

Biogeographical survey of the Orthoptera Fauna in Central Part of the Carpathian Basin (Hungary):

Fauna types and community types

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Abstract

Purpose of this work is the delineation of modern zoogeographical pattern of Orthoptera fauna in central part of the Carpathian Basin (Hungary) and foundation of nature protectional qualification for habitats of the continental open plant associations by determination of Orthoptera ensembles attaching to these plant associations. For this purpose, focus areas of the postglacial spreading, fauna-circles attachable to them and faunistic elements of the fauna-circles were defined on the basis of the recent area patterns. Characteristic Orthoptera communities of the major association groups (ecofaunas) were determined by a quantitative analysis. Species ensembles of the major geographical landscapes and (or faunistic region were determined with UTM net maps. Executing life-form type analysis of the ecofaunas, connection of the ecofaunas with the migrational stages (periods, direction etc.) in the Carpathian Basin as well as connection of these phases with the historical processes of vegetation were determined.

Zusammenfassung

Das Ziel dieser Arbeit war einerseits die Aufzeichnung des heutigen tiergeographischen Bildes der Orthopterenfauna Ungarns, andererseits die Bewertung von terrestrischen Lebensräumen offener Pflanzengesellschaften mit dazu gehörenden Orthopteren-Gruppen. Dazu wurden die Zentren der postglazialen Verbreitung definiert, die dazu gehörenden Faunenkreise und deren Faunenelemente nach den rezenten Arealbildern. Mit Hilfe einer quantitativen Analyse wurden die charakteristischen Orthoptera-Gemeinschaften (Ökofaunen) der einzelnen Hauptassoziationsgruppen bestimmt. Mit UTM-Netzkartenanalyse wurden die Artengruppen der geographischen Großlandschaften und / oder Faunenkreise definiert. Nach der Lebensformtypanalyse der Ökofaunen erfolgte die Bestimmung des Verhältnisses zu den postglazialen Migrationsphasen im Karpaten-Becken (Migrationszeiten, Migrationssichtungen), bzw. deren Zusammenhang mit den Vorgängen der Vegetationsgeschichte.

1. Preliminaries and object

For the Carpathian Basin - particularly for Hungary - we have not had a very high orthopterological knowledge, and there is not a summary of the scientific studies since the appearance of volume of Fauna Regni Hungariae (FRIVALDSZKY 1867,

PUNGUR 1900). Regarding the zoogeographical literature, the situation is more unfavourable, although recently, possessing the modern theoretical foundations of European Orthoptera fauna, and that of biogeography, it is possible to applicate them in the case of Orthoptera.

At the time, the environment protection needs a habitat qualification system applicable even in the field by species or ensembles, which are suitable for bioindication. It has been known for a long time that *Orthoptera* species (mainly *Acridoidea*) highly attach to certain plant communities because of their primary consumption and their microclimatic demands, therefore, some species and ensembles of species are suitable to satisfy this claim.

In my work, as stated above, there are two main object:

- 1 I tried to outline the modern biogeographical pattern of the Orthoptera fauna, and
- 2 I liked to found a qualificalational system for the habitats of non-water open plant assosciations.

These two objects are joined by determination of Orthoptera ensembles attaching to the plant associations.

To realize these objects, I have tried to answer the following questions:

1. What kind of glacial refuges, as focus areas, can be identifiical by analysis of the recent areal pattern of Orthoptera species in the Carpathian Basin (particulary in Hungary)?
2. Starting from the above mentioned question:
What kind of fauna-groups do the given species and faunistic elements belong to?
3. Using the data base and illustrating it on UTM system spreading map:
What spreading do the species have, on which a chorological analysis can be based, i.e. which can create the basis of a qualification system for the non-water habitats?
4. By comparative analysis of quantitative insertion of the data base:
 - 4.a. What faunistic ensembles are organized under the given ecological conditions (open plant associations)?
 - 4.b. What faunistic ensembles represent the certain geographical major regions and / or fauna-districts?
5. Accomplishing the life style type analysis of species of ecofauna:
 - 5.a. What connections do the ecofaunas have with the postglacial migration phases of the Carpathian Basin?
 - 5.b. What major migrational periods and directions can be determined?
 - 5.c. What is the connection between them and the historical processes of vegetation?
6. What is the zoogeographical pattern of the Hungary on the basis of the Orthoptera fauna?

II. Resource material and methods

The resource material has been a data base, which was founded by my collections and that of the workers of my departement. This material was collected by a

quantitative sampling method. The collection can be found in the Department of Evolutional Zoology and Human Biology of KLTE, together with the collection of NAGY, B., which formed the base of the collection of our department. From 60's to 1992, this material was completed from Hortobágy (NAGY 1943A, 1943B, 1943C, 1944, 1947, 1950, 1951, 1974C, 1983) Nyírség, Szatmár-Bereg Plain, Kiskunság (RÁCZ 1986B), Zemplén Mountain, Hernád Valley (VARGA & RÁCZ 1986), Aggtelek Karst (PARRAGH 1987), Bükk Mountain (NAGY 1974B, RÁCZ & VARGA 1978, PARRAGH 1983), Mátra Mountain, Bakony Mountain and Balaton Highland (NAGY 1948, 1949-50, RÁCZ 1973), Somogy Hills, Mecsek, Villány Mountain (RÁCZ & VARGA 1985), and W-Hungary.

Over and above, Orthoptera collections of Hungarian Natural History Museum (MTM) (RÁCZ 1992), Bakony Natural History Museum (RÁCZ 1979), Mátra Museum (RÁCZ 1986a) as well as available literature references were also revised (ARADI 1955, GAUSZ 1969, 1970-71A,B, GALLÉ & GAUSZ 1968, NAGY 1948, 1949/50, 1953, 1958, 1959, 1974A, 1981, 1987, 1990A, 1990B, 1992, NAGY, BÁNK & NAGY, 1965, SZELÉNYI, NAGY, SÁRINGER 1974, SCHMIDT & SCHACH 1978, NAGY, KIS & NAGY 1983, SCHMIDT 1987, NAGY & RÁCZ 1996, RÁCZ, VARGA, MEZŐ & PARRAGH 1997, ORCI 1997) (Table 1).

To define the faunistic elements, I have used the so called area analytic method, which is a comparison of the recent area patterns by certain points of view.

