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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 Aufzeichung des heutigen tiergeographischen Bildes der Orthopterenfauna Ungarns, anderseits die Bewertung von terrestrischen Lebensräumen offener Planzengesellschaften 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.

I. 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 appearence 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 fundations 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 qualificational system for the habitats of non-water open plant assosiacions.
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 identifical 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) Nyirség, 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 dominancy resemblancy factor (FDRF) as well as the Shannon-Weawer 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 togethered under the name of Angara (26 species) (Figure 1).

1. As a result of the analysis of recent area pattern, for which the paleoarctic 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 oreal 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-Turkestian 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: Tettigonioidea					
Phaneroptera falcata (Poda, 1761)	Eu-Si	Si-Pc	Th	0,252	IV
Phaneroptera nana nana Fieber, 1853	S-Eu	Holo-Med	Th	0,146	III
Isophya kraussii (Brunner v.W., 1878)	C-SE-Eu	Ba-Il	Ch	0,041	I
Isophya modestior stysi Cejchan, 1957	N-E-Car	Da	Ch	0,006	I
Isophya modesta Frivaldszky, 1867	C-SE-Eu	Ba(Moe)	Ch	0,031	I
Isophya costata Brunner v.W., 1878	C-Eu	Pan	Ch	0,003	I
Barbitites serricauda (Fabricius, 1798)	C-W-Eu	Po-Pan	Th	0,035	I
Barbitites constrictus Brunner v. W., 1878	C-E-Eu	Ba(Moe)	Th	0,006	I
Leptophyes punctatissima (Bosc, 1972)	Eu	Po-Ca	Th	0,012	I
Leptophyes albovittata (Kollar, 1833)	Eu	Po-Med	Th	0,188	III
Leptophyes boscii Brunner v. W., 1878	C-Eu	Extra-Med	Th	0,089	II
Leptophyes discoidalis (Frivaldszky, 1867)	C-E-Eu	Da	Th	0,003	I
Poecilimon affinis (Frivaldszky, 1876)	S-E-Eu	Ba(Moe)	Th	0,003	I
Poecilimon fussi Brunner v. W., 1878	S-E-Eu	Po-Pan	Th	0,009	I
Poecilimon schmidtii (Fieber, 1853)	E-SE-Eu	Po-Med	Th	0,003	I
Poecilimon intermedius (Fieber, 1853)	E-Eu, W-As	W-Si	Th	0,003	I
Polysarcus denticauda (Charpentier, 1825)	C-SE-Eu	Po-Med	Ch	0,028	I
Meconema thalassinum (DeGeer, 1773)	Eu	Extra-Med	Th	0,095	II
Meconema meridionale Costa, 1856	S-Eu	Adr-Med	Th	0,003	I
Conocephalus discolor Thunberg, 1815	Eu-Si	Si-Pc	Th	0,335	IV
Conocephalus dorsalis (Latreille, 1804)	Eu-W-As	Po-Ca	Th	0,111	II
Ruspolia nitidula (Scopoli, 1786)	Af-Eu-Si	Af	Th	0,095	II
Tettigonia viridissima Linnaeus, 1758	Eu-Si	Si-Pc	Th	0,169	III
Tettigonia caudata (Charpentier, 1845)	C-E-Eu	Po-Ca	Ch-Th	0,038	I
Tettigonia cantans (Fuessly, 1775)	Eu-Si	Si	Th	0,041	I
