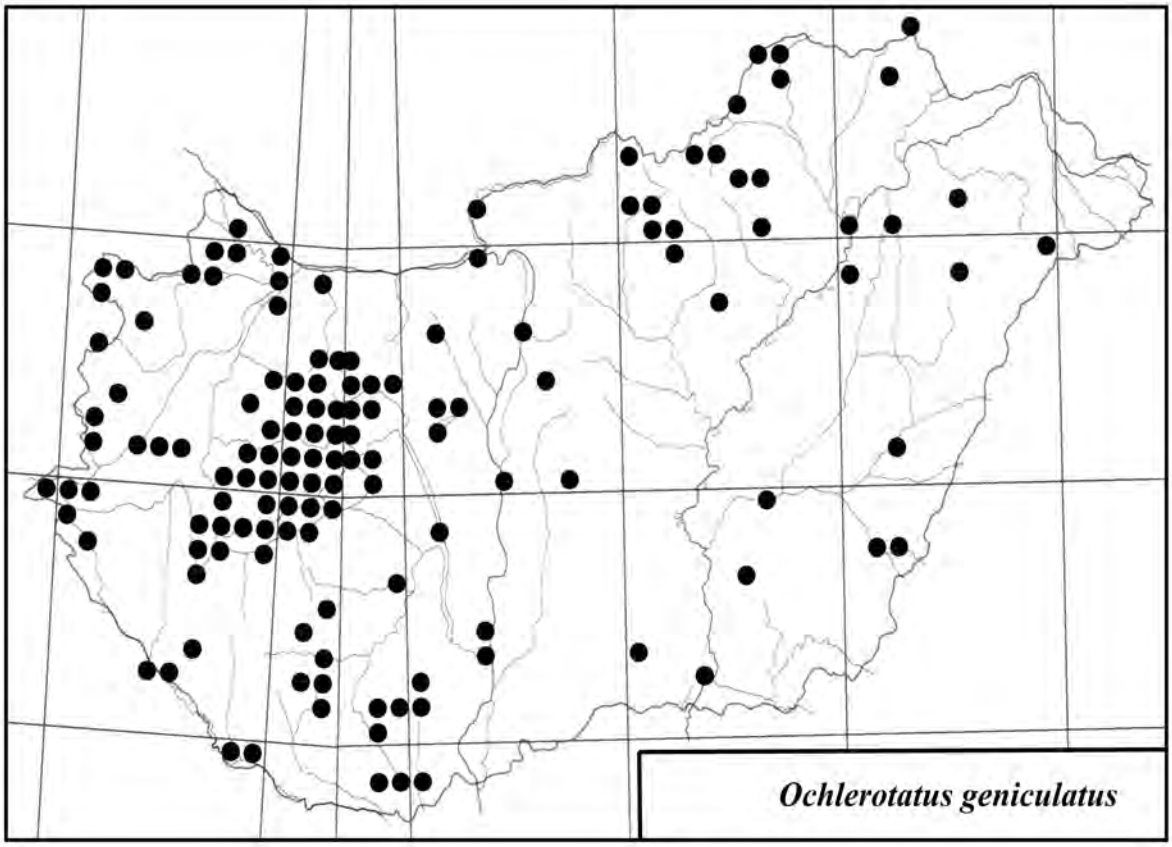
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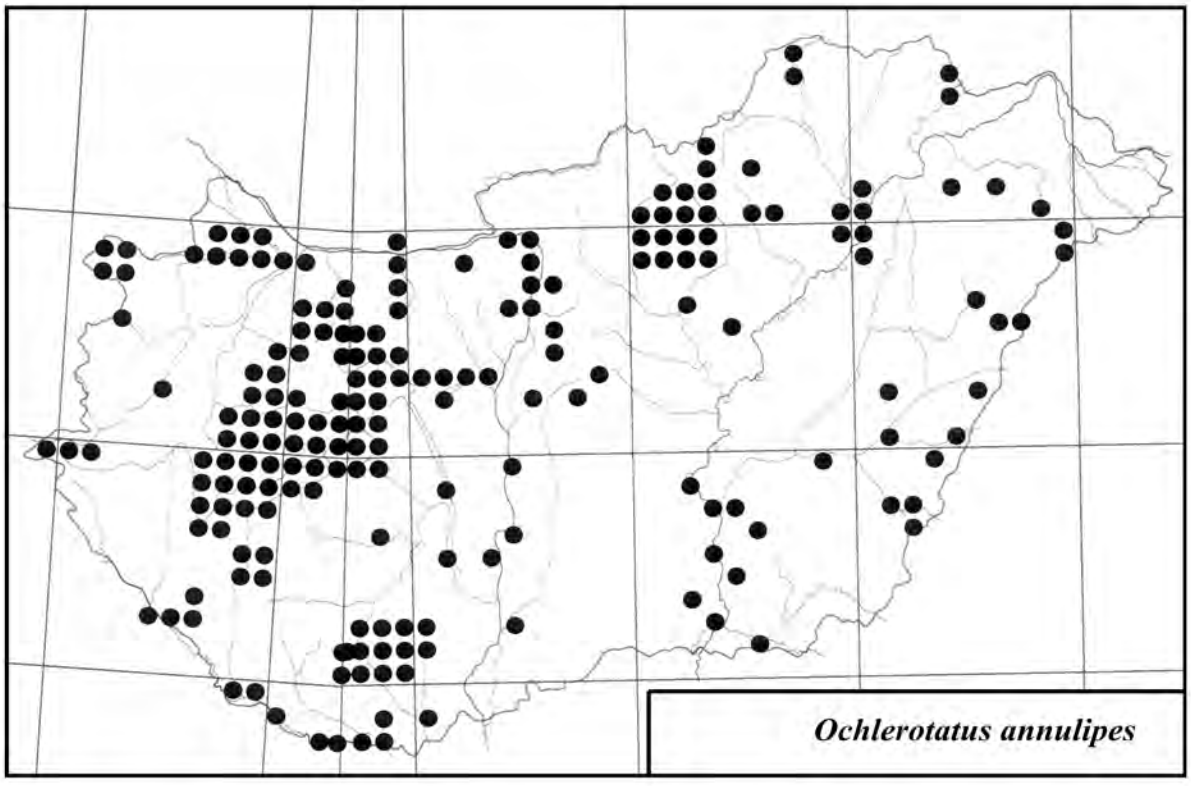
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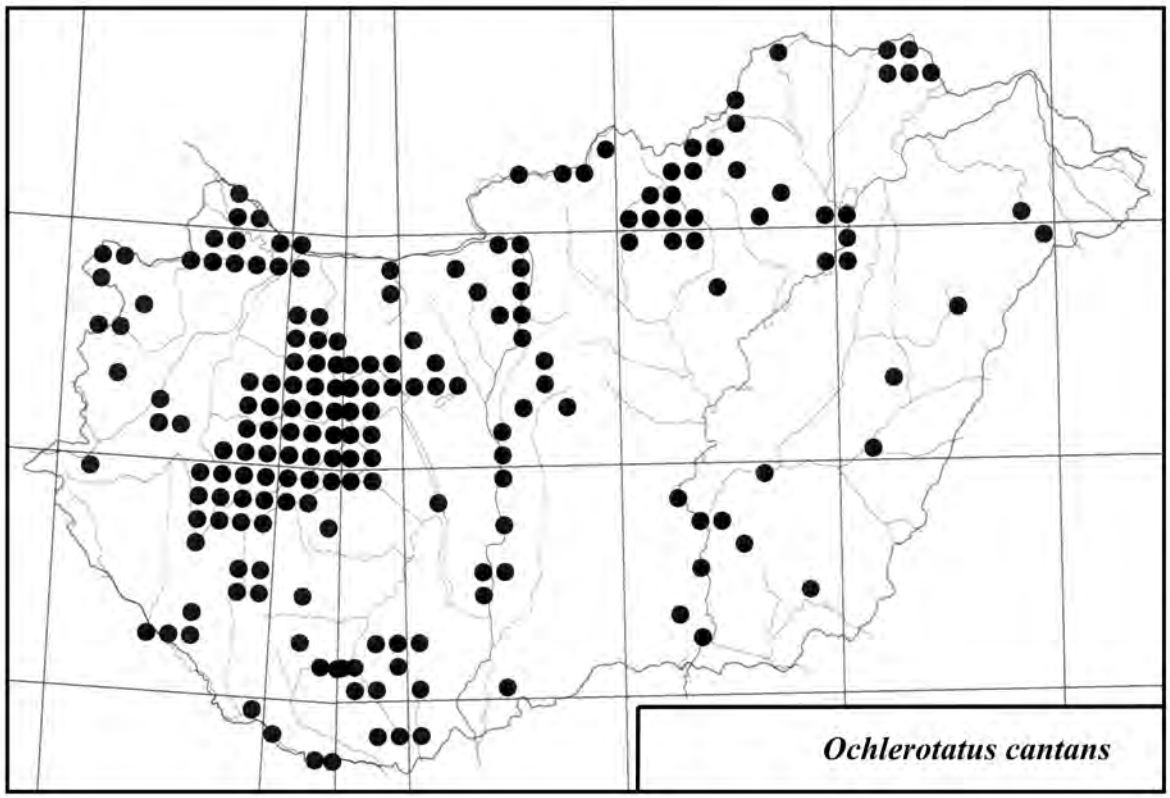
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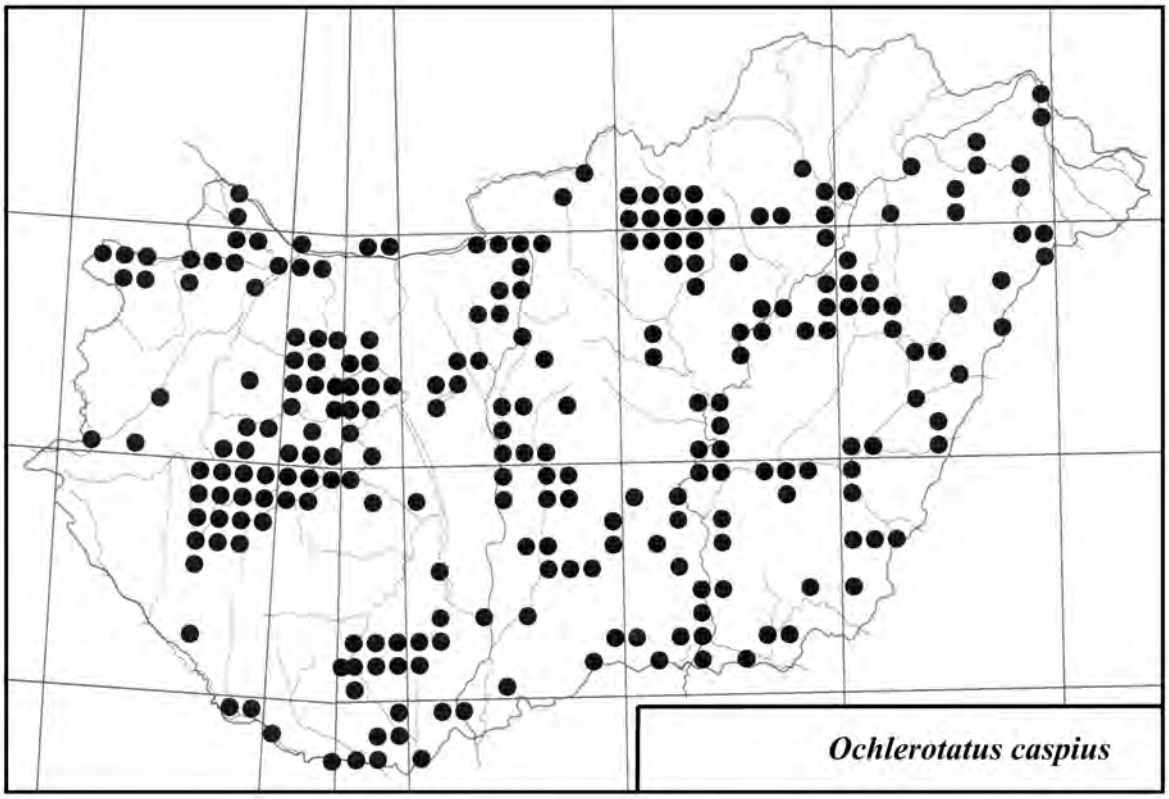
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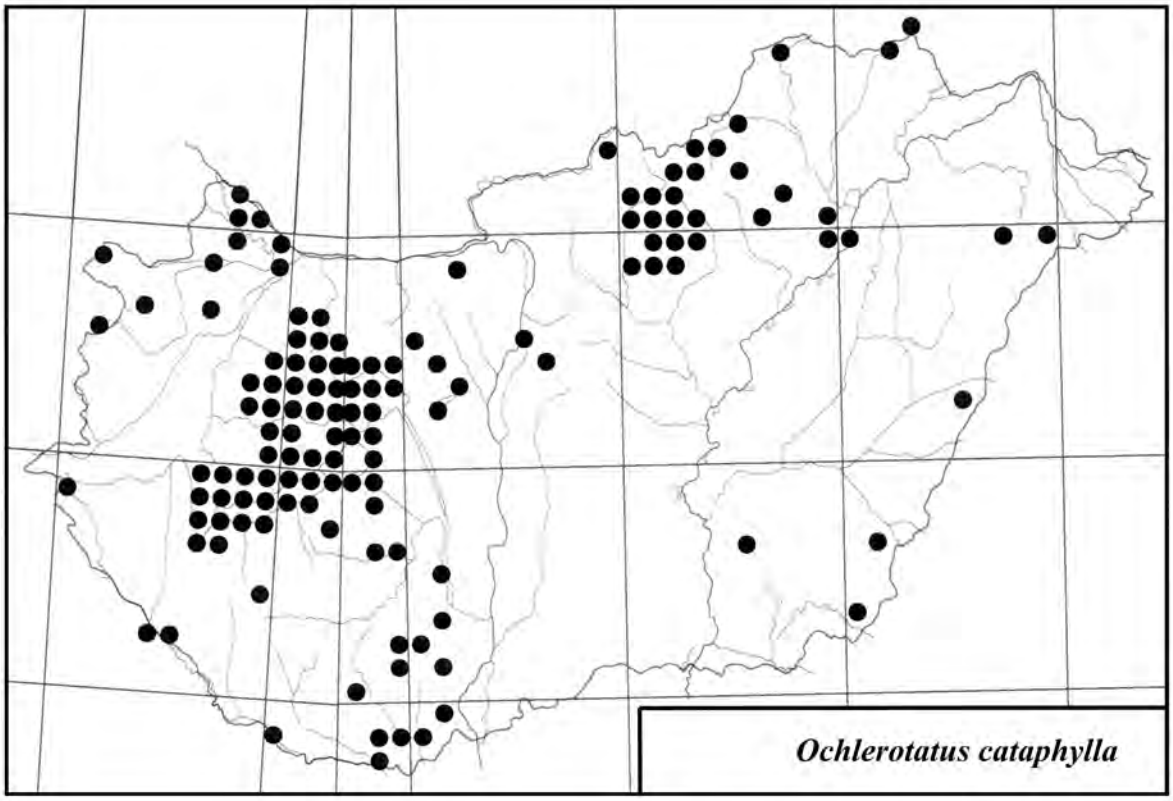