Our collections were excuted by method making a quantitative comparison possible. To evaluate the data, I used the own developed fauna dominance ressemblancy factor (FDRF) as well as the Shannon-Weaver diversity function (H), and cluster analysis of the SPSS program pocket.

Among the multivariable analysis of NUCOSA 1.00 program pocket (TÓTH-MÉRÉSZ, 1993) - using the Jaccard coefficient - , cluster analysis, main co-ordinate analysis, polar ordination, and correspondence analysis were performed on the insertion groups which are considerable quantitative ones of the summarized data base.

III. New scientific results

The Mediterranean main refuge can be divided into secondary refuges; among the Siberian refuges, the Mongolian, the W Siberian, and the Angara ones (which can be considered to be primary refuges for Orthoptera) (Uvarov 1929), the W Siberian and the Angara refuges were together under the name of Angara (26 species) (Figure 1).

1. As a result of the analysis of recent area pattern, for which the paleoartic spreading map of the given species were compiled, it could be established that majority of the *Orthoptera* species belongs to more arboreal centres, i.e. to Mediterranean (29 species), to Ponto-Caspian (16 species), and to the wider defined Siberian (41 species) great refuges.

The oreol is represented by 1 - 1 species of Mediterranean-xeromontaneous, as well as alpine and mountaneous spreading types, further 4 species show Inner Asean xeromontaneous connection.

The eremial is represented by 1 Iranian and 1 Irano-Turkestanian faunistic element, further 2 species are Afro-eremial.

African elements (3 species) represent special type. On the basis of the available knowledge, it is impossible to claim about species of Grylloidea, Tetrigoidea, and Tridactyloidea family species (Table 2).

Table 1: Orthoptera species of Hungary and their geographical range, faunal type, life forms, relative abundance and categories of abundance

Taxon	Geographical range	Faunal type	Life forms	Relative abundance	Cat.
Ordo: Ensifera (Grylloptera)					
Superfamilia: Tettigonioidae					
<i>Phaneroptera falcata</i> (Poda, 1761)	Eu-Si	Si-Pc	Th	0,252	IV
<i>Phaneroptera nana nana</i> Fieber, 1853	S-Eu	Holo-Med	Th	0,146	III
<i>Isophya kraussii</i> (Brunner v.W., 1878)	C-SE-Eu	Ba-II	Ch	0,041	I
<i>Isophya modestior stysi</i> Čejchan, 1957	N-E-Car	Da	Ch	0,006	I
<i>Isophya modesta</i> Frivaldszky, 1867	C-SE-Eu	Ba(Moe)	Ch	0,031	I
<i>Isophya costata</i> Brunner v.W., 1878	C-Eu	Pan	Ch	0,003	I
<i>Barbitites serricauda</i> (Fabricius, 1798)	C-W-Eu	Po-Pan	Th	0,035	I
<i>Barbitites constrictus</i> Brunner v. W., 1878	C-E-Eu	Ba(Moe)	Th	0,006	I
<i>Leptophyes punctatissima</i> (Bosc, 1972)	Eu	Po-Ca	Th	0,012	I
<i>Leptophyes albivittata</i> (Kollar, 1833)	Eu	Po-Med	Th	0,188	III
<i>Leptophyes boscii</i> Brunner v. W., 1878	C-Eu	Extra-Med	Th	0,089	II
<i>Leptophyes discoidalis</i> (Frivaldszky, 1867)	C-E-Eu	Da	Th	0,003	I
<i>Poecilimon affinis</i> (Frivaldszky, 1876)	S-E-Eu	Ba(Moe)	Th	0,003	I
<i>Poecilimon fussi</i> Brunner v. W., 1878	S-E-Eu	Po-Pan	Th	0,009	I
<i>Poecilimon schmidtii</i> (Fieber, 1853)	E-SE-Eu	Po-Med	Th	0,003	I
<i>Poecilimon intermedius</i> (Fieber, 1853)	E-Eu, W-As	W-Si	Th	0,003	I
<i>Polysarcus denticauda</i> (Charpentier, 1825)	C-SE-Eu	Po-Med	Ch	0,028	I
<i>Meconema thalassinum</i> (DeGeer, 1773)	Eu	Extra-Med	Th	0,095	II
<i>Meconema meridionale</i> Costa, 1856	S-Eu	Adr-Med	Th	0,003	I
<i>Conocephalus discolor</i> Thunberg, 1815	Eu-Si	Si-Pc	Th	0,335	IV
<i>Conocephalus dorsalis</i> (Latreille, 1804)	Eu-W-As	Po-Ca	Th	0,111	II
<i>Ruspolia nitidula</i> (Scopoli, 1786)	Af-Eu-Si	Af	Th	0,095	II
<i>Tettigonia viridissima</i> Linnaeus, 1758	Eu-Si	Si-Pc	Th	0,169	III
<i>Tettigonia caudata</i> (Charpentier, 1845)	C-E-Eu	Po-Ca	Ch-Th	0,038	I
<i>Tettigonia cantans</i> (Fuessly, 1775)	Eu-Si	Si	Th	0,041	I
<i>Decticus verrucivorus</i> (Linnaeus, 1785)	Eu-Si	An	Ch-Th	0,21	III
<i>Platycleis grisea</i> (Fabricius, 1781)	SE-Eu	Po-Ca	Th	0,23	III
<i>Platycleis affinis</i> Fieber, 1853	SE-Eu	Po-Ca	Th	0,143	III
<i>Platycleis montana</i> Kollar, 1833	Eu-Si	An	Ch	0,038	I
<i>Platycleis vittata</i> (Charpentier, 1825)	C-SE-Eu	Po-Ca	Th	0,115	II
<i>Metrioptera brachyptera</i> (Linnaeus, 1761)	Eu-Si	Si-Pc	Ch	0,019	I
<i>Metrioptera bicolor</i> (Philippi, 1830)	Eu-Si	An	Ch	0,159	III
<i>Metrioptera roeselii</i> (Hagenbach, 1822)	Eu	Po-Ca	Ch	0,22	III
<i>Pholidoptera aptera</i> (Fabricius, 1793)	C-Eu	Extra-Med-M	Th	0,063	II
<i>Pholidoptera transsylvanica</i> (Fischer, 1853)	N-E-Car	Da	Ch	0,015	I
<i>Pholidoptera fallax</i> (Fischer, 1853)	S-Eu	Po-Med	Ch	0,102	II
<i>Pholidoptera griseoptera</i> (DeGeer, 1773)	Eu	Po-Ca	Th	0,166	III
<i>Pachytachys gracilis</i> (Brunner v. W., 1861)	SE-Eu	Po-Med	Th	0,06	I
<i>Rhacocleis germanica</i> Herrich-Schaeffer, 1840	S-Eu	Po-Med	Th	0,076	II
<i>Gampsocleis glabra</i> (Herbst, 1786)	Eu-Am	Po-Ca	Th	0,063	II
<i>Saga pedo</i> (Pallas, 1771)	Eu-Si-Am	Po-Ca	Ch-Th	0,051	I
<i>Ephippiger ephippiger</i> (Fiebig, 1784)	C-E-Eu	Po-Med	Th	0,14	III
Superfamilia: Grylloidea					
<i>Gryllus campestris</i> Linnaeus, 1758	Af-Eu, W-As	Af	Fi	0,124	III
<i>Melanogryllus desertus</i> (Pallas, 1771)	Eu-Si	Po-Med	Fi	0,057	I
<i>Modiocoryllus frontalis</i> (Fieber, 1844)	E-C-Eu, W-As	Po-Med	Fi	0,031	I
<i>Acheta domesticus</i> Linnaeus, 1758	Cos		Fi	0,028	I
<i>Nemobius sylvestris</i> (Bosc, 1972)	Eu	Eu-Pc	Fi	0,095	II
<i>Tartarogryllus burdigalensis</i> (Latreille, 1804)	S-SE-Eu	Med	Fi	0,095	II
<i>Pteronemobius heydenii</i> (Fisher, 1853)	Eu-C-As	Med	Fi	0,006	I
<i>Myrmecophyllus acervorum</i> (Panzer, 1799)	Eu	Eu-Pc	Fi	0,003	I
<i>Oecanthus pellucens</i> (Scopoli, 1763)	S-Eu	Po-Med	Ch	0,095	II
<i>Gryllotalpa gryllotalpa</i> (Linnaeus, 1758)	Eu-W-As	Eu-Pc	Fi	0,038	I