Decticus verrucivorus (Linnaeus, 1785)	Eu-Si	An	Ch-Th	0,21	III
Paltycleis grisea (Fabricius, 1781)	SE-Eu	Po-Ca	Th	0,23	III
Platycleis affinis Fieber, 1853	SE-Eu	Po-Ca	Th	0,143	III
Platycleis montana Kollar, 1833	Eu-Si	An	Ch	0,038	I
Platycleis vittata (Charpentier, 1825)	C-SE-Eu	Po-Ca	Th	0,115	II
Metrioptera brachyptera (Linnaeus, 1761)	Eu-Si	Si-Pc	Ch	0,019	I
Metrioptera bicolor (Philippi, 1830)	Eu-Si	An	Ch	0,159	III
Metrioptera roeselii (Hagenbach, 1822)	Eu	Po-Ca	Ch	0,22	III
Pholidoptera aptera (Fabricius, 1793)	C-Eu	Extra-Med-M	Th	0,063	II
Pholidoptera transsylvanica (Fischer, 1853)	N-E-Car	Da	Ch	0,015	I
Pholidoptera fallax (Fischer, 1853)	S-Eu	Po-Med	Ch	0,102	II
Pholidoptera griseoaptera (DeGeer, 1773)	Eu	Po-Ca	Th	0,166	III
Pachytrachys gracilis (Brunner v. W., 1861)	SE-Eu	Po-Med	Th	0,06	I
Rhacocleis germanica Herrich-Schaeffer, 1840	S-Eu	Po-Med	Th	0,076	II
Gampsocleis glabra (Herbst, 1786)	Eu-Am	Po-Ca	Th	0,063	II
Saga pedo (Pallas, 1771)	Eu-Si-Am	Po-Ca	Ch-Th	0,051	I
Ephippiger ephippiger (Fiebig, 1784)	C-E-Eu	Po-Med	Th	0,14	III
Superfamilia: Grylloidea					
Gryllus campestris Linnaeus, 1758	Af-Eu, W-As	Af	Fi	0,124	III
Melanogryllus desertus (Pallas, 1771)	Eu-Si	Po-Med	Fi	0,057	I
Modicogryllus frontalis (Fieber, 1844)	E-C-Eu, W-As	Po-Med	Fi	0,031	I
Acheta domesticus Linnaeus, 1758	Cos		Fi	0,028	I
Nemobius sylvestris (Bosc, 1972)	Eu	Eu-Pc	Fi	0,095	II
Tartarogryllus burdigalensis (Latreille, 1804)	S-SE-Eu	Med	Fi	0,095	II
Pteronemobius heydenii (Fisher, 1853)	Eu-C-As	Med	Fi	0,006	I
Myrmecophylus acervorum (Panzer, 1799)	Eu	Eu-Pc	Fi	0,003	I
Oecanthus pellucens (Scopoli, 1763)	S-Eu	Po-Med	Ch	0,095	II
Gryllotalpa gryllotalpa (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					
Pezotettix giornae (Rossi, 1794)	S-Eu	Po-Med	G-Ch	0,073	II
Podisma pedestris (Linnaeus, 1758)	Eu-Si	An	Ch	0,009	I
Odontopodisma schmidtii (Fieber, 1835)	E-Eu	Ba(II)	Ch	0,003	I
Odontopodisma rubripes (Ramme, 1931)	N-E-Car	Da	Th	0,009	I
Odontopodisma decipiens Ramme, 1951	E-Eu	Po-Med	Ch	0,003	I
Miramella alpina (Kollar, 1833)	Pi, Al	Al	Th	0,003	I
Pseudopodisma fieberi (Scudd, 1898)	SW-C-Eu	Po-Med-M	Ch	0,125	II
Pseudopodisma nagyi (Galvagni et Fontana,	C-E-Eu	Ba-Da	Ch	0,125	II
Calliptamus italicus (Linnaeus, 1758)	Eu-Si	An	G-Ch	0,178	III
Calliptamus barbarus (Costa, 1836)	S-Eu, N-Af, Am	Ir-Tur	G-Psm	0,038	I
Paracaloptenus caloptenoides (B. v.W., 1861)	C-SE-Eu	Ba(II)	G	0,014	I
Psophus stridulus (Linnaeus, 1758)	Eu-Si	An	Ch	0,035	I
Locusta migratoria (Linnaeus, 1758)	Cos	Pc		0,015	I
Oedaleus decorus (Germar, 1826)	Eu-As	Pc	G	0,118	II
Celes variabilis (Pallas, 1771)	Eu-As	Pc	G-Ch	0,099	II
Oedipoda caerulescens (Linnaeus, 1758)	Eu-As	Pc	G	0,309	IV
Sphingonotus caerulans (Linnaeus, 1758)	Eu	Po-Ca	G	0,041	I