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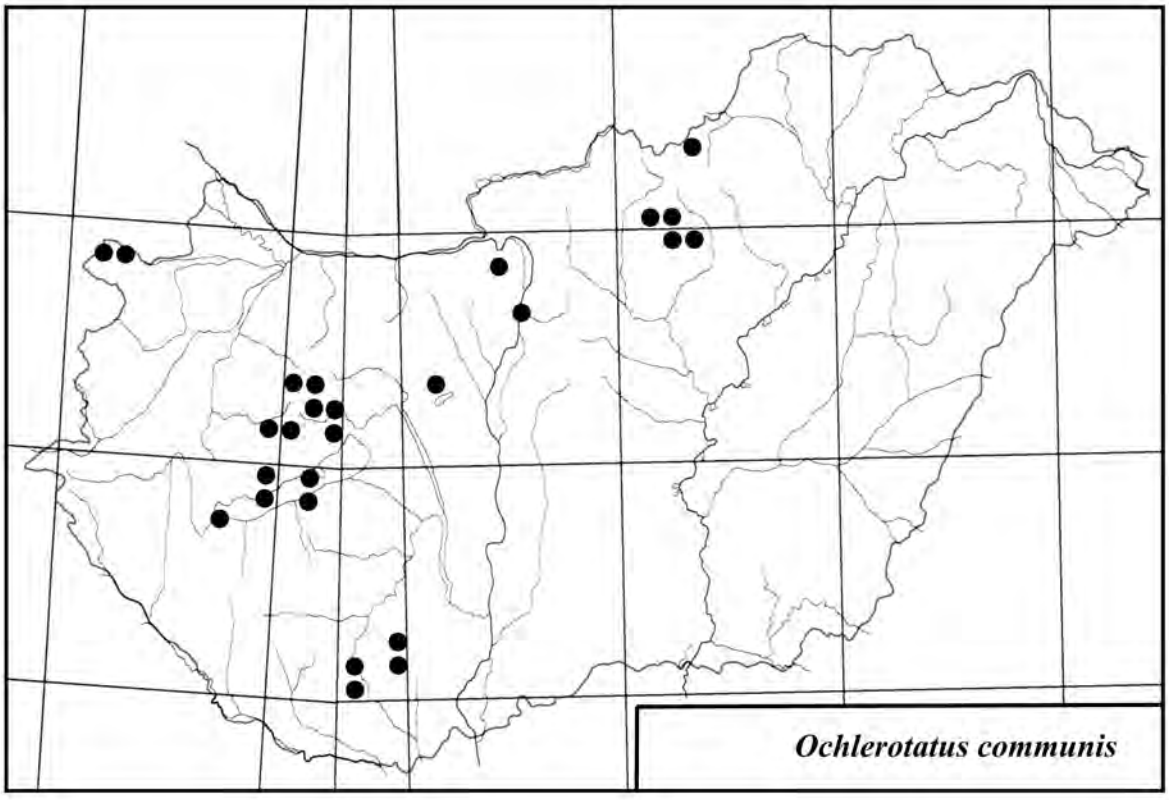
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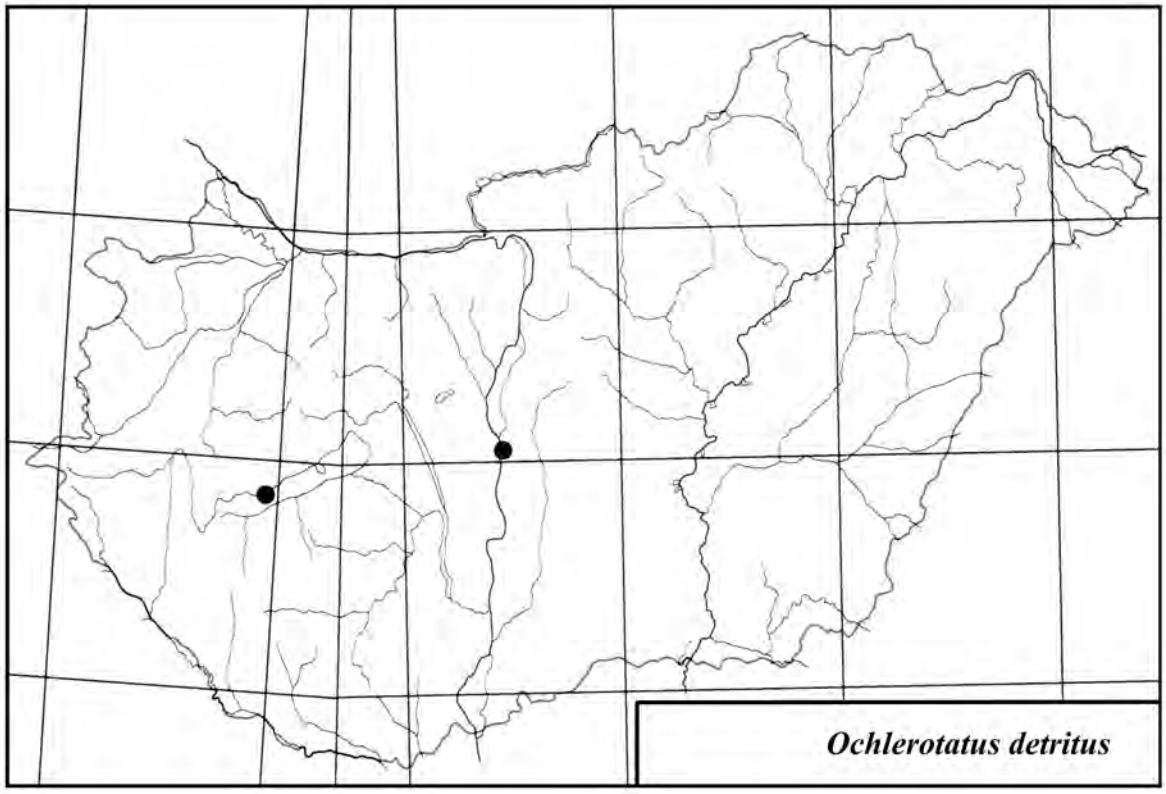
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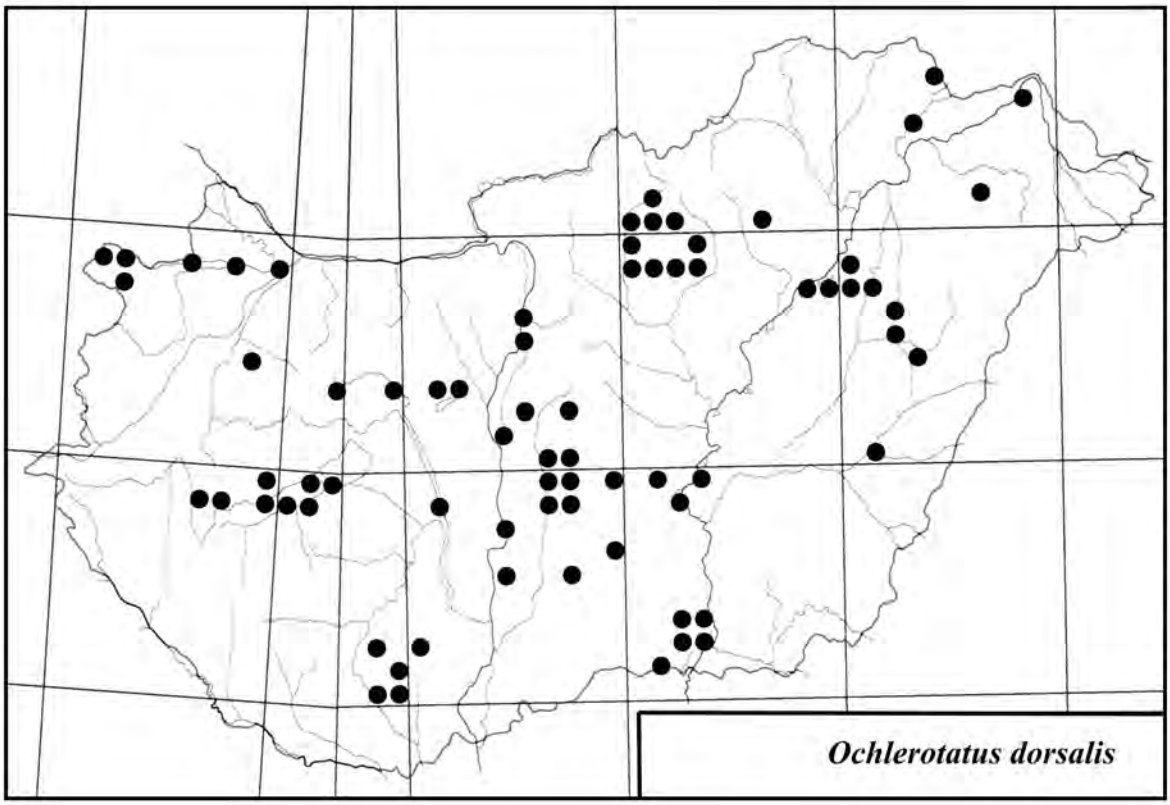
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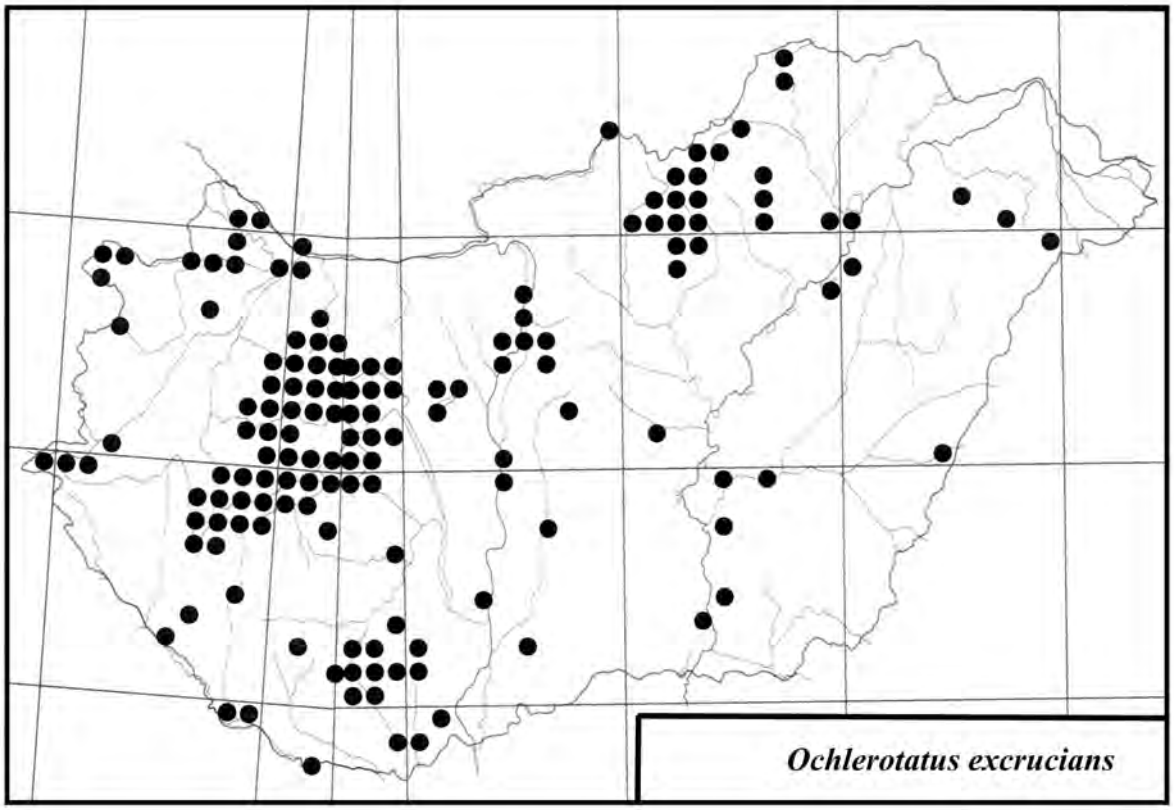
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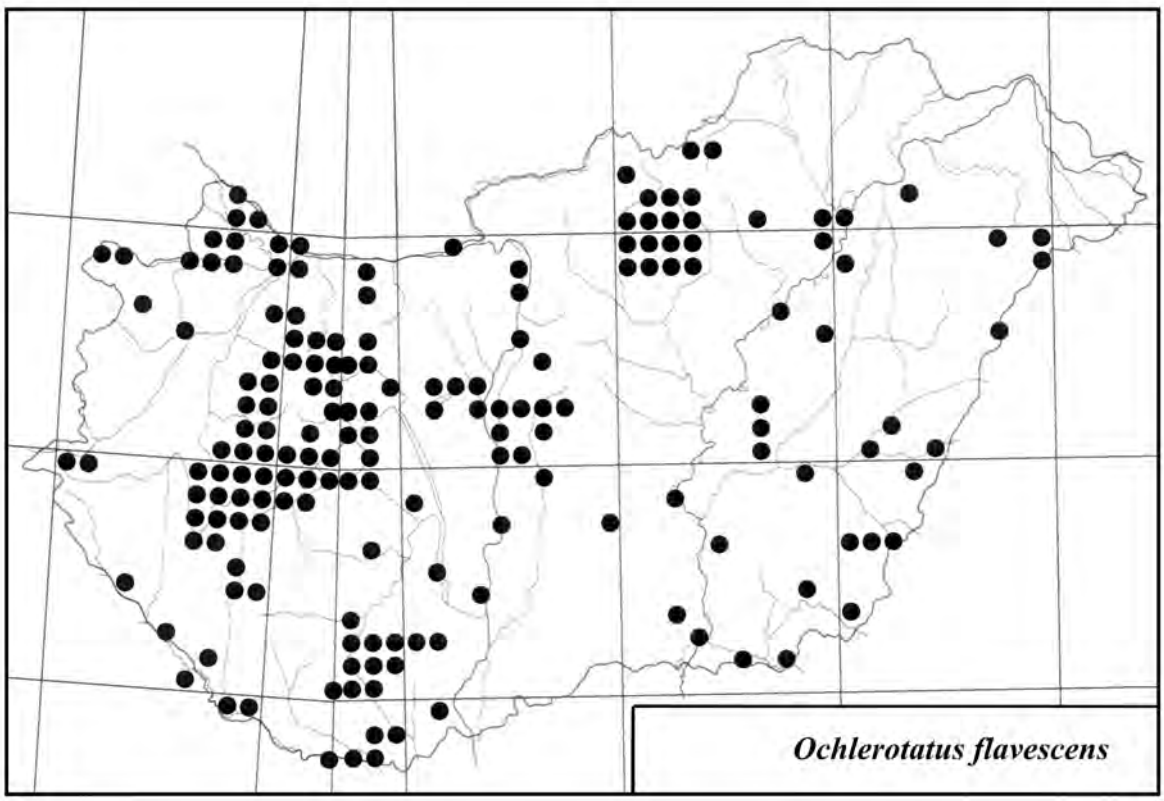