Taxon	Geographical range	Faunal type	Life forms	Relative abundance	Cat.
Ordo: Caelifera (Orthoptera s.str.)					
Superfamilia: Acridoidea					
<i>Pezotettix giornae</i> (Rossi, 1794)	S-Eu	Po-Med	G-Ch	0,073	II
<i>Podisma pedestris</i> (Linnaeus, 1758)	Eu-Si	An	Ch	0,009	I
<i>Odontopodisma schmidtii</i> (Fieber, 1835)	E-Eu	Ba(II)	Ch	0,003	I
<i>Odontopodisma rubripes</i> (Ramme, 1931)	N-E-Car	Da	Th	0,009	I
<i>Odontopodisma decipiens</i> Ramme, 1951	E-Eu	Po-Med	Ch	0,003	I
<i>Miramelia alpina</i> (Kollar, 1833)	PI, AI	AI	Th	0,003	I
<i>Pseudopodisma fieberi</i> (Scudd, 1898)	SW-C-Eu	Po-Med-M	Ch	0,125	II
<i>Pseudopodisma nagyi</i> (Galvagni et Fontana,	C-E-Eu	Ba-Da	Ch	0,125	II
<i>Calliptamus italicus</i> (Linnaeus, 1758)	Eu-Si	An	G-Ch	0,178	III
<i>Calliptamus barbarus</i> (Costa, 1836)	S-Eu, N-Af, Am	Ir-Tur	G-Pam	0,038	I
<i>Paracaloptenus caloptenoides</i> (B. v.W., 1861)	C-SE-Eu	Ba(II)	G	0,014	I
<i>Psophus stridulus</i> (Linnaeus, 1758)	Eu-Si	An	Ch	0,035	I
<i>Locusta migratoria</i> (Linnaeus, 1758)	Cos	Pc		0,015	I
<i>Oedaleus decorus</i> (Germar, 1826)	Eu-As	Pc	G	0,118	II
<i>Celex variabilis</i> (Pallas, 1771)	Eu-As	Pc	G-Ch	0,099	II
<i>Oedipoda caerulescens</i> (Linnaeus, 1758)	Eu-As	Pc	G	0,309	IV
<i>Sphingonotus caeruleus</i> (Linnaeus, 1758)	Eu	Po-Ca	G	0,041	I
<i>Acrotylus insubricus</i> (Scopoli, 1786)	Af, S-Eu, W-As	Af-Er	G	0,086	II
<i>Acrotylus longipes</i> (Charpentier, 1845)	Af, S-Eu, W-As	Af-Er	G-Pam	0,019	I
<i>Aiolopus thalassinus</i> (Fabricius, 1781)	Cos	Af	G-Ch	0,214	III
<i>Aiolopus strepens</i> (Latreille, 1804)	Af-Eu, Am	Af	G-Ch	0,006	I
<i>Epacromius coerulipes</i> (Ivanov, 1887)	Eu-Si	Mon	G-Ch	0,019	I
<i>Epacromius tergestinus</i> (Charpentier, 1825)	Eu, Am	N-Med-Pc	G-Ch	0,025	I
<i>Stethophyma grossum</i> (Linnaeus, 1758)	Eu-Si	Ma	Ch	0,191	III
<i>Parapleurus alliaceus</i> (Germar, 1817)	Eu-Si	Ma	Ch	0,099	II
<i>Acrida hungarica</i> (Herbst, 1786)	C-SE-Eu, Af	Af	G-Ch	0,169	III
<i>Chrysoschraon dispar</i> (Germar, 1834)	Eu-Si	An	Ch	0,105	II
<i>Euthystiria brachyptera</i> (Ocksay, 1826)	Eu-Si	An	Ch	0,121	II
<i>Stenobothrus eurasius</i> Zubowski, 1898	C-Eu, W-As	An	Ch	0,019	I
<i>Stenobothrus crassipes</i> (Charpentier, 1825)	E-Eu	Po-Med	Ch	0,201	III
<i>Stenobothrus lineatus</i> (Panzer, 1796)	Eu-Si	An	Ch	0,239	III
<i>Stenobothrus nigromaculatus</i> (H.-S. 1840)	Eu-Si	An	Ch	0,172	III
<i>Stenobothrus fischeri</i> (Eversmann, 1848)	S-E-Eu, As	An	G-Pam-Ch	0,044	I
<i>Stenobothrus stigmaticus</i> (Rambur, 1838)	S-SE-Eu	Po-Ca	Ch	0,143	III
<i>Omocestus viridulus</i> (Linnaeus, 1758)	Eu-Si	An	Ch	0,003	I
<i>Omocestus rufipes</i> (Zetterstedt, 1821)	Eu-Si	An	Ch	0,313	IV
<i>Omocestus haemorrhoidalis</i> (Charpentier, 1825)	Eu-Si	An	Ch	0,293	IV
<i>Omocestus petraeus</i> (Brisout, 1855)	Eu-Si	An	G-Ch	0,153	III
<i>Stauromerus scalaris</i> (Fischer-v. Waldheim, 1846)	Eu-Si	An	Ch	0,012	I
<i>Chorthippus apricarius</i> (Linnaeus, 1758)	Eu-Si	An	Ch	0,14	III
<i>Chorthippus pullus</i> (Philippi, 1830)	C-E-Eu, W-As	Po-Ca	Ch	0,003	I
<i>Chorthippus vagans</i> (Eversmann, 1848)	Eu, W-As	W-As	Ch	0,006	I
<i>Chorthippus biguttulus</i> (Linnaeus, 1758)	Eu	Po-Ca	Ch	0,434	IV
<i>Chorthippus brunneus</i> (Thunberg, 1815)	Eu-Si	An	Ch	0,523	V
<i>Chorthippus mollis</i> (Charpentier, 1825)	Eu-Si	An	Ch	0,351	IV
<i>Chorthippus eisenrauti</i> Ramme, 1931	Dal	En	Ch	0,009	I
<i>Chorthippus albomarginatus</i> (DeGeer, 1773)	Eu-Si	Si-Pc	Ch	0,306	IV
<i>Chorthippus dorsatus</i> (Zetterstedt, 1821)	Eu-Si	Si-Pc	Ch	0,46	IV
<i>Chorthippus loratus</i> Fischer-v. Waldheim, 1864	S-E-Eu	Po-Ca	Ch	0,028	I
<i>Chorthippus dichrous</i> Eversmann, 1895	Eu-Si	An	Ch	0,035	I
<i>Chorthippus parallelus</i> (Zetterstedt, 1821)	Eu-Si	An	Ch	0,399	IV
<i>Chorthippus montanus</i> (Charpentier, 1825)	Eu-Si	An	Ch	0,191	III
<i>Euchorthippus declivus</i> (Brisout 1848)	S-Eu	N-Med-Pc	G-Ch	0,402	IV
<i>Euchorthippus pulvinatus</i> (Fischer-v. Waldheim	S-E-Eu, W-As	Po-Ca-Tur	G-Ch	0,057	I
<i>Myrmeleotettix antennatus</i> (Fieber, 1853)	Eu-Si	An	G-Ch	0,044	I
<i>Myrmeleotettix maculatus</i> (Thunberg, 1815)	Eu-Si	An	G-Ch	0,07	II
<i>Gomphocerippus rufus</i> (Linnaeus, 1758)	Eu-Si	An	Ch	0,23	III
<i>Dociostaurus maroccanus</i> (Thunberg 1815)	Eu, Am	Ir-Tur	Ch	0,031	I
<i>Dociostaurus brevicollis</i> (Eversmann, 1848)	Eu, Am	Po-Ca-Tur	G-Ch	0,162	III
<i>Arcyptera fusca</i> (Pallas, 1773)	Eu-Si	An	Ch	0,019	I
<i>Pararcyptera microptera</i> (Fischer-v. Waldheim,	Eu-Si	An	G-Ch	0,025	I