Acrotylus insubricus (Scopoli, 1786)	Af, S-Eu, W-As	Af-Er	G	0,086	II
Acrotylus longipes (Charpentier, 1845)	Af, S-Eu, W-As	Af-Er	G-Psm	0,019	I
Aiolopus thalassinus (Fabricius, 1781)	Cos	Af	G-Ch	0,214	III
Aiolopus strepens (Latreille, 1804)	Af-Eu, Am	Af	G-Ch	0,006	I
Epacromius coerulipes (Ivanov, 1887)	Eu-Si	Mon	G-Ch	0,019	I
Epacromius tergestinus (Charpentier, 1825)	Eu, Am	N-Med-Pc	G-Ch	0,025	I
Stethophyma grossum (Linnaeus, 1758)	Eu-Si	Ma	Ch	0,191	III
Parapleurus alliaceus (Germar, 1817)	Eu-Si	Ma	Ch	0,099	II
Acrida hungarica (Herbst, 1786)	C-SE-Eu, Af	Af	G-Ch	0,169	III
Chrysochraon dispar (Germar, 1834)	Eu-Si	An	Ch	0,105	II
Euthystria brachyptera (Ocskay, 1826)	Eu-Si	An	Ch	0,121	II
Stenobothrodes eurasius Zubowski, 1898	C-Eu,W-As	An	Ch	0,019	I
Stenobothrus crassipes (Charpentier, 1825)	E-Eu	Po-Med	Ch	0,201	III
Stenobothrus lineatus (Panzer, 1796)	Eu-Si	An	Ch	0,239	III
Stenobothrus nigromaculatus (H.-S. 1840)	Eu-Si	An	Ch	0,172	III
Stenobothrus fischeri (Eversmann, 1848)	S-E-Eu, As	An	G-Psm-Ch	0,044	I
Stenobothrus stigmaticus (Rambur, 1838)	S-SE-Eu	Po-Ca	Ch	0,143	III
Omocestus viridulus (Linnaeus,. 1758)	Eu-Si	An	Ch	0,003	I
Omocestus rufipes (Zetterstedt, 1821)	Eu-Si	An	Ch	0,313	IV
Omocestus haemorrhoidalis (Charpentier, 1825)	Eu-Si	An	Ch	0,293	IV
Omocestus petraeus (Brisout, 1855)	Eu-Si	An	G-Ch	0,153	III
Stauroderus scalaris (Fischer-v.Waldheim, 1846)	Eu-Si	An	Ch	0,012	I
Chorthippus apricarius (Linnaeus,.1758)	Eu-Si	An	Ch	0,14	III
Chorthippus pullus (Philippi, 1830)	C-E-Eu, W-As	Po-Ca	Ch	0,003	I
Chorthippus vagans (Eversmann, 1848)	Eu, W-As	W-As	Ch	0,006	I
Chorthippus biguttulus (Linnaeus,. 1758)	Eu	Po-Ca	Ch	0,434	IV
Chorthippus brunneus (Thunberg, 1815)	Eu-Si	An	Ch	0,523	V
Chorthippus mollis (Charpentier, 1825)	Eu-Si	An	Ch	0,351	IV
Chorthippus eisentrauti Ramme, 1931	Dal	En	Ch	0,009	I
Chorthippus albomarginatus (DeGeer, 1773)	Eu-Si	Si-Pc	Ch	0,306	IV
Chorthippus dorsatus (Zetterstedt, 1821)	Eu-Si	Si-Pc	Ch	0,46	IV
Chorthippus loratus Fischer-v.Waldheim, 1864	S-E-Eu	Po-Ca	Ch	0,028	I
Chorthippus dichrous Eversmann, 1895	Eu-Si	An	Ch	0,035	I
Chorthippus parallelus (Zetterstedt, 1821)	Eu-Si	An	Ch	0,399	IV
Chorthippus montanus (Charpentier, 1825)	Eu-Si	An	Ch	0,191	III
Euchorthippus declivus (Brisout 1848)	S-Eu	N-Med-Pc	G-Ch	0,402	IV
Euchorthippus pulvinatus (Fischer-v.Waldheim	S-E-Eu, W-As	Po-Ca-Tur	G-Ch	0,057	I
Myrmeleotettix antennatus (Fieber, 1853)	Eu-Si	An	G-Ch	0,044	I
Myrmeleotettix maculatus (Thunberg, 1815)	Eu-Si	An	G-Ch	0,07	II
Gomphocerippus rufus (Linnaeus,.1758)	Eu-Si	An	Ch	0,23	III
Dociostaurus maroccanus (Thunberg 1815)	Eu, Am	Ir-Tur	Ch	0,031	I
Dociostaurus brevicollis (Eversmann, 1848)	Eu, Am	Po-Ca-Tur	G-Ch	0,162	III
Arcyptera fusca (Pallas, 1773)	Eu-Si	An	Ch	0,019	I
Pararcyptera microptera (Fischer-v.Waldheim,	Eu-Si	An	G-Ch	0,025	I