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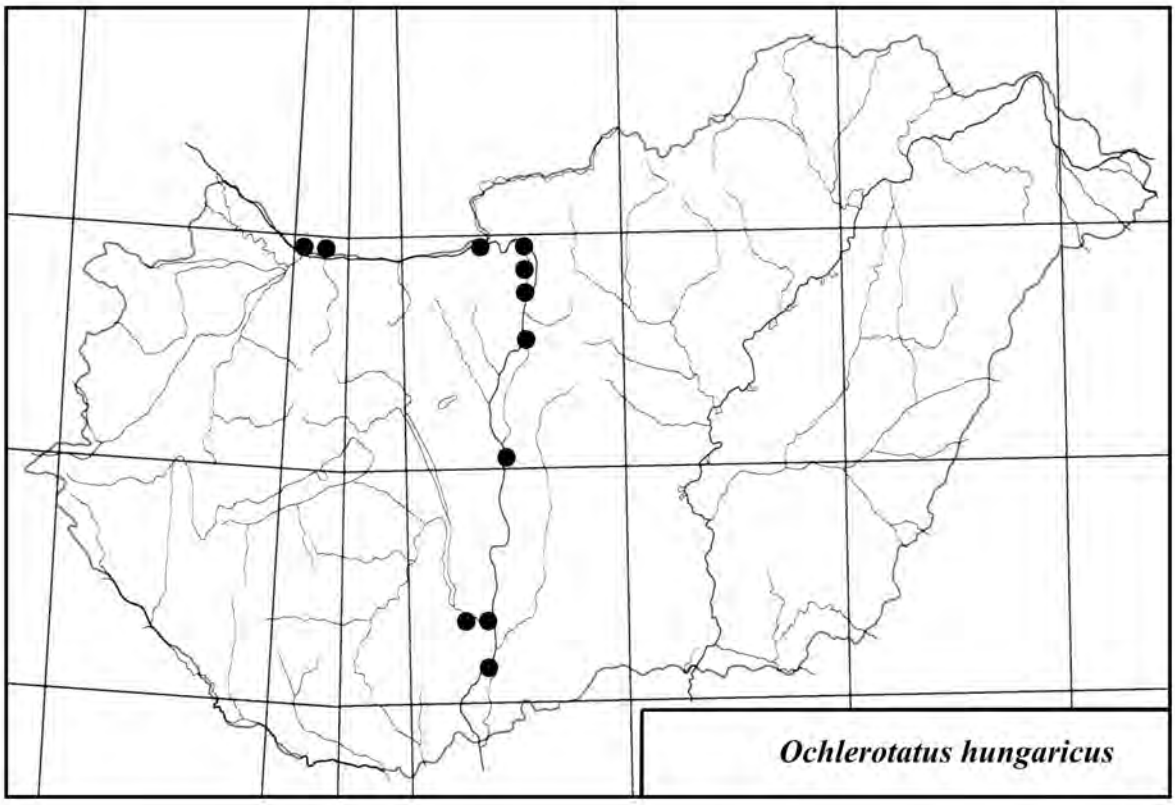
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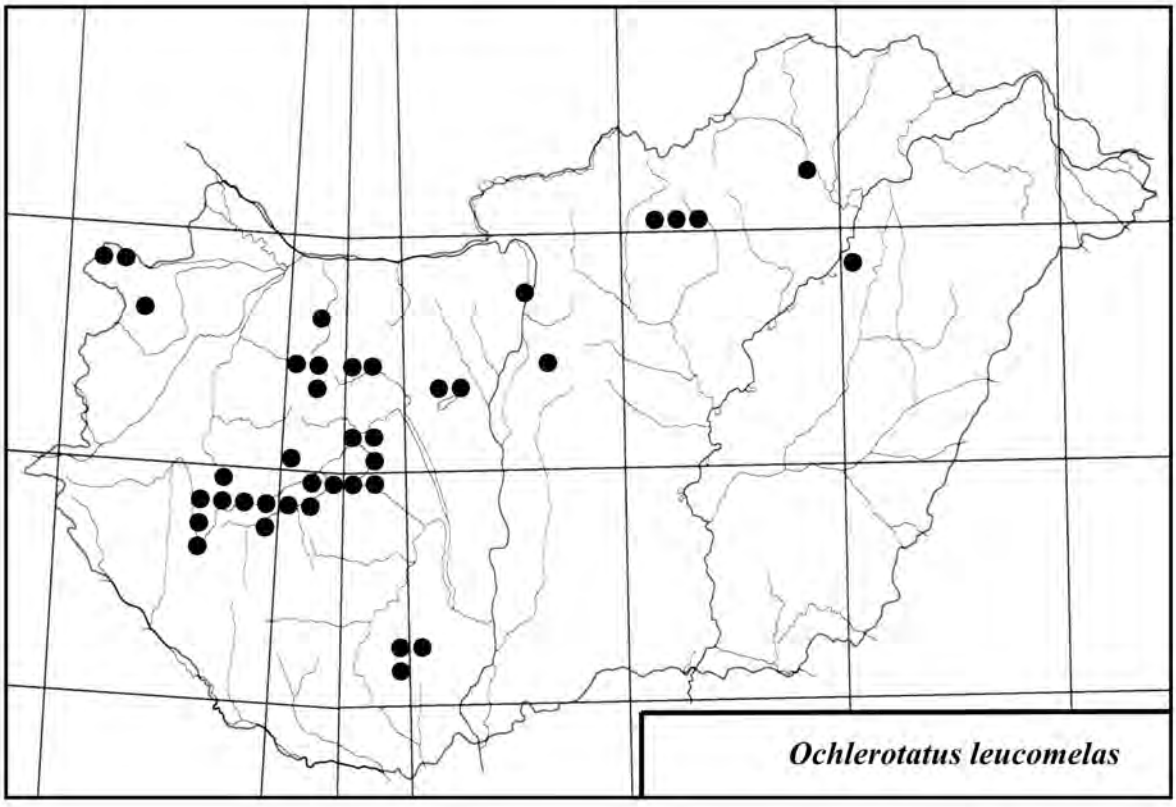
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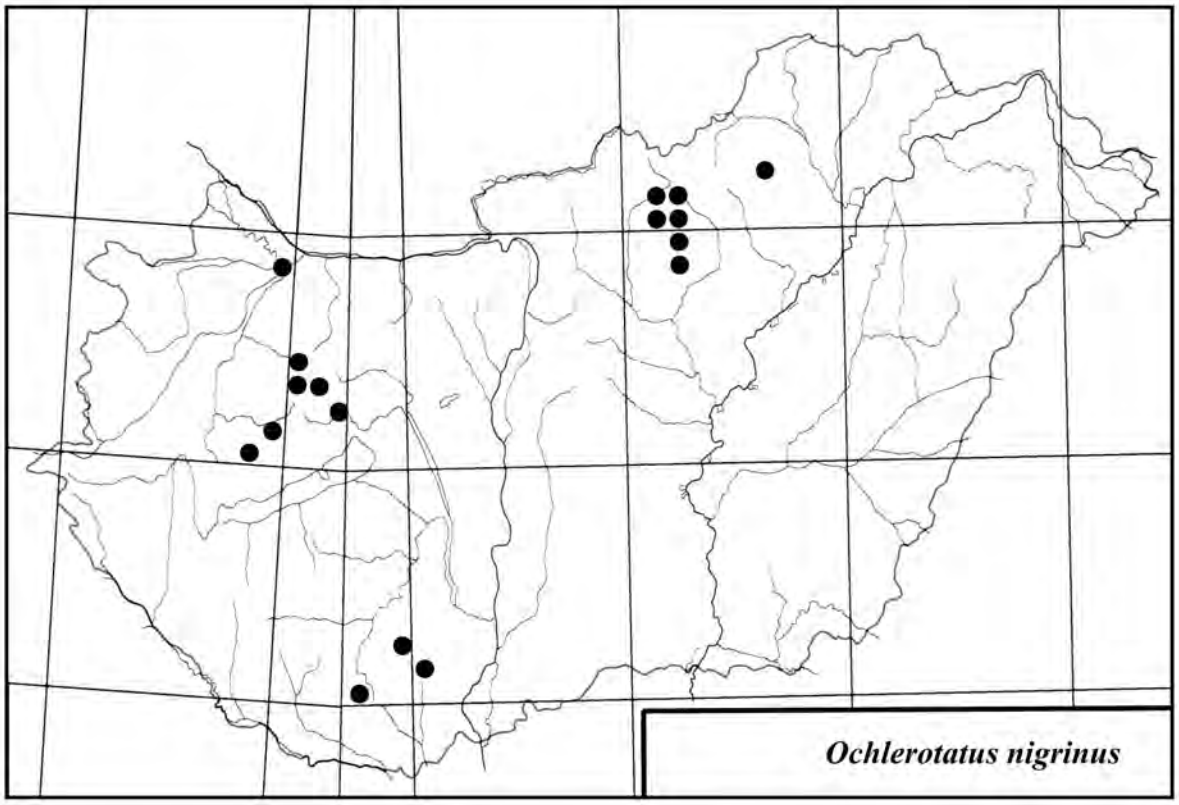
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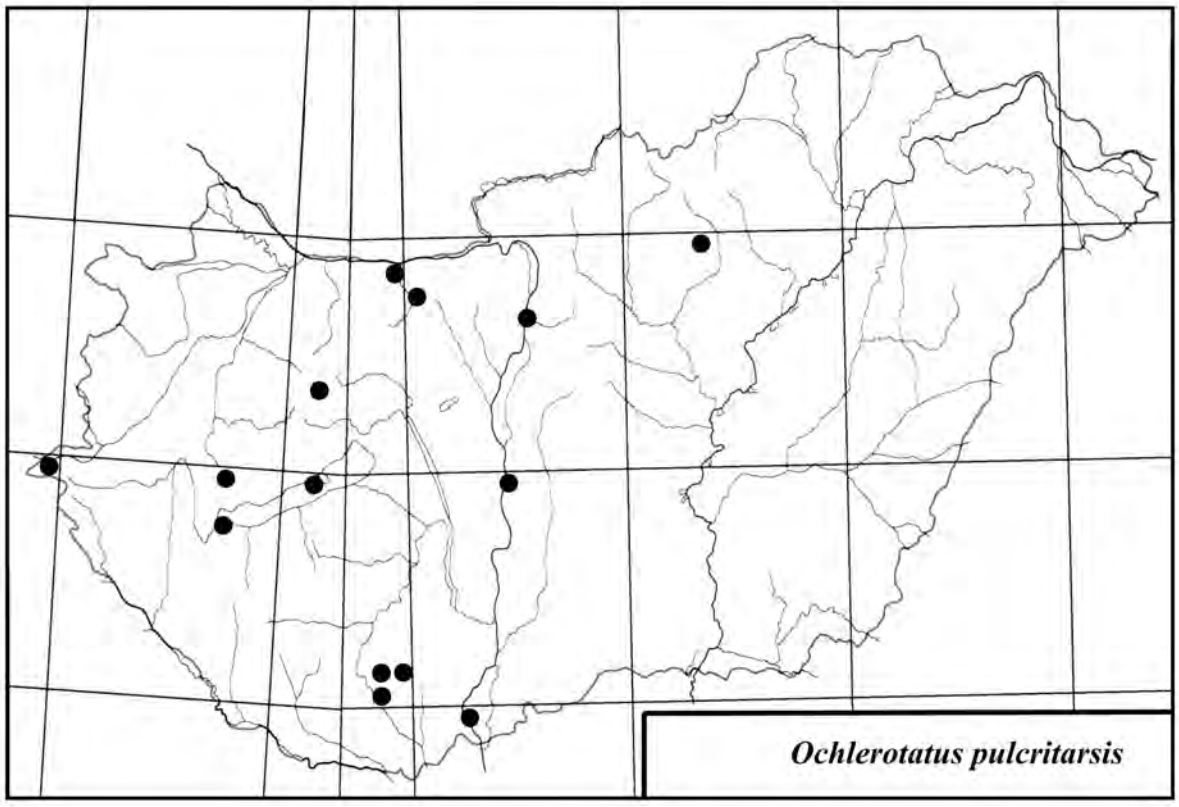
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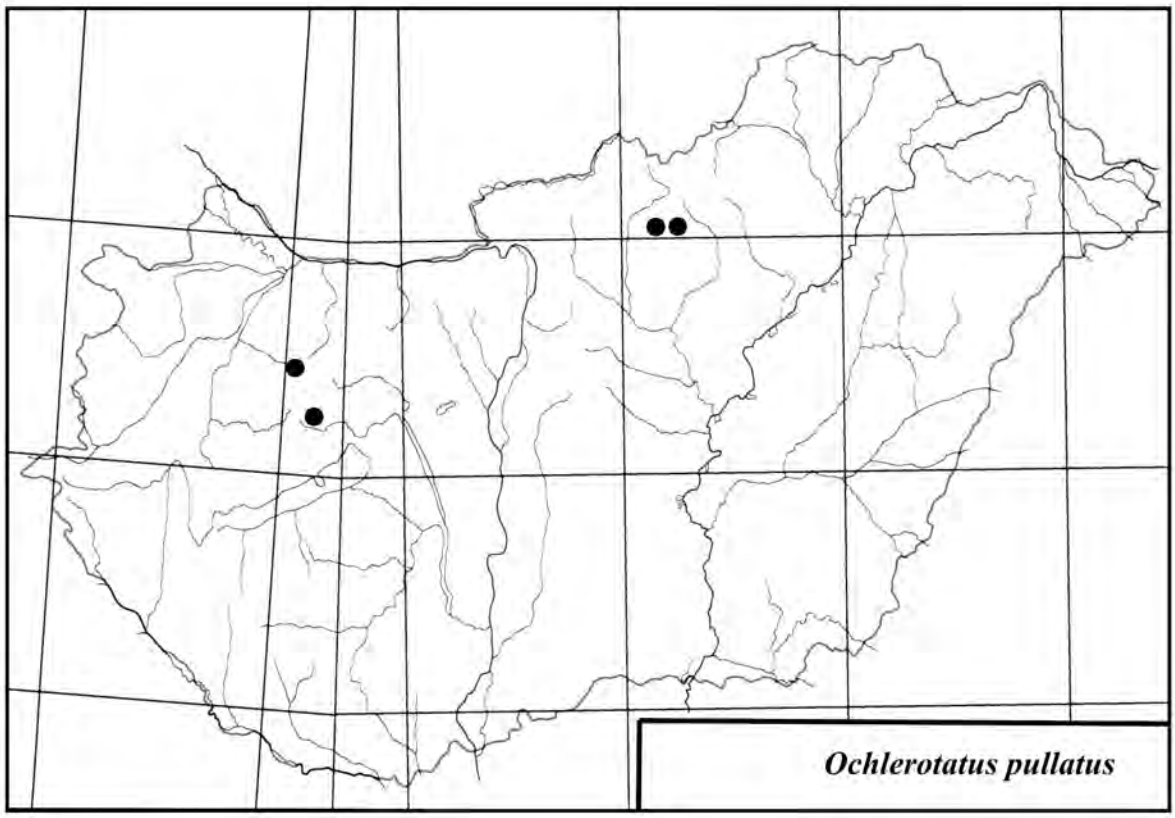