Taxon	Geographical range	Faunal type	Life forms	Relative abundance	Cat.
Superfamilia: Tetrigoidea					
<i>Tetrix subulata</i> (Linnaeus., 1758)	Ho	Eu-Pc	Ch	0,188	III
<i>Tetrix tuerki</i> Krauss, 1876	Eu	Eu-Pc	Ch	0,041	I
<i>Tetraterix undulata</i> (Sowerby, 1806)	W-Pa	Eu-Pc	Ch	0,038	I
<i>Tetraterix bipunctata</i> (Linnaeus., 1758)	Pa	Si-Pc	Ch	0,102	II
<i>Tetraterix tenuicornis</i> (Shalberg, 1893)	Pa	Si-Pc	Ch	0,143	III
Superfamilia: Tridactyloidea					
<i>Tridactylus variegatus</i> (Latreille, 1809)	Af-EuAs-Indom.	Pc	Fi	0,012	I
<i>Tridactylus pfaendleri</i> Harz, 1970	Af-S-C-Eu	Pc	Fi	0,003	I

ABBREVIATIONS:

Af = African (Ethiopian)	E = East	N = North	0,0625	rare	I
Al = Alpidian	En = Endemic	Pa = Palaearctic	0,0626-0,125	scattered	II
Am = Asia minor	Er = Eremialian	Pan = Pannonian	0,1251-0,250	low frequent	III
An = Angarian	Eu = European	Pc = Policentric	0,2501-0,500	frequent	IV
As = Asian	Geo = Geobiont	Pi = Pirenean	0,5001	common	V
Ba = Balcanic	Il = Ilyrian	Psm = Psammobiont			
C = Central	Ir = Iranian	Po = Pontic			
Ca = Caspian	Ho = Holarctic	S = South			
Car = Carpathian	M = Mountain	Si = Siberian			
Ch = Chortobiont	Ma = Manchurian	Th = Thamniont			
Cos = Cosmopolitan	Med = Mediterranean	Tu = Turanian			
Da = Dacian	Moe = Moesian	Tur = Turcesthanian			
Dal = Dalmatian	Mon = Mongolian	W = West			

Table 2: Number of species which belong to refuges of Arboreal and Non-Arboreal.
(Samples of species are mapped on Map 1-5).