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

ABBREVIATIONS:

Af = African (Ethiopian)	E = East	N = North	0,0625	rare	I
Al = Alpian	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 = Pirenian	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 = Thamnobiont			
Cos = Cosmpolitan	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 Extra- Mediterranean Endemic (dacian)	29 species *(i.e.:Phaneroptera nana)* *(i.e.:Pholidoptera aptera)* *(i.e.:Pholidoptera transsylvanica)*	Mediterranean-Xero-Mountain	1 species *(i.e.:Paracolptenus caloptenoides)*	Iranian	1 species *(i.e.:Dociostaurus maroccanus)*
Ponto-Caspian	16 species *(Tettigonia caudata)*	Alpin	1 species *(i.e.:Miramella alpina)*	Iranian Turcesthanian	1 species *(i.e.:Calliptamus barbarus)*
Siberian (s.l.) *Angarian*	41 species *(i.e.:Chorthippus albomarginatus)* 26 species *(i.e.:Arcyptera fusca)*	Inner-Asian -Xero-Mountain	4 species *(i.e.:Celes variabilis)*		
Ethiopian	3 species *(i.e.:Acrida hungarica)*			Ethiopian	2 species *(i.e.:Acrotylus insubricus)*

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 caerulans - 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 dominancy *Bicolorana bicolor* and *Stenobothrus crassipes*; in dryer type of the lowland with the dominancy 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 - Dociostaurus 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 apricarius - 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 toll and short grasses, and higher dominancy 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 invated 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, Turkesthanian) and Ponto-Mediterranean elments, the cool steppe species were forced back into the higher altitudes. Former species invated the Carpathian Basin from a ESE direction (Vaskapu, Törcsvár), while the latters do it from SSE. Forestation of the Atlantic and Boreal period forced the Boreal species onto edaphyc 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 postglacial 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 considevable 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 localyties). For this calculation, I compild 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).