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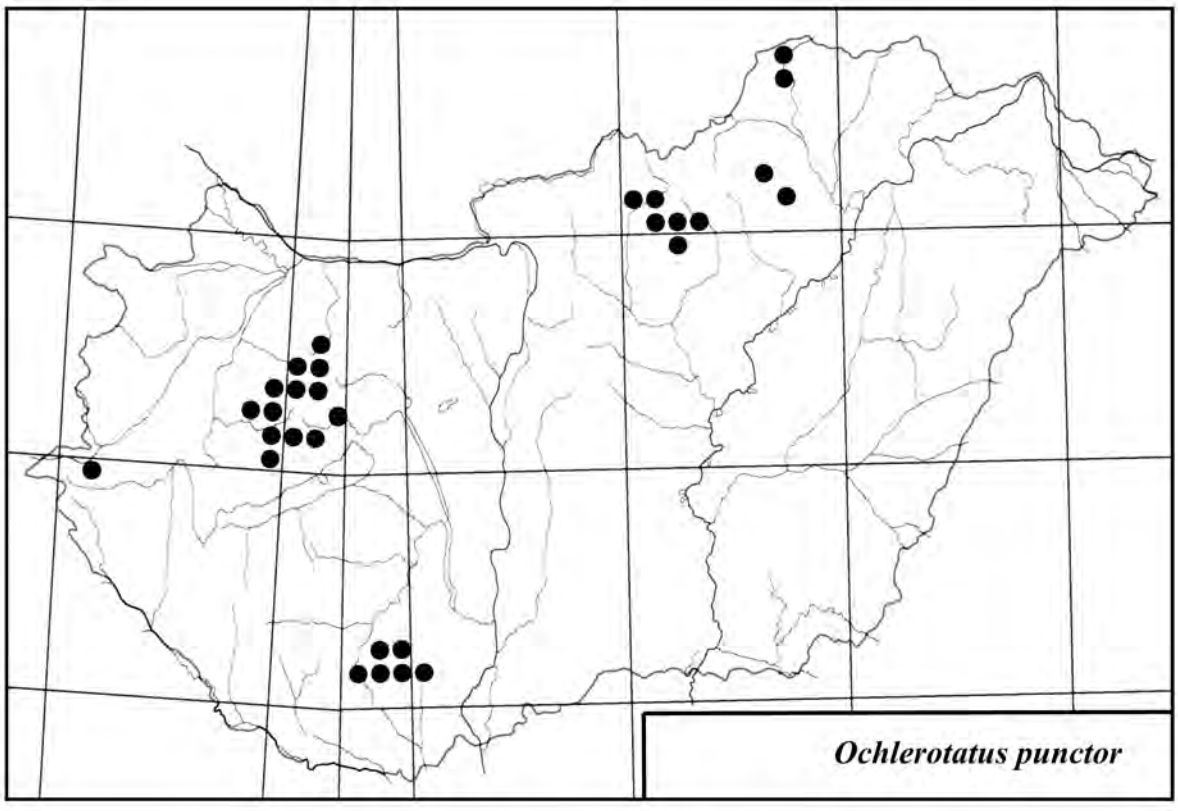
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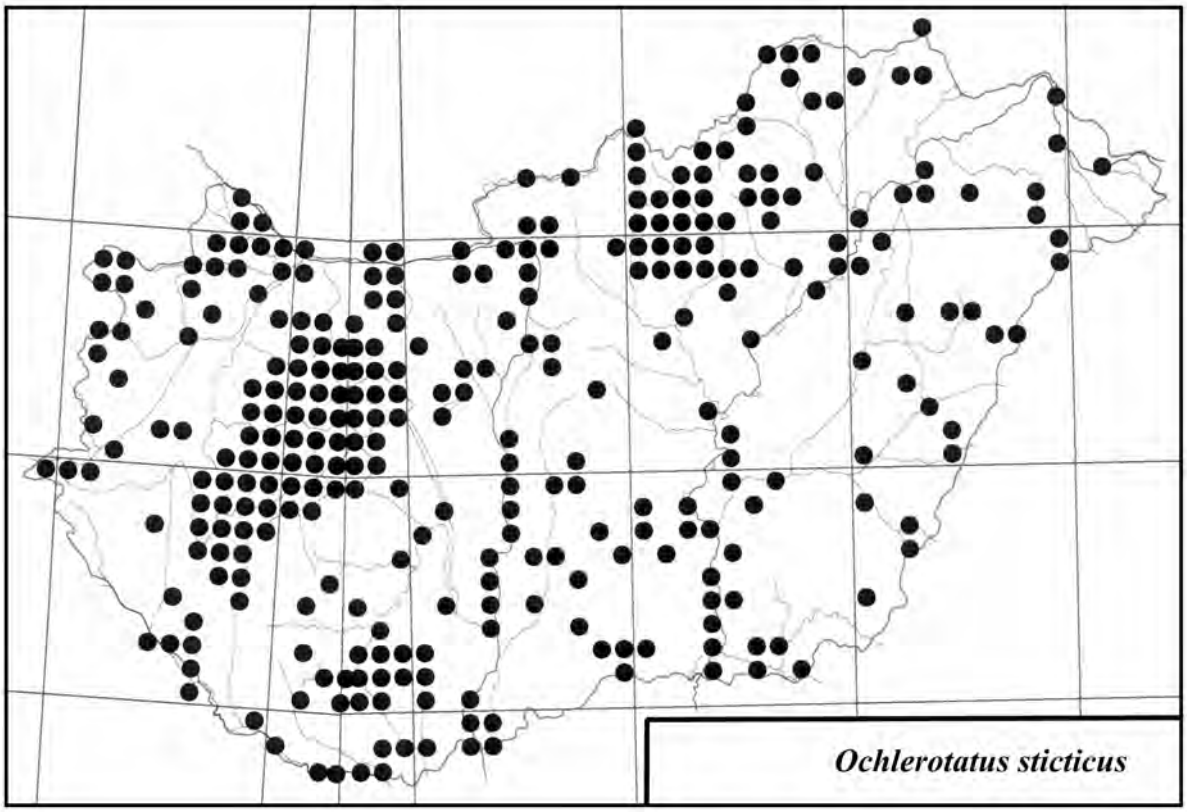
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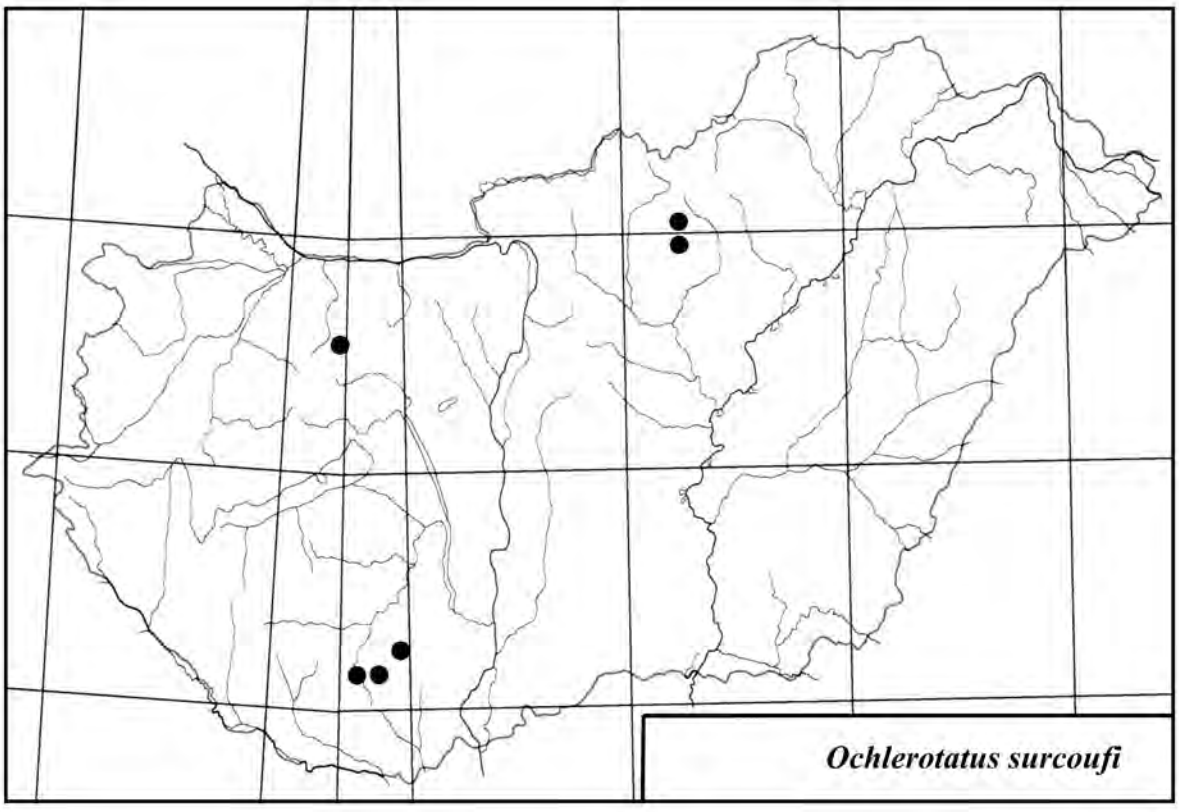
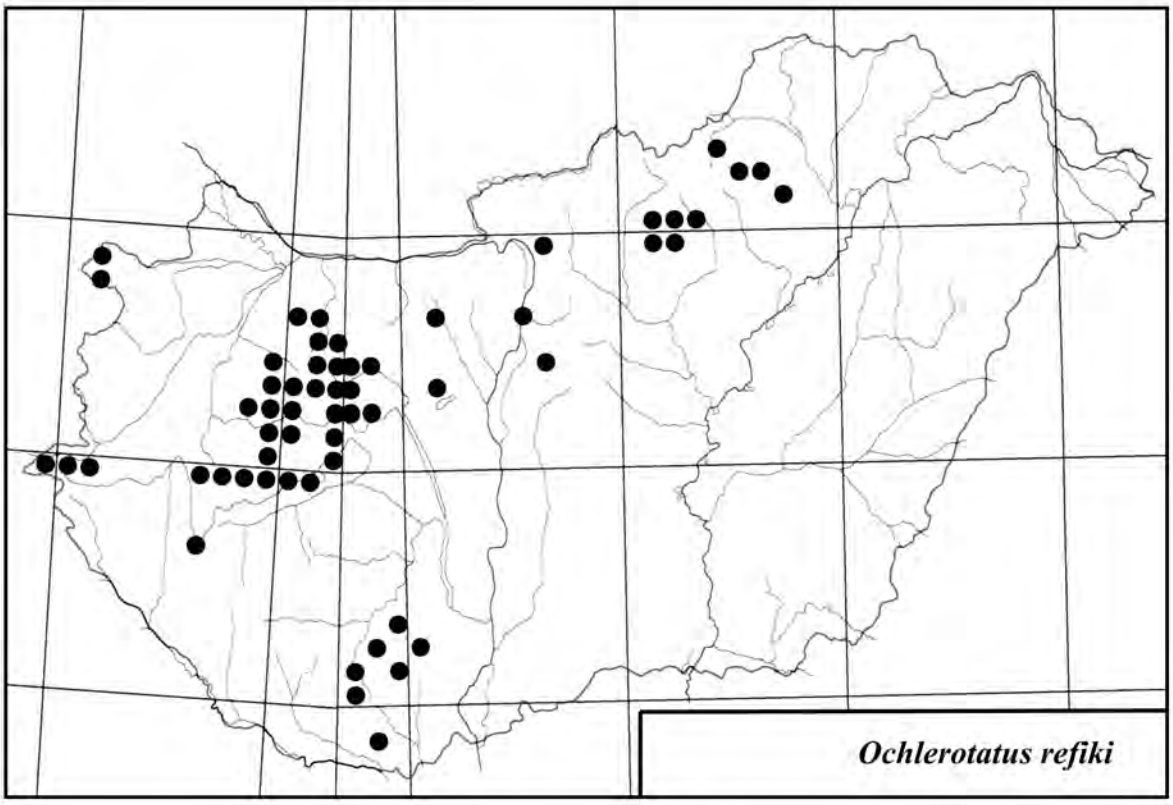

Ochlerotatus surcoufi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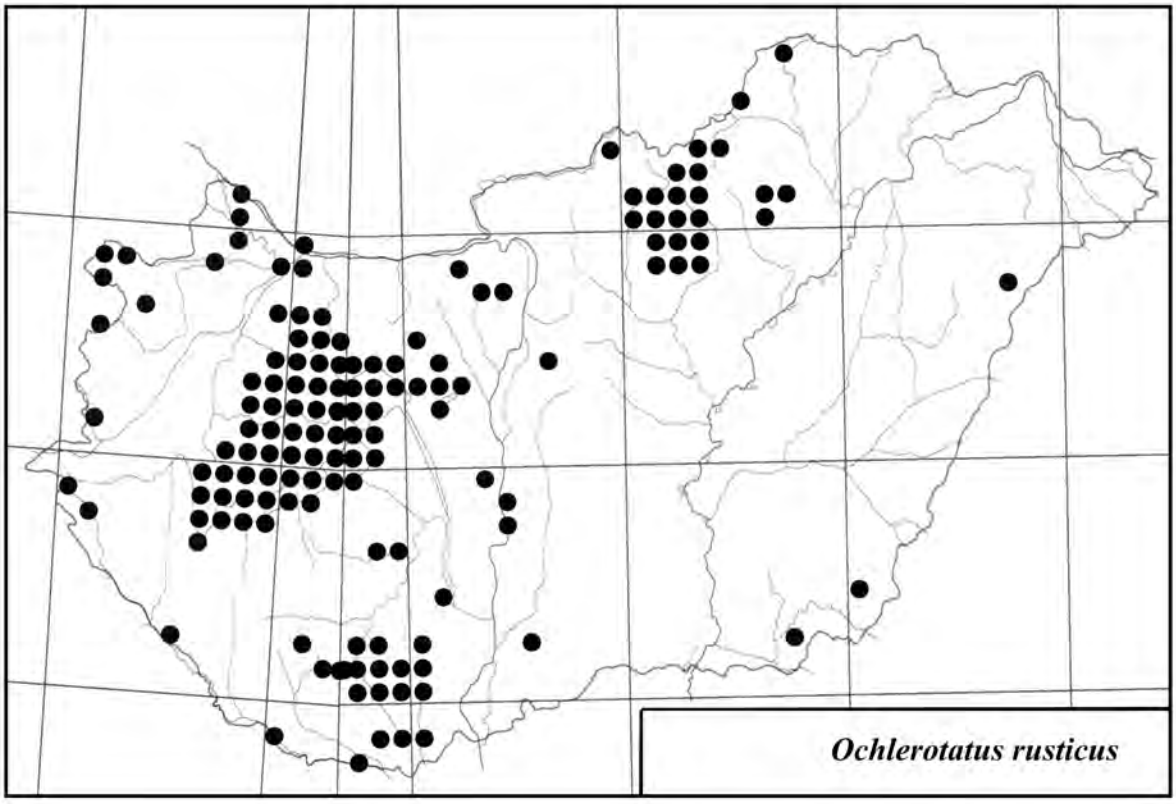