Arboreal		Non Arboreal			
		Oreal		Eremial	
Mediterranean	29 species (i.e. <i>Phanoptera nana</i>)	Mediterranean-Xero-Mountain	1 species (i.e. <i>Paracoptenus caloptenoides</i>)	Iranian	1 species (i.e. <i>Dociostaurus maroccanus</i>)
Extra-Mediterranean	(i.e. <i>Pholidoptera aptera</i>)				
Endemic (decian)	(i.e. <i>Pholidoptera transsylvanica</i>)				
Ponto-Caspian	16 species (<i>Tettigonia caudata</i>)	Alpin	1 species (i.e. <i>Miramelia alpina</i>)	Iranian Turcesthanian	1 species (i.e. <i>Calipterus barbarus</i>)
Siberian (s.l.)	41 species (i.e. <i>Chorthippus albomarginatus</i>)	Inner-Asian-Xero-Mountain	4 species (i.e. <i>Celex variabilis</i>)		
Angarian	26 species (i.e. <i>Arcyptera fusca</i>)				
Ethiopian	3 species (i.e. <i>Acrida hungarica</i>)			Ethiopian	2 species (i.e. <i>Acrotylus insubricus</i>)

2. In the case of important association groups, analysis of Orthoptera ensembles characterizing certain plant associations gives the following species combinations:

2.1. Open sandy grasslands (Festucion vaginatae association group): *Acrotylus insubricus* - *Myrmeleotettix maculatus* - *Acrida hungarica*; local character species: *Calliptamus barbarus* - *Acrotylus longipes* - *Sphingonotus caeruleans* - *Myrmeleotettix antennatus*, as well as *Montana montana* and *Euchorthippus pulvinatus* on limy sand and *Stenobothrus crassipes* on loessy sand.

2.2. Loessy grasslands (Salvio-Festucetum type associations): *Platycleis affinis* - *Tesselana vittata* - *Bicolorana bicolor* - *Stenobothrus crassipes* - *Glyptobothrus biguttulus*; in more humid middle mountainous type with the dominance *Bicolorana bicolor* and *Stenobothrus crassipes*; in dryer type of the lowland with the dominance of *Tesselana vittata*.

2.3. Halophytic grasslands

2.3.1. Salicornion association group: *Chorthippus albomarginatus* - *Epacromius coerulipes*.

2.3.2. Beckmannion eruciformis association group: *Chorthippus albomarginatus* - *Euchorthippus declivus* - *Omocestus rufipes*.

2.3.3. Puccinellion distantis association group: *Chorthippus albomarginatus* - *Aiolopus thalassinus* - *Docostaurus brevicollis*.

2.3.4. Festucion pseudovinae association group: *Omocestus haemorrhoidalis* - *Omocestus petraeus* - *Chorthippus albomarginatus*.

Epacromius tergestinus, which indicates the difference between halophytic grasslands, is a differential species between solonetz-solonchak of Hortobágy and Kiskunság.

2.4. Middle-mountainous grasslands

2.4.1. Karstic-shrubforest-grassland mosaic complex: *Stenobothrus lineatus* - *Stenobothrus crassipes* - *Rhacocleis germanica* - *Pachytrachis gracilis*.

Differential species:

- Aggtelek Karst: *Stenobothrus eurasius* - *Stauroderus scalaris* - *Euchorthippus pulvinatus*.

- Bükk Mountain: *Saga pedo*.

- Isle Hills of Baranya: *Aiolopus strepens* - *Odontopodisma decipiens*.

- Ceraso-Quercetum: *Bicolorana bicolor*.

- Cotino-Quercetum: *Pezotettix giornae*.

2.4.2 Steppe type associations: *Stenobothrus crassipes* - *Euthystira brachyptera* - *Stenobothrus lineatus* - *Glyptobothrus apicarius* - *Isophya kraussii*; local character species: *Stenobothrus eurasius* - *Euchorthippus pulvinatus* - *Isophya modesta* - *Saga pedo*.

Differential species:

- Middle Mountains of North Hungary: *Psophus stridulus* - *Stauroderus scalaris* - *Metrioptera brachyptera* - *Barbitistes constrictus* (NE of Bükk Mountain).

- Aggtelek Karst, Zemplén Mountain: *Pholidoptera transsylvanica* - *Isophya modestior stysi* - *Poecilimon affinis* - *Poecilimon intermedius* - *Arcyptera fusca*.

2.4.3. Molinion coeruleae, Agrostidion albae, Arrhenatherion elatioris:

Euthystira brachyptera - *Chrysochraon dispar* - *Glyptobothrus apricarius* - *Glyptobothrus biguttulus* - *Chorthippus dorsatus* - *Chorthippus parallelus* - *Chorthippus montanus*; local character species: *Polysarcus denticauda*.

3. On the basis of analysis of the life-style types, it can be established that chorto- and thamnobiont life-styles dominate in the closed grasslands characterized by tall and short grasses, and higher dominance of the thamnobiont grasshoppers are characteristic of them. On the other hand in grassland which are opened to various extent, depending on degree of the openness, i.e. extension of the bare soil and/or rock surface, geo- and geo-chortobiont species are characteristic and primarily the locust species dominate (RÁCZ & VARGA 1996).

4. The great invasion of Angara elements which invaded Europe from East at the time of three periods, possibly started in Würm period (but at least in Würm III) from the Siberian refuges, utilizing periglacial cool steppe and tundra zone as a faunistic corridor.

Last species could reached the Carpathian Basin in the Infraboreal, partly from East, partly avoiding the arc of the Carpathians, from NW. The calm climate of the Boreal favour has caused the spreading of the steppe fauna (Ponto-Caspian, Iranian, Turkestanian) and Ponto-Mediterranean elements, the cool steppe species were forced back into the higher altitudes. Former species invaded the Carpathian Basin from a ESE direction (Vaskapu, Töröcsvár), while the latter do it from SSE. Forestation of the Atlantic and Boreal period forced the Boreal species onto edaphic slopes, as a refuges, of the Paleo-Mátra, from where they were able to go down the Alföld again during formation of the mosaic landscape of the Subatlantic climatic phase. The so called Extramediterranean species possibly separated from their former Mediterranean focus areas also at the same time. The antropogene alteration of landscape has left the relict groups of the post-glacial steppe only in loessy backsides, therefore, they have had an important role in the formation of Orthoptera ensembles of the recent Hungarian steppes.