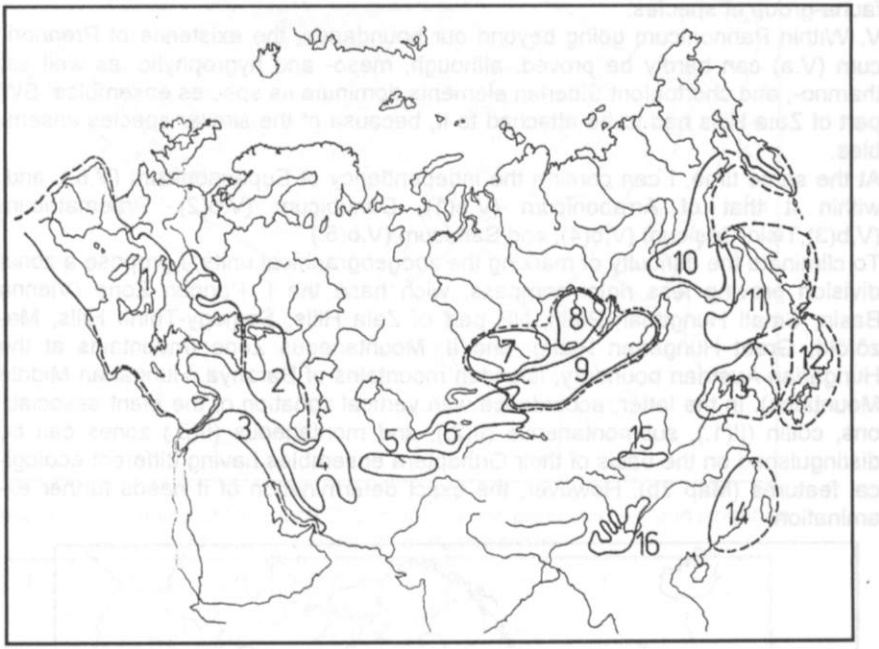


Fig. 1: Palaeoarctical refuges of Orthoptera fauna (1 Mediterranean, 2 Ponto-Kaspian, 3 Sirian, 4 Iranian, 5 Afganian, 6 Turchestanian, 7, 8, 9 Angarian, 10 E-Siberian, 11 Mandshurian, 12 Japonian, 13 Korean, 14 Sinopacifian, 15 Sinotibetian, 16 Yünnanian refuges).

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

II. Influence of Carpathicum 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 dicscolidalis* in associations of the forest edges of the Bereg Plain.

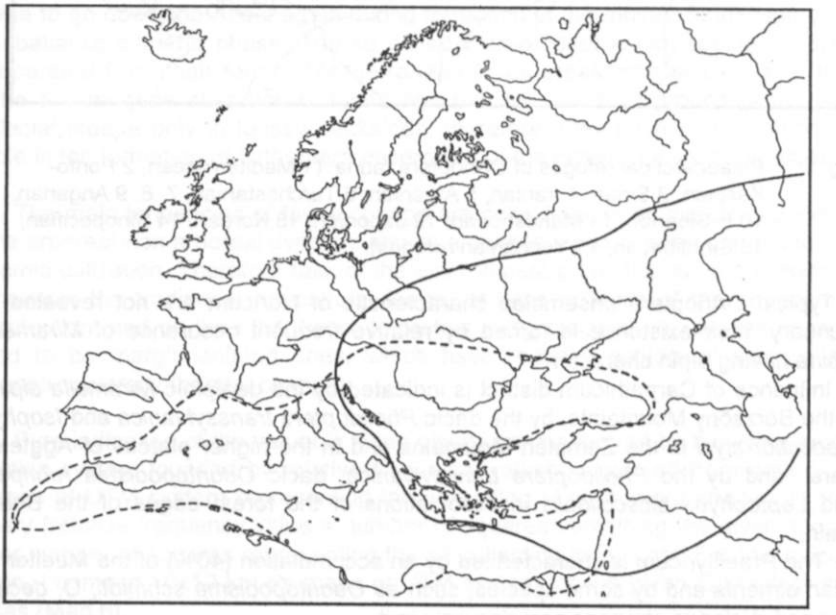
III. The Praeillyricum is characterized by an accumulation (40%) of the Mediterranean elments and by some species, such as *Odontopodisma schmidti, O. decipiens* and *Aiolopus strepens* occuring only in it.

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.