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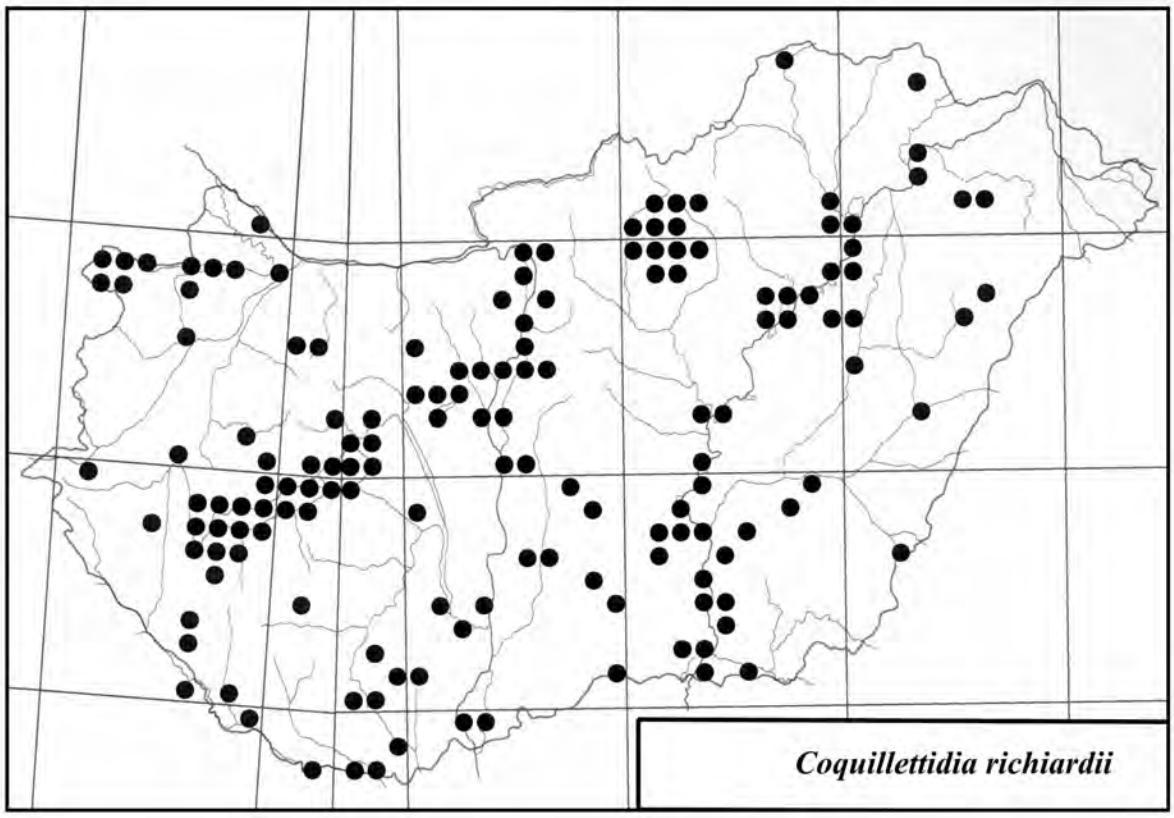
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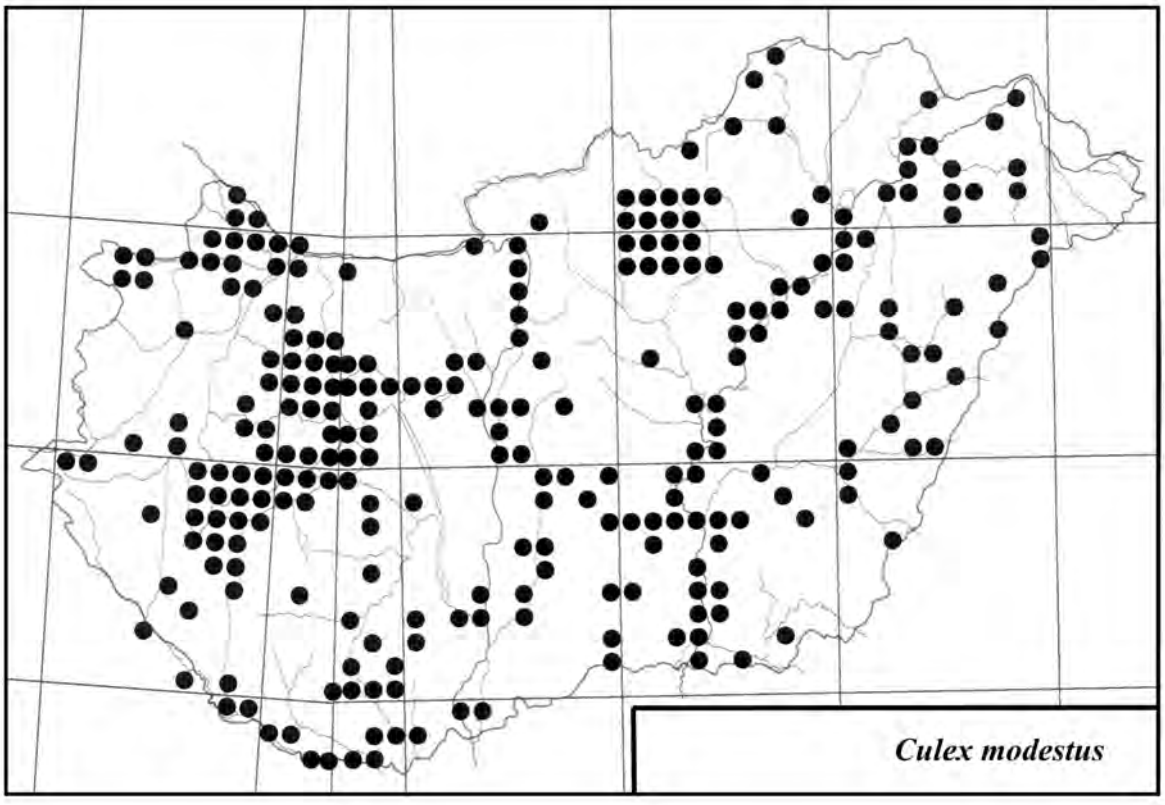
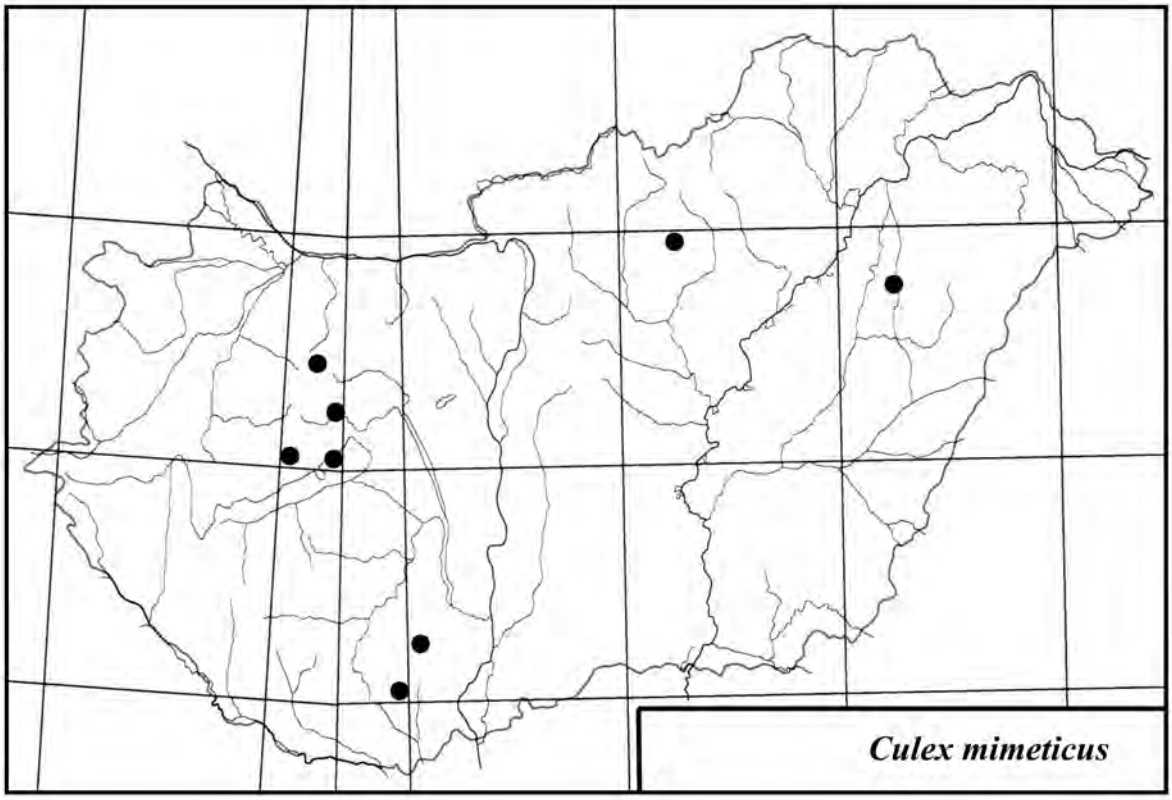

Culex modestus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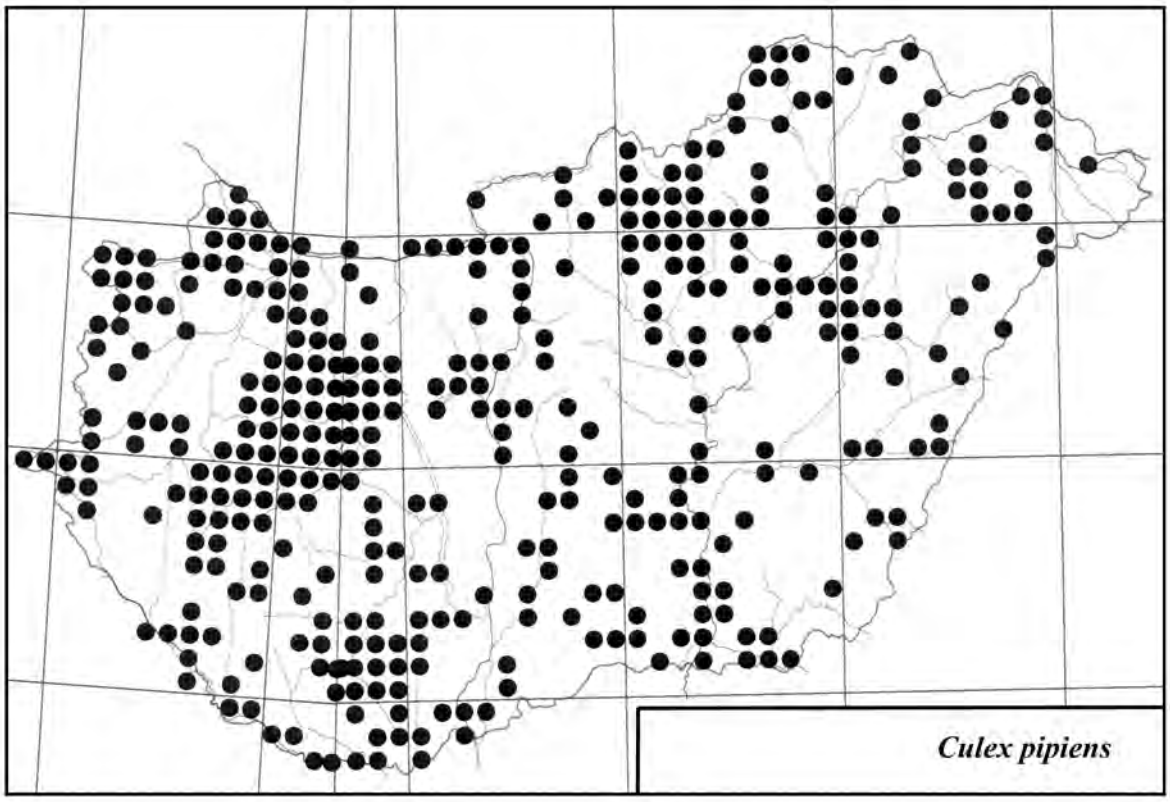
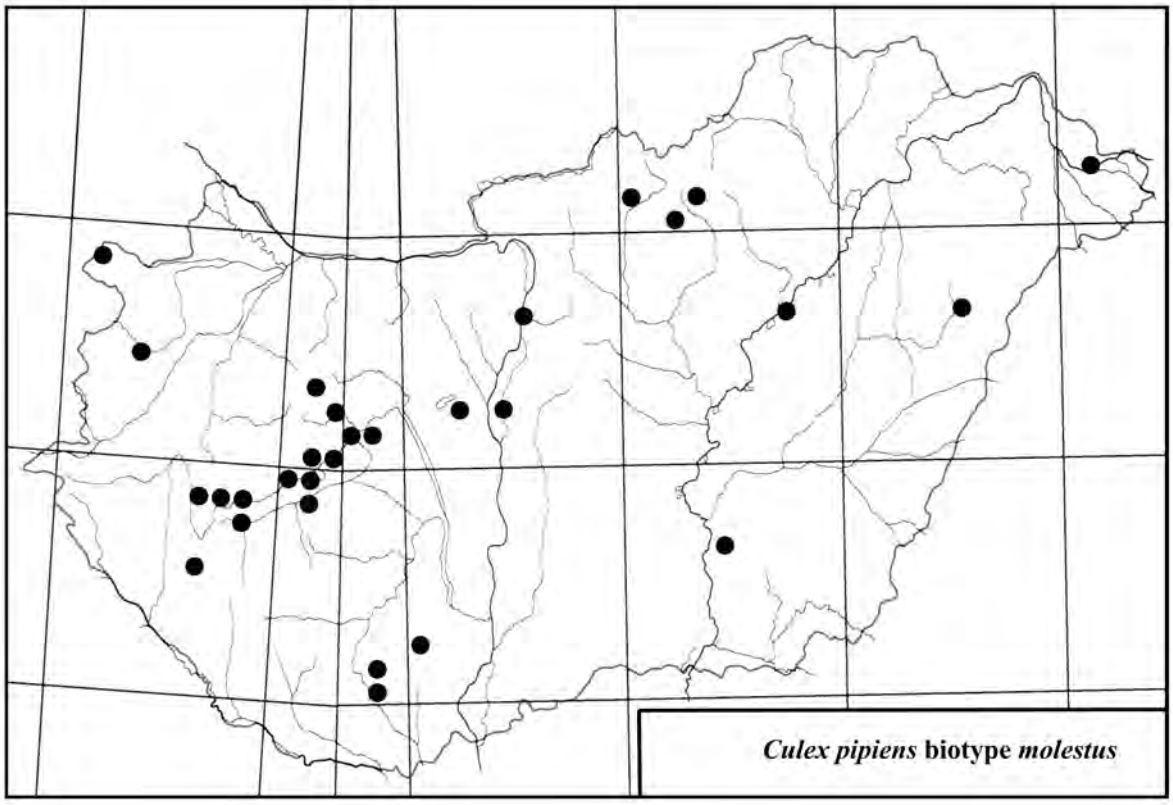
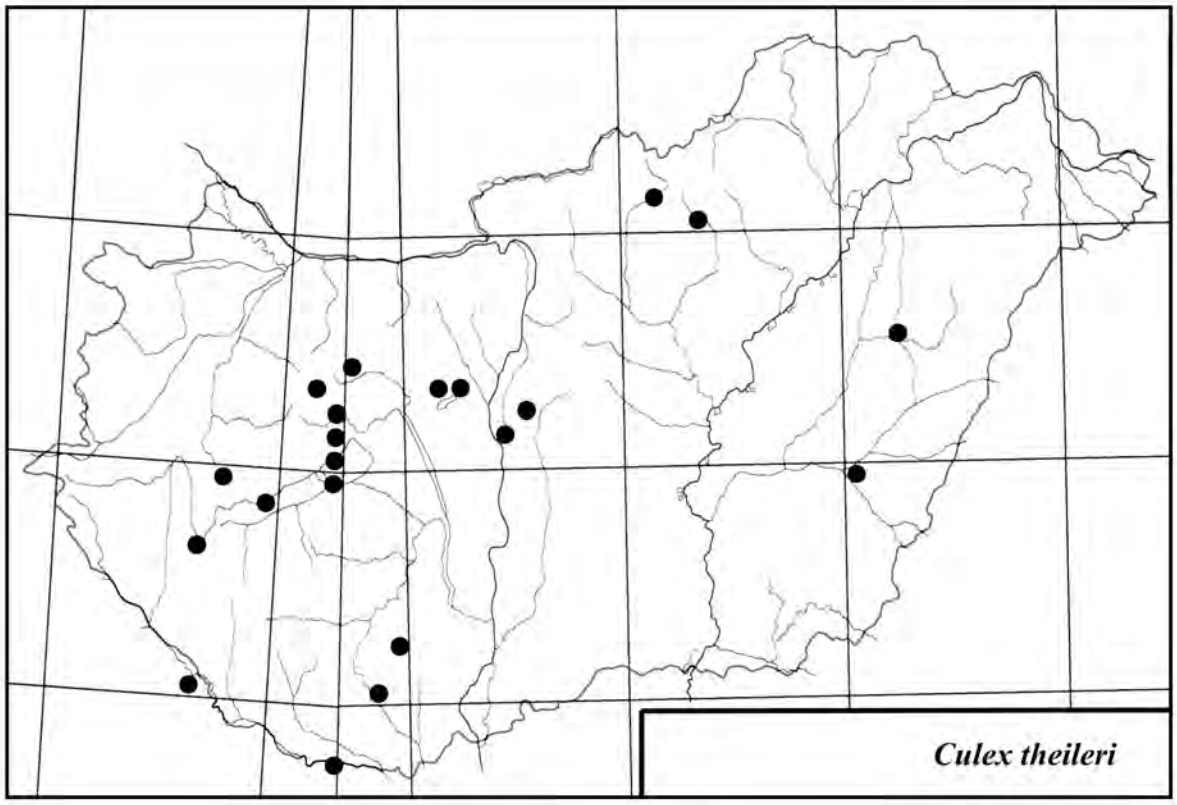