5. The main tendencies of fauna change are considerable as the initial period of the arboreal-non arboreal dynamic and as a consequence of alteration of the economic utilization. Therefore task of the environment protection is, in one hand, to maintain the traditional agricultural forms, at least in lands of the environment protection, and on the other hand, to protect living place of populations considered to be margin-isolated ones, which have reduced ecological valency and genetic diversity (habitat change).

6. Sure indication of the valuable living places can be served by the living qualification system founded by relative frequency values calculated from data of net maps of UTM system representing the spreading of Orthoptera species in Hungary (relative frequency value = number of squares containing the given species per number of squares representing the all collecting localities). For this calculation, I compiled 10x10 km mt maps of UTM system for the given Orthoptera species (Map 6).

7. On the basis of Orthoptera fauna, zoogeographical division of Hungary can only be interpreted at level of fauna-districts, and in some other cases units (Map 7a).

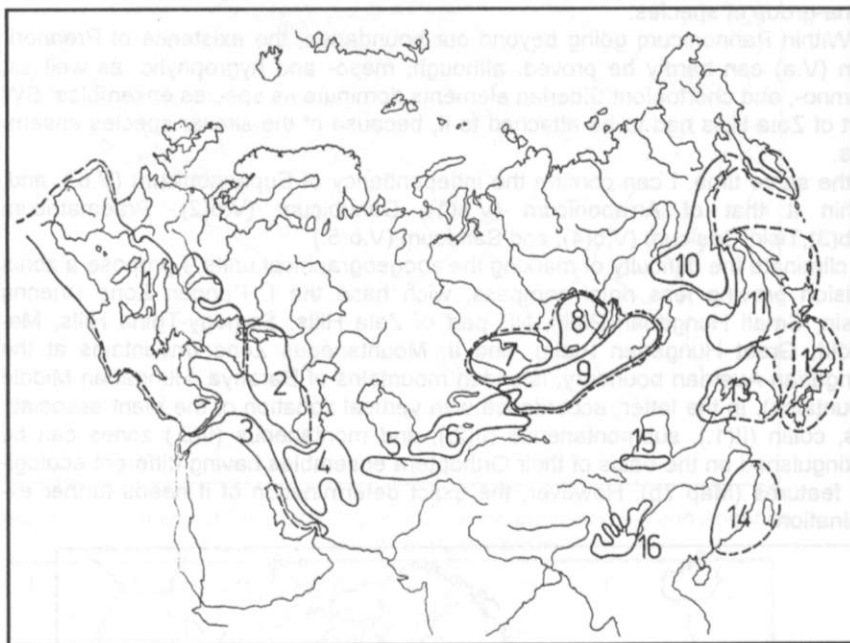


Fig. 1: Palaearctical refuges of Orthoptera fauna (1 Mediterranean, 2 Ponto-Kaspian, 3 Sirian, 4 Iranian, 5 Afganian, 6 Turchestanian, 7, 8, 9 Angarian, 10 E-Siberian, 11 Mandshurian, 12 Japonian, 13 Korean, 14 Sinopacifian, 15 Sinotibetian, 16 Yünnanian refuges).

I. Typical Orthoptera ensembles characteristic of Noricum are not revealed in Hungary, their existence is forced by relative frequent occurrence of *Miramella alpina* having alpin character.

II. Influence of Carpathic district is indicated by the dealpinic *Miramella alpina* in the Börzsöny Mountaints, by the dacic *Pholidoptera transsylvanica* and *Isophya modestior stysi* in the Zemplén Mountains and in the higher platous of Aggtelek Karst, and by the *Pholidoptera transsylvanica*, dacic *Odontopodisma rubripes*, and *Leptophyes discoidalis* in associations of the forest edges of the Bereg Plain.

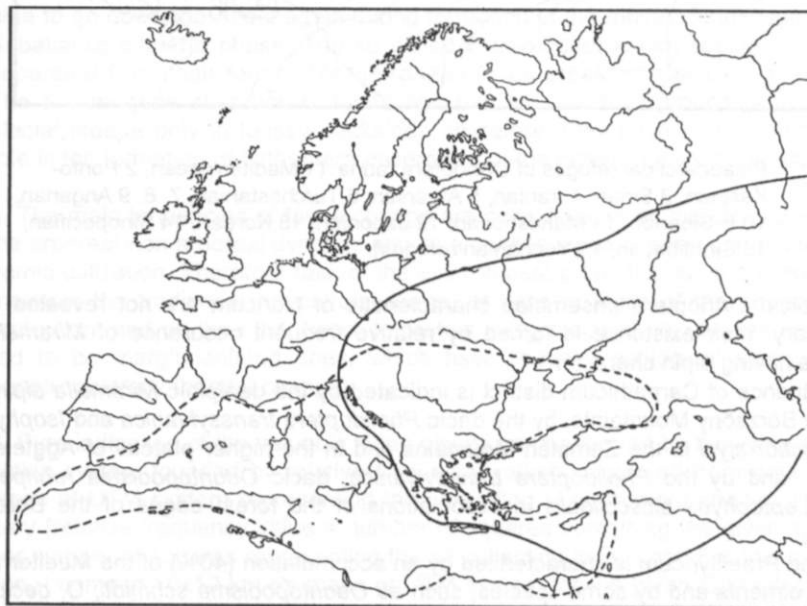
III. The Praeillyricum is characterized by an accumulation (40%) of the Mediterranean elements and by some species, such as *Odontopodisma schmidtii*, *O. decipiens* and *Aiolopus strepens* occuring only in it.

IV. It seems to be reasonable to delimit Matricum as a fauna-district, and to divide it into two fauna-country, namely the Pilisicum (IV.a) mainly characterized by elements of the Mediterranean fauna-group of species, and second the Eumatricum (IV.b) rather characterized by the dominancy of elements of the Siberian fauna-group of species.