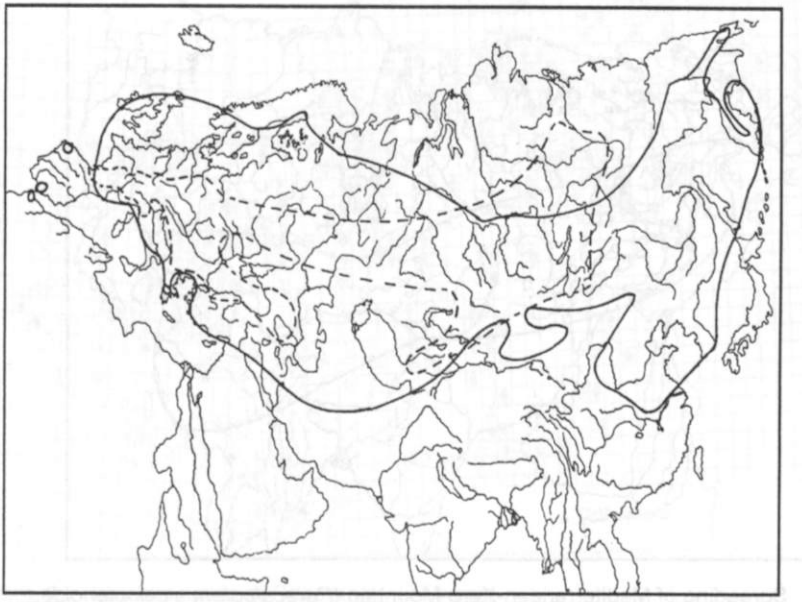
V. Within Pannonicum going beyond our boundaries, the existence of Preanoricum (V.a) can hardly be proved, although, meso- and hygrophylic, as well as, thamno-, and chortobiont Siberian elements dominate its species ensembles. SW part of Zala Hills had to be attached to it, because of the similar species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

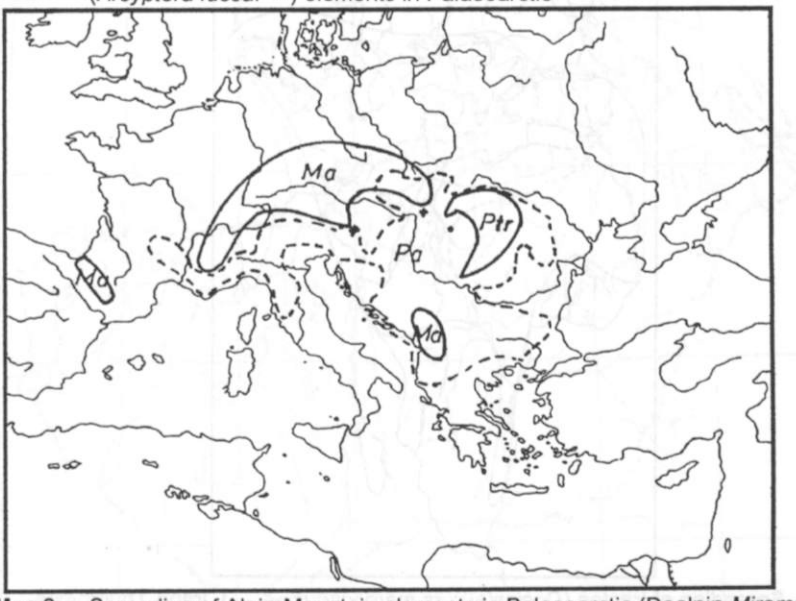
To climinate the difficulty of marking the zoogeographical units, I propose a zonal division proving less rigiol compass, wich hase the I. Pannon Zone (Vienna Basin, Small Hungarian Plain, NE part of Zala Hills, Somogy-Tolna Hills, Mezőföld, Great Hungarian Plain), and II. Mountaneous Zone (mountains at the Hungarian-Austrian boundary, islanden 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.



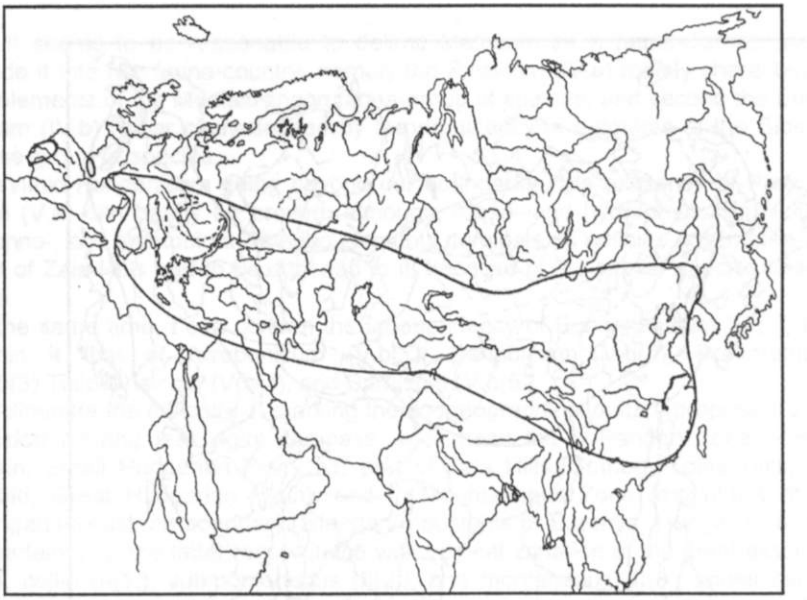
Map 1: Spreading of Mediterranean (*Phaneroptera nana*: ---), and Ponto-Caspian (*Tettigonia caudata*: —) elements in Palaeoarctic