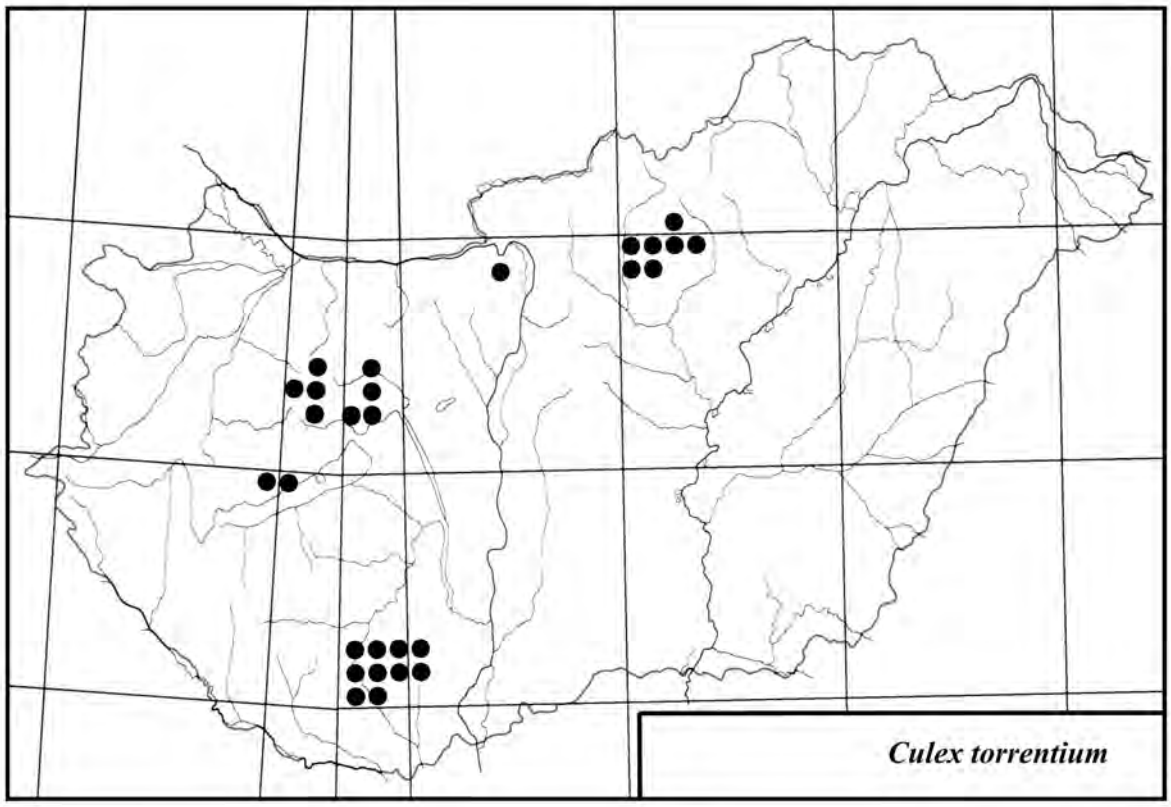

Culex pipiens


Culex pipiens biotype *molestus*


Culex theileri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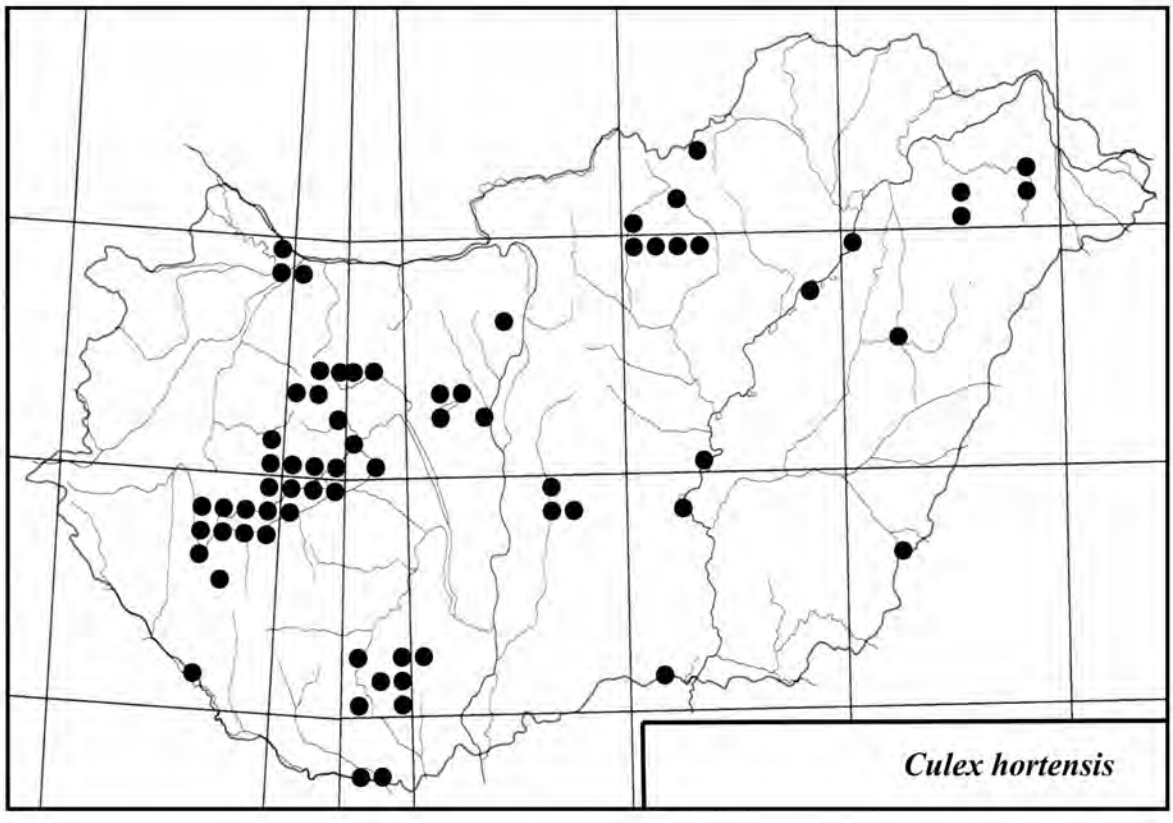
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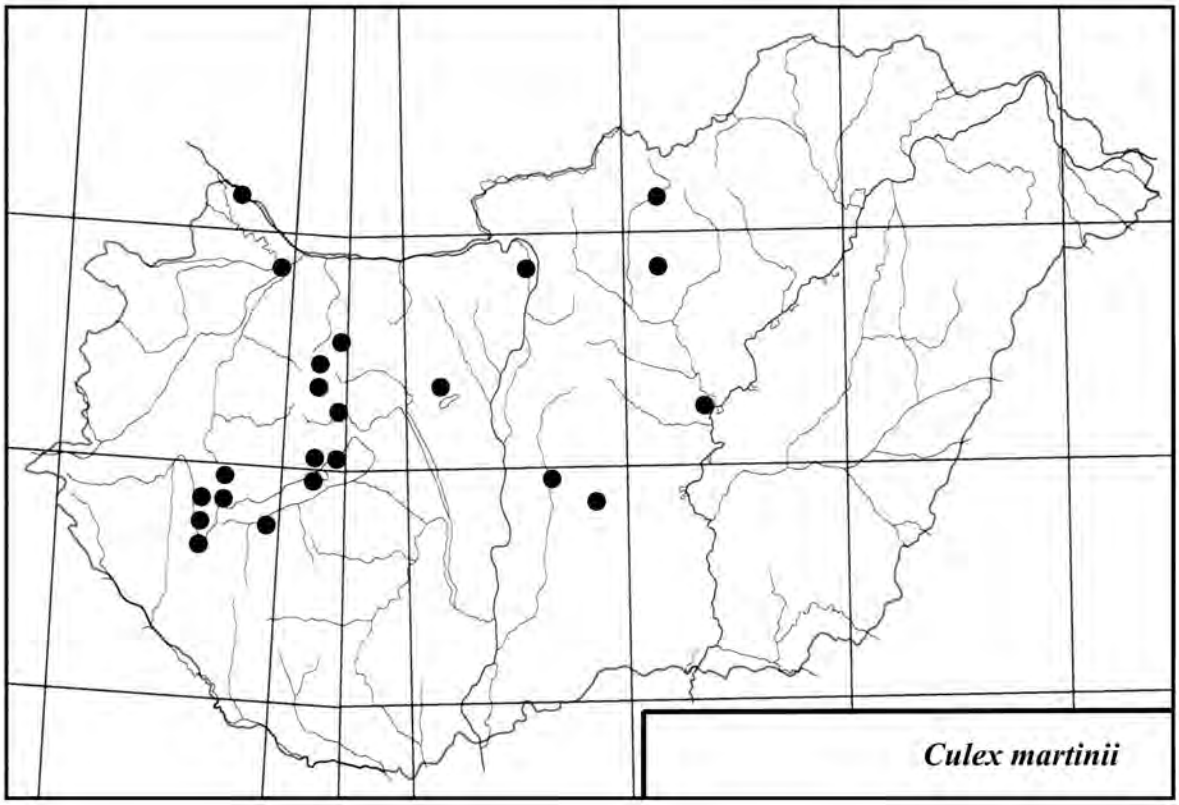
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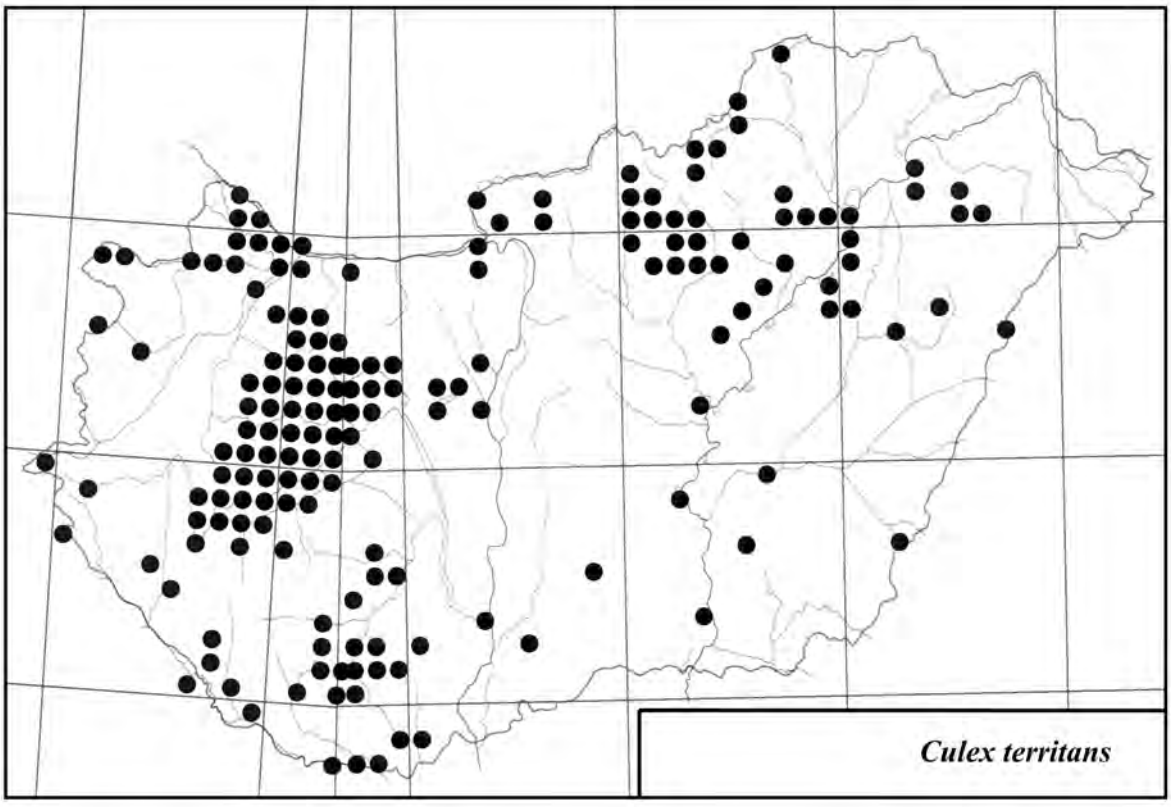
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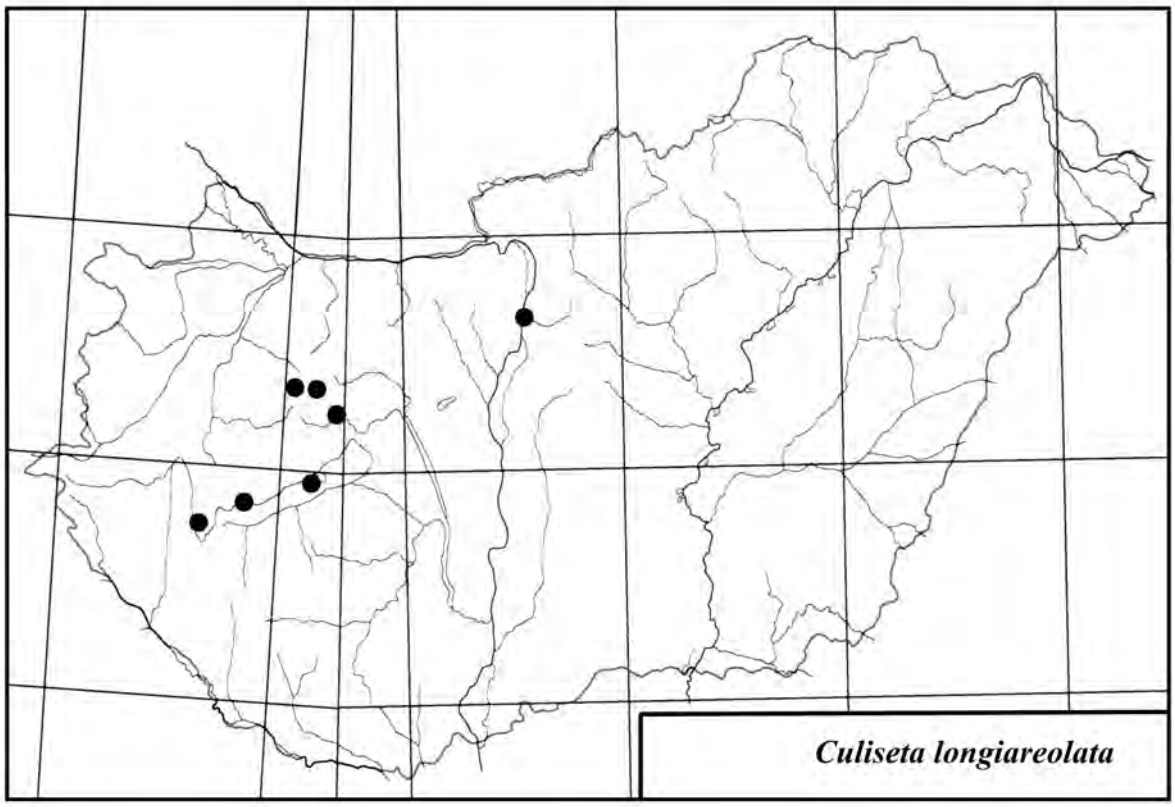