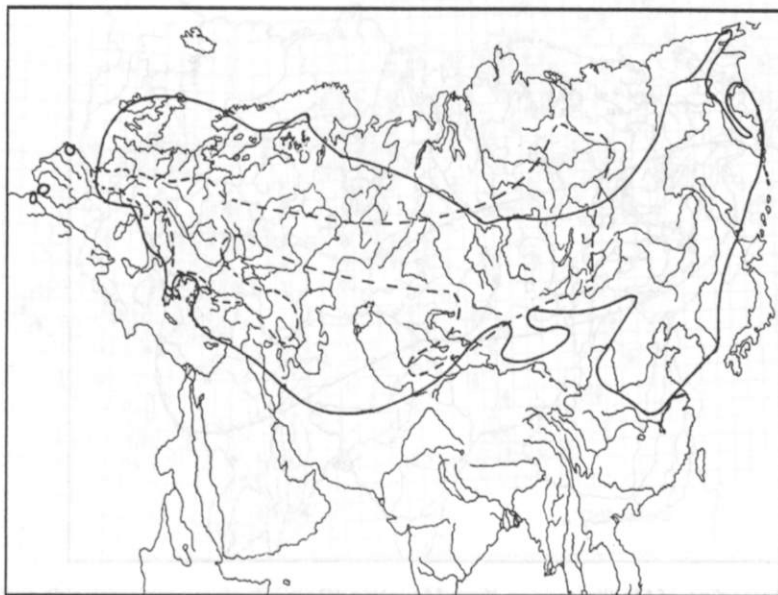
V. Within Pannonicum going beyond our boundaries, the existence of Preanoricum (V.a) can hardly be proved, although, meso- and hygrophilic, as well as, thamno-, and chortobiont Siberian elements dominate its species ensembles. SW part of Zala Hills had to be attached to it, because of the similar species ensembles.

At the same time, I can confirm the independency of Eupannonicum (V.b.), and, within it that of Arrabonicum (V.b(1), Danubicum (V.b(2), Praematricum (V.b(3), Tisio-Crisicum (V.b(4), and Samicum (V.b(5).

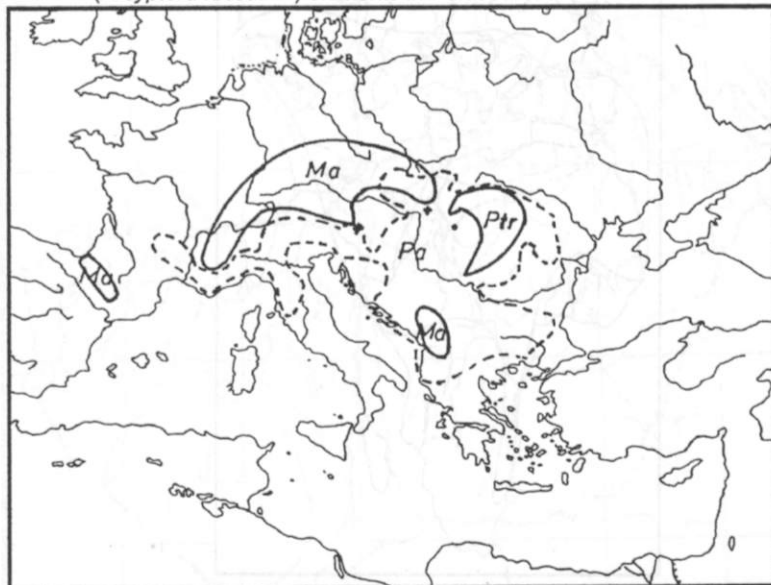
To eliminate the difficulty of marking the zoogeographical units, I propose a zonal division proving less rigid compass, which has the I. Pannon Zone (Vienna Basin, Small Hungarian Plain, NE part of Zala Hills, Somogy-Tolna Hills, Mezőföld, Great Hungarian Plain), and II. Mountaneous Zone (mountains at the Hungarian-Austrian boundary, island mountains of Baranya, Hungarian Middle Mountains). In the latter, accordance with vertical zonation of the plant associations, collin (II(1.), submontaneous (II(2.), and montaneous (II(3.) zones can be distinguished on the basis of their Orthoptera ensembles having different ecological features (Map 7b). However, the exact determination of it needs further examination.



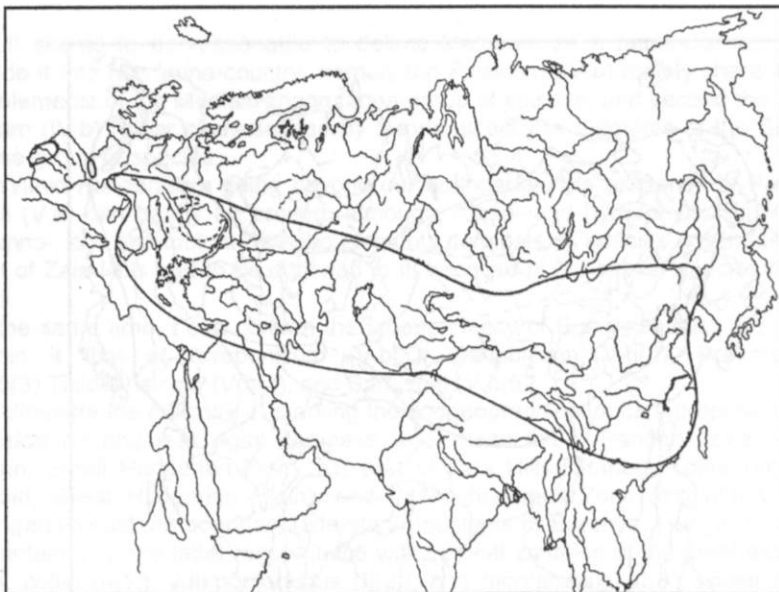
Map 1: Spreading of Mediterranean (*Phaneroptera nana*: —), and Ponto-Caspian (*Tettigonia caudata*: ---) elements in Palaearctic



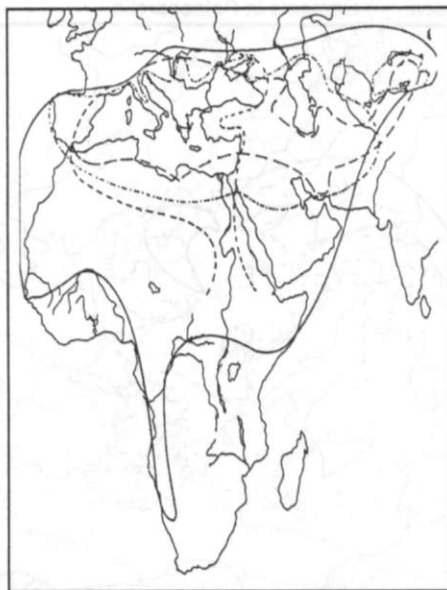
Map 2: Spreading of Siberian (*Chorthippus albomarginatus*: —) and Angarian (*Arcyptera fusca*: ---) elements in Palaearctic