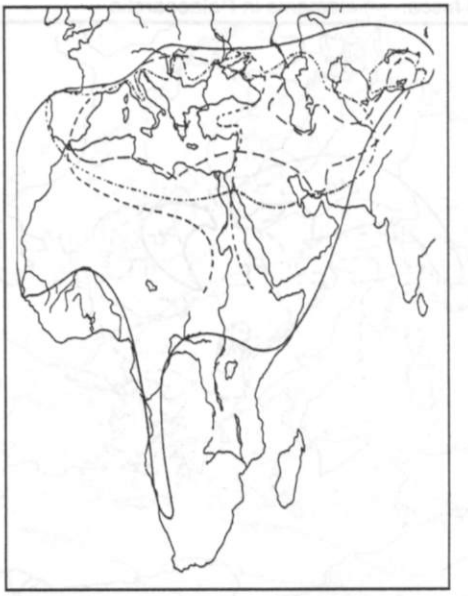
Map 2: Spreading of Siberian (*Chorthippus albomarginatus*: —) and Angarian (*Arcyptera fusca*: ---) elements in Palaeoarctic



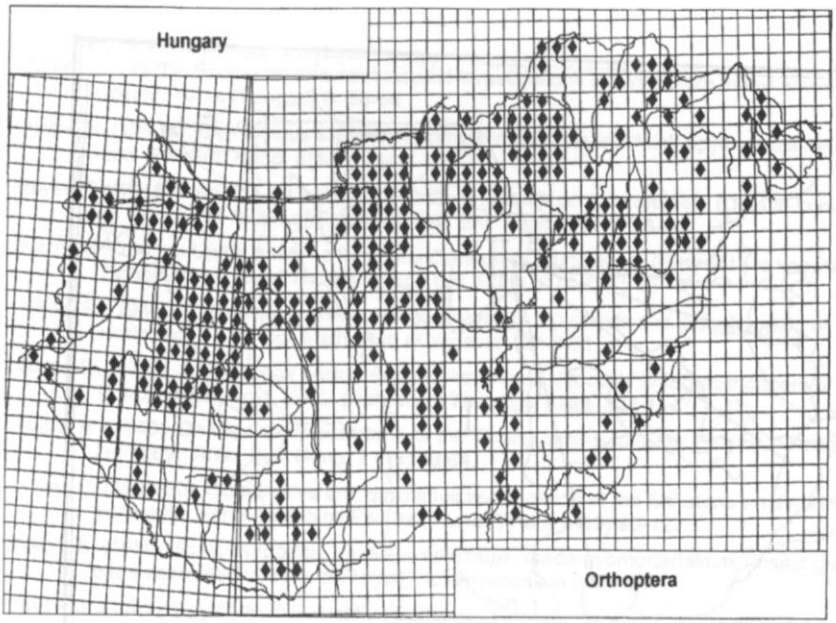
Map 3: Spreading of Alpin-Mountain elements in Palaeoarctic (Dealpin *Miramella alpina*: Ma and +; Dacian *Pholidoptera transsylvanica*: Ptr and *; Extra-Mediteranean *Pholidoptera aptera*: Pa).