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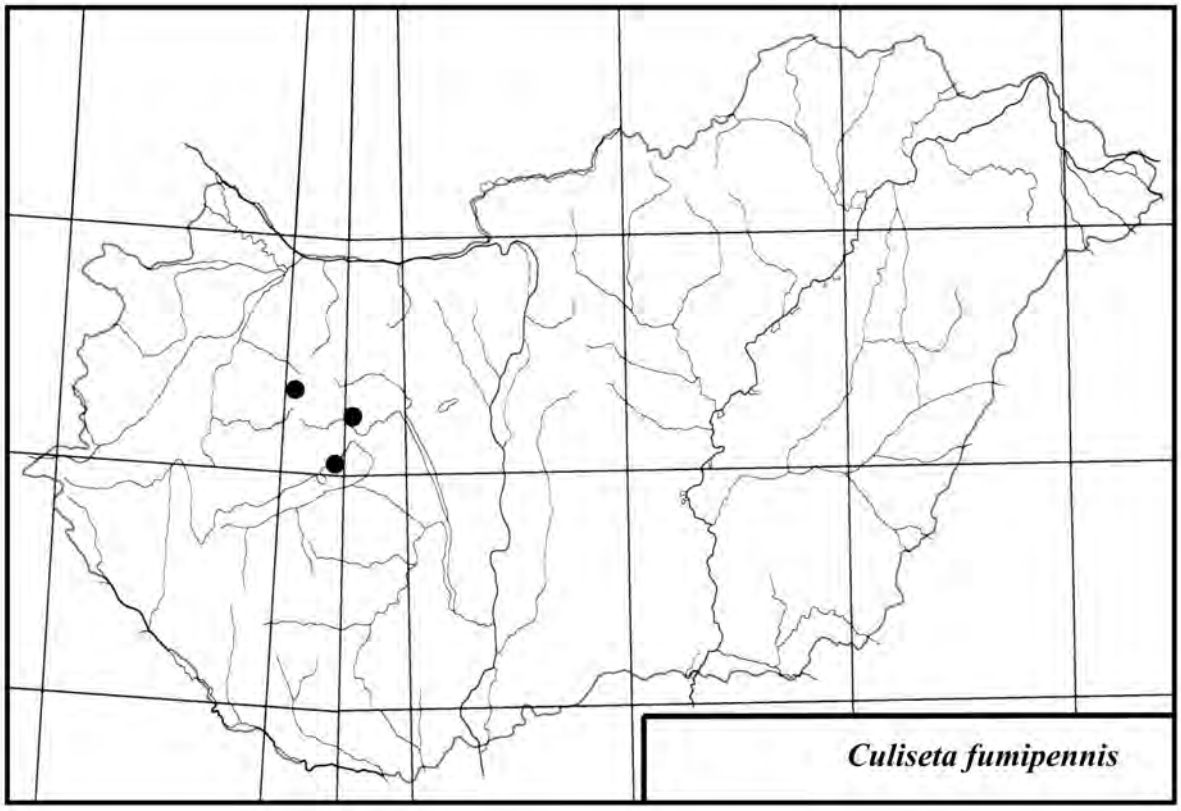
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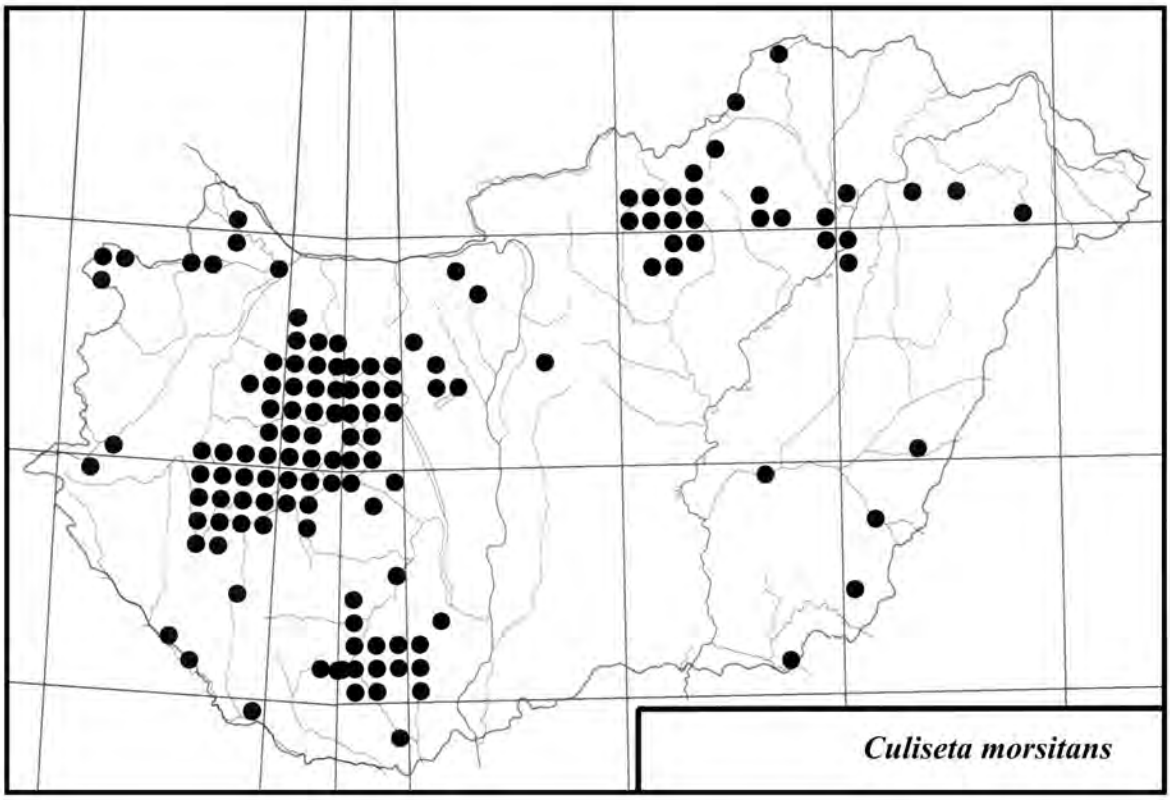
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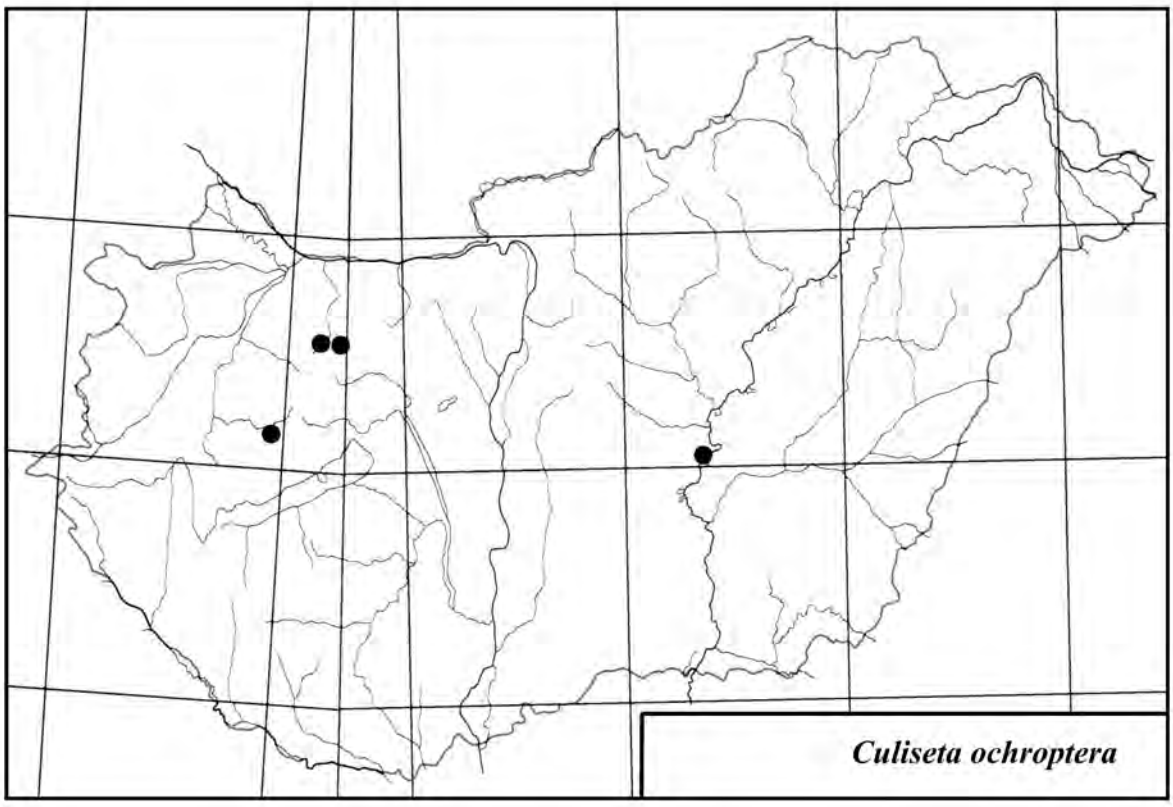
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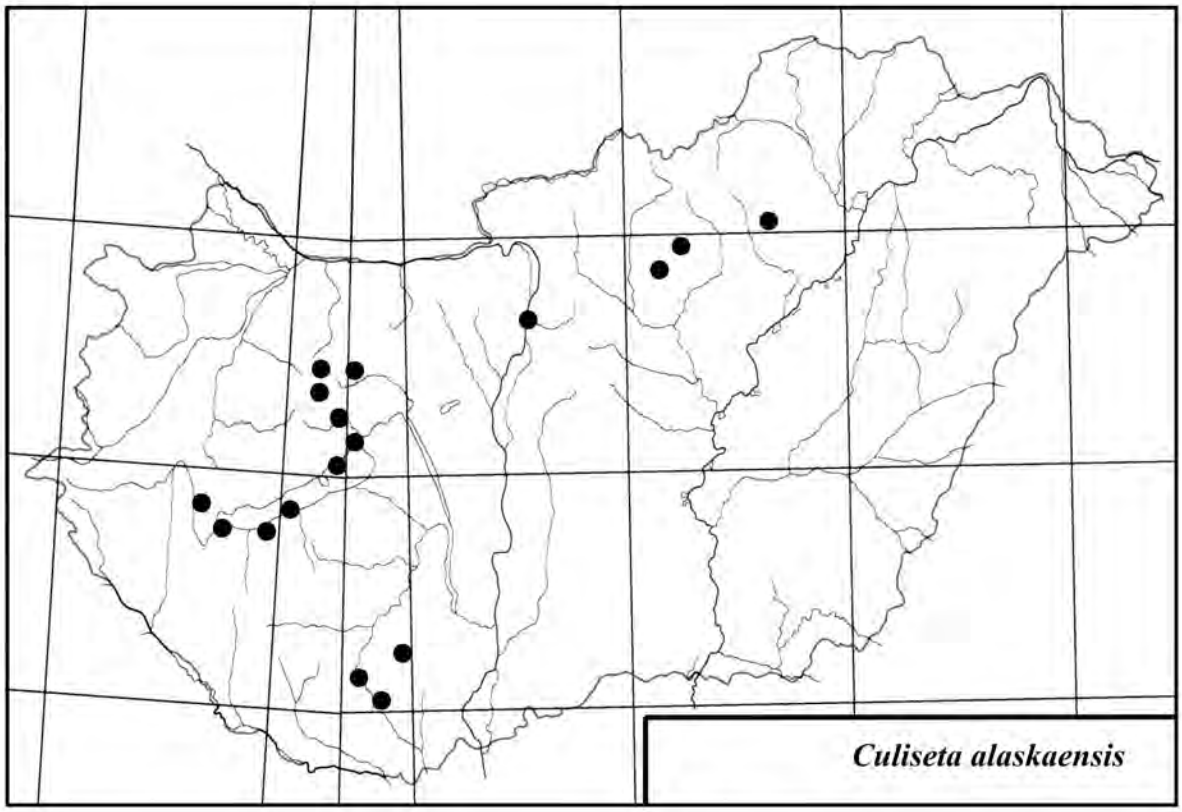