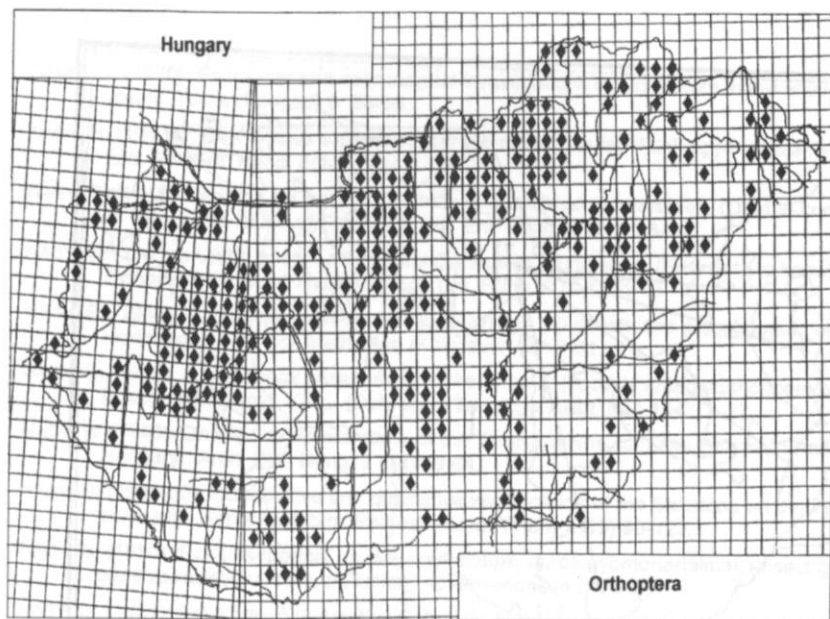
Map 3: Spreading of Alpin-Mountain elements in Palaearctic (Dealpin *Miramella alpina*: Ma and +; Dacian *Pholidoptera transsylvanica*: Ptr and *; Extra-Mediterranean *Pholidoptera aptera*: Pa).



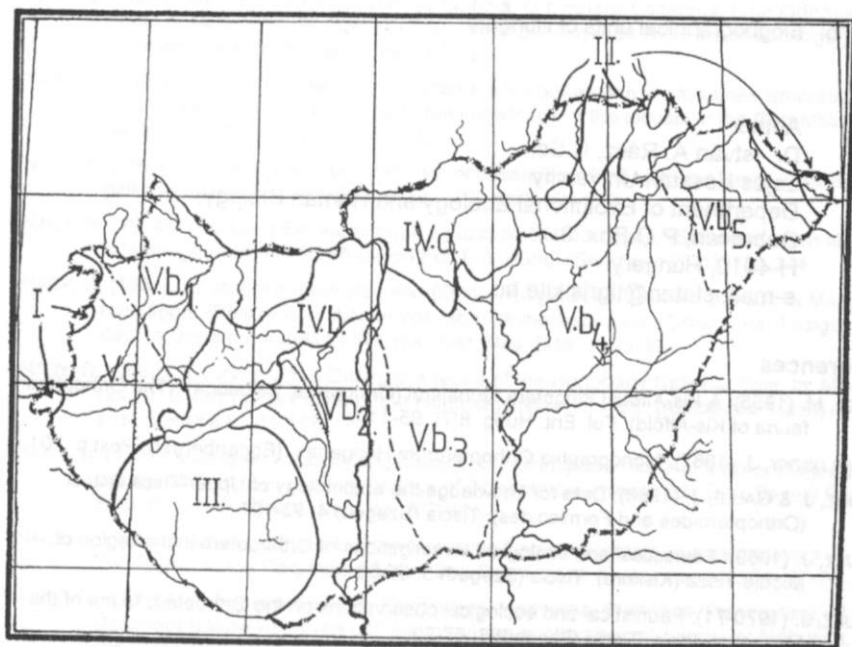
Map 4: Spreading of Mediterranean-Xero-Mountain (*Paracalptenus caloptenoides*: - -), and Inner-Asian-Xero-Mountain (*Celes variabilis*: —) elements in Palaeo-arctic



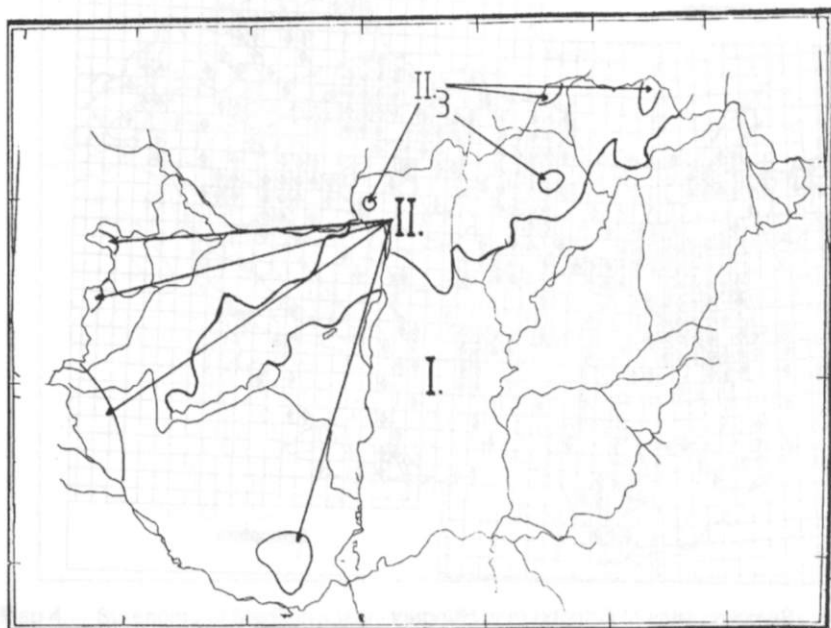
Map 5: Spreading of Iranian (*Dociostaurus maroccanus*: — —), Irano-Thurchestanian (*Calliptamus barbarus*: - -), Ethiopian (*Acrida hungarica*: ---), and Afro-Erimialean (*Acrotylus insubricus*: —) elements in Palaeo-arctic



Map 6: Sampling sites of Orthoptera in Hungary



Map 7a: Biogeographical units of Hungary



Map 7b: Biogeographical units of Hungary

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