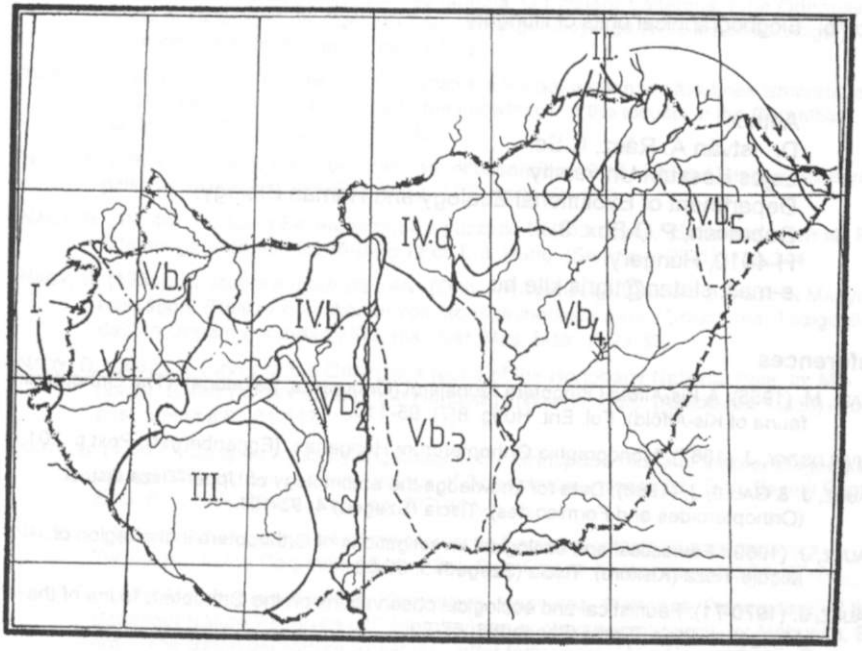
Map 4: Spreading of Mediterranean-Xero-Mountain (*Paracalpotenus caloptenoides*: - –), and Inner-Asian-Xero-Mountain (*Celes variabilis*: —) elements in Palaeoarctic



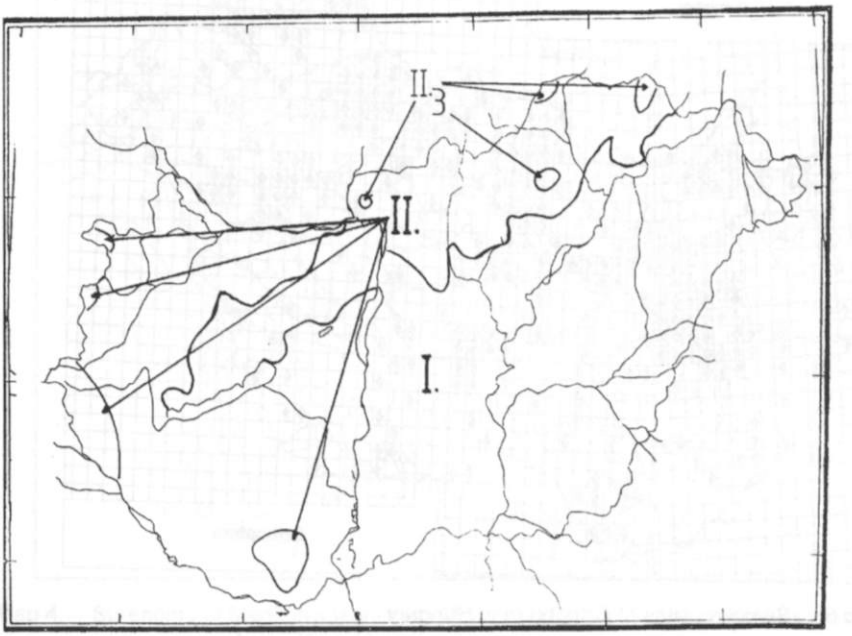
Map 5: Spreading of Iranian (*Dociostaururs maroccanus*: — —), Irano-Thurchestanian (*Calliptamus barbarus*: -.-), Ethiopian (*Acrida hungarica*: ---), and Afro-Erimialean (*Acrotylus insubricus*: —) elements in Palaeoarctic



Map 6: Sampling sites of Orthoptera in Hungary



Map 7a: Biogeographical units of Hungary



Map 7b: Biogeographical units of Hungary

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