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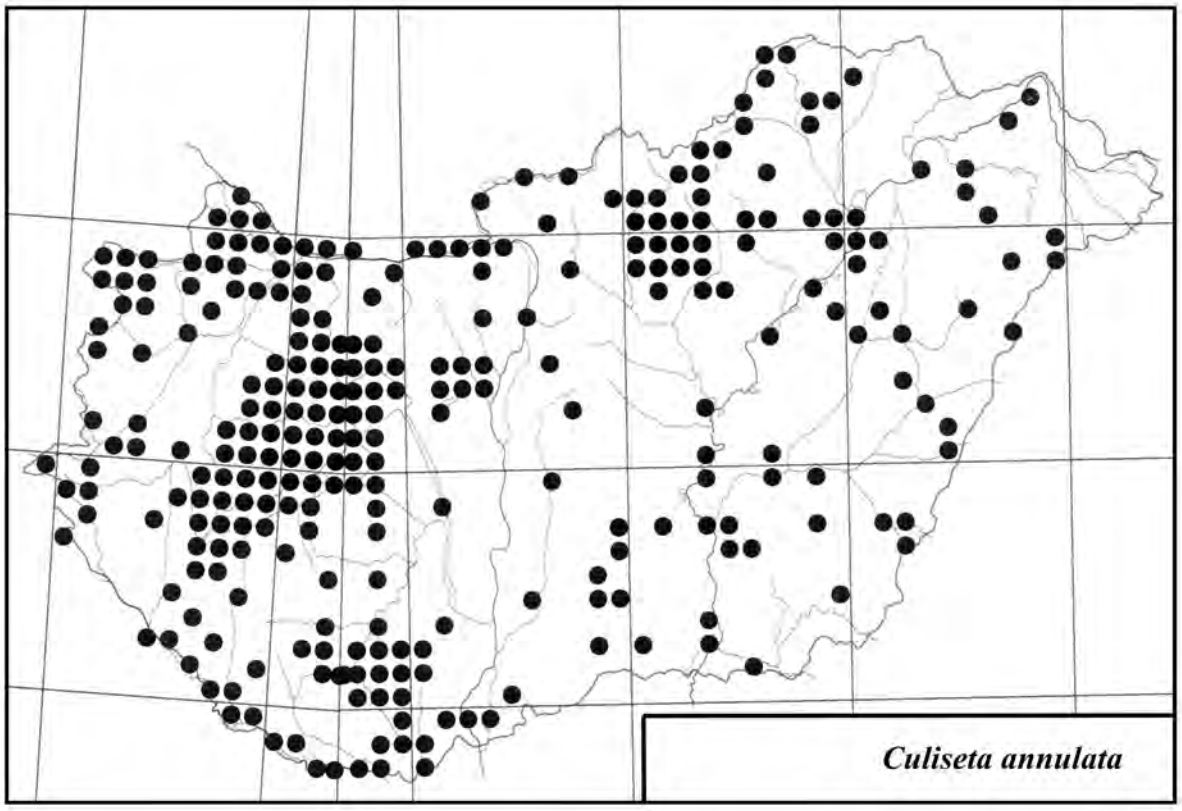
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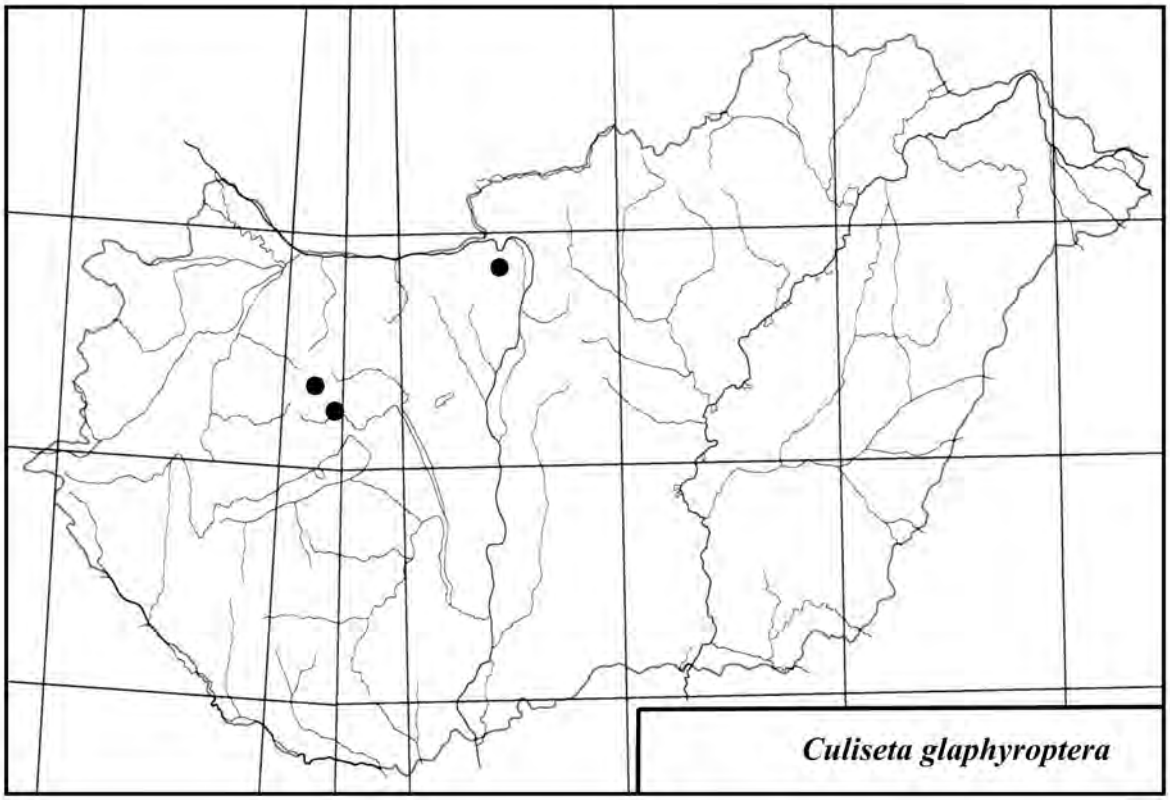
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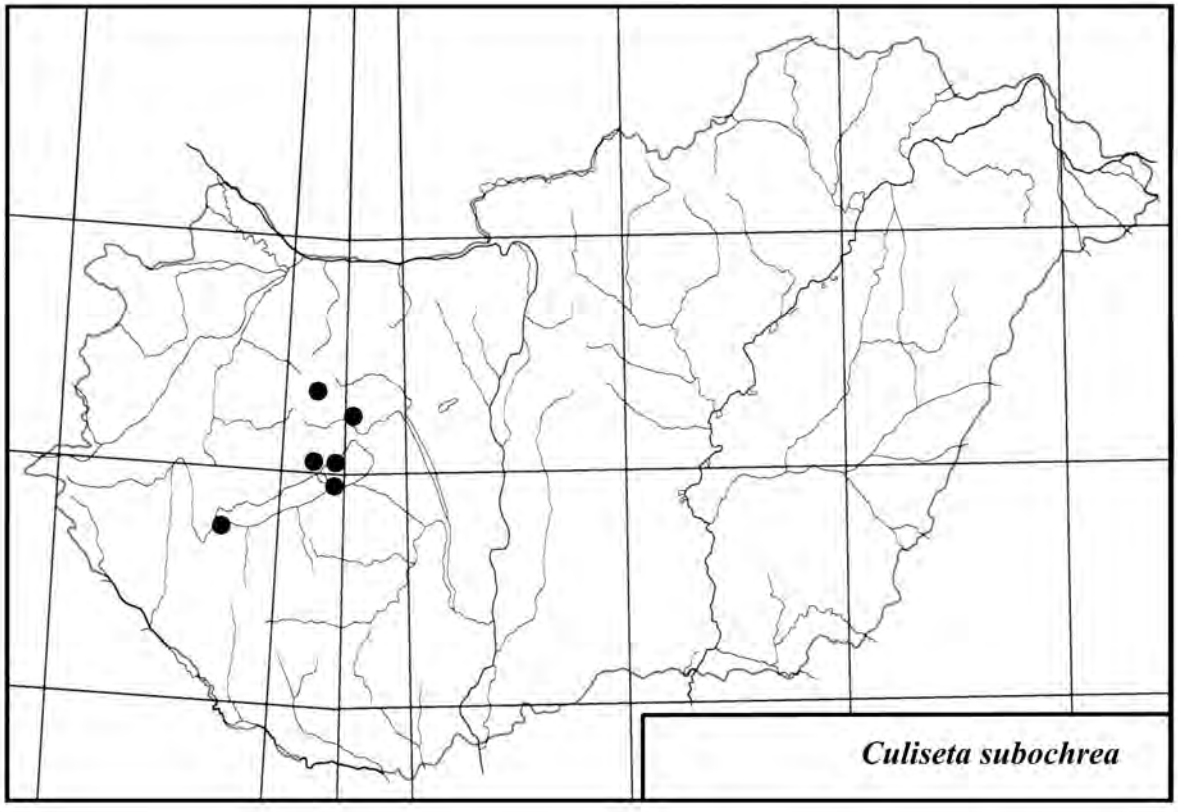
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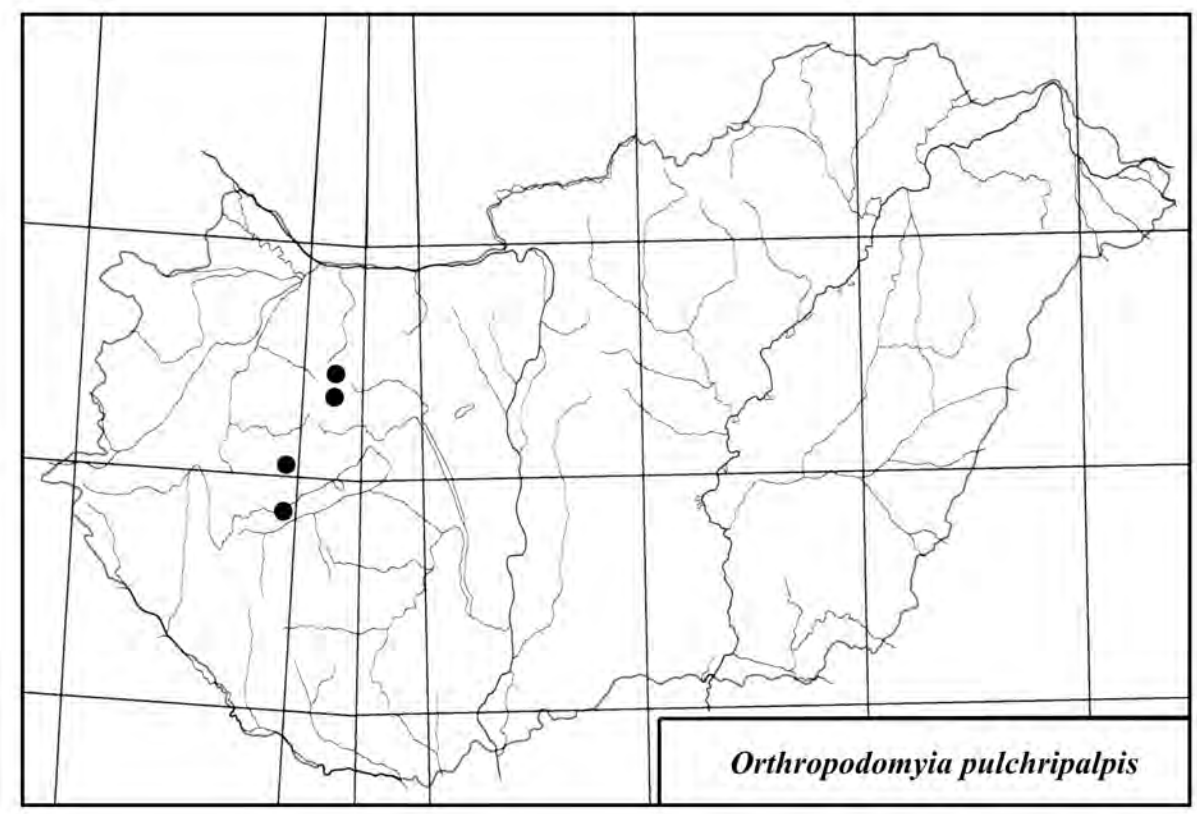
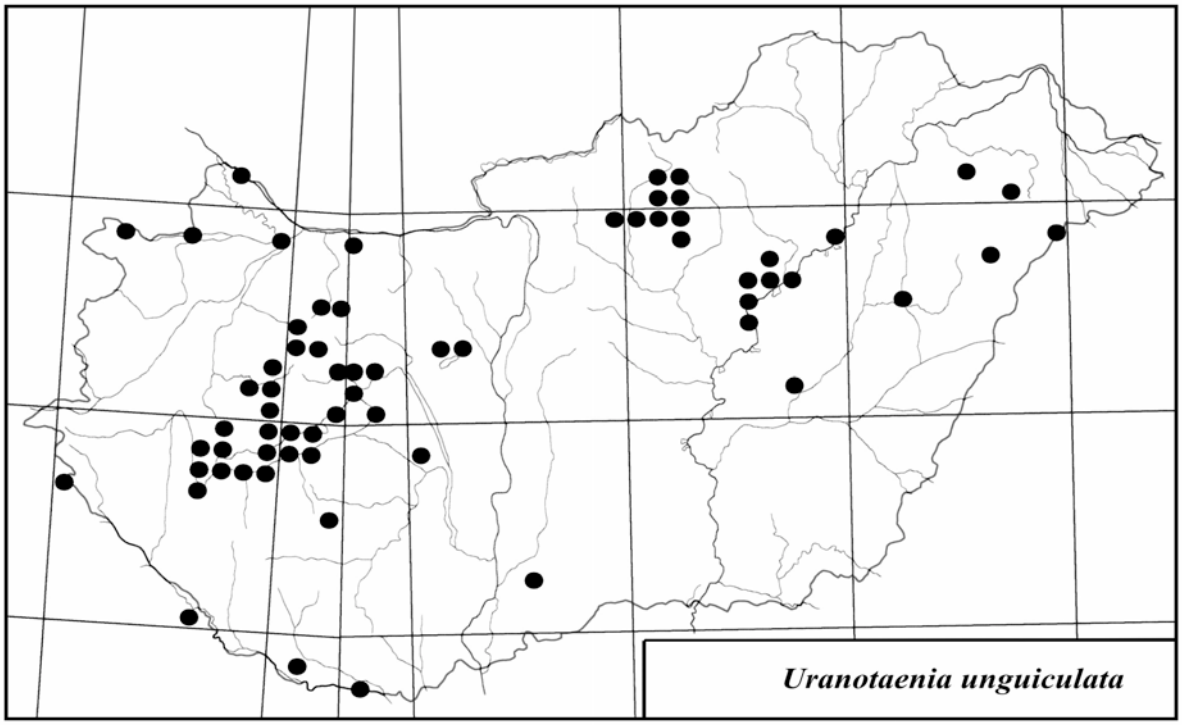

Orthropodomyia pulchripalpis


Uranotaenia unguiculata