

Contribution to the knowledge on the Orthoptera of the Žumberak and Samobor Mountains (Northwest Croatia)

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Abstract

In the Žumberak-Samoborsko gorje Nature Park (northwest Croatia) 39 Orthoptera and 1 Mantodea species were recorded in three types of habitats in 2003. The richest assemblages could be found in mesic hayfields where the species of dry and wet habitats occur together. A far larger number of species were found on mesic grasslands (12) than on the wet type (2), whereas the dry type grassland was intermediate (7). The distribution of the species of dry habitats was the most heterogeneous, while the two other types were more uniform. The Orthoptera fauna resembled the characteristic fauna of the northern Praellyricum (e.g. the Mecsek and the Villány Hills in southern Hungary).

Zusammenfassung

Im Naturpark Žumberak-Samoborsko gorje (NW-Kroatien) wurden im Jahr 2003 insgesamt 39 Heuschreckenarten und *Mantis religiosa* in verschiedenen Grünlandgesellschaften nachgewiesen. Die meisten Arten wurden auf den mesophilen Gebirgswiesen angetroffen, wo Arten der feuchten und trockenen Lebensräume zusammen vorkamen. Die grösste Anzahl der Arten (12) war für die mesophilen Biotope charakteristisch, im Gegensatz zu der sehr geringen Anzahl an Feuchtbiotop-Arten (2). Die Artenzahl der Trockenbiotope nahm eine Zwischenstellung ein (7). Die Artenzusammensetzung der Trockenbiotope war überaus heterogen, während sich die Gesellschaften der beiden anderen Rasentypen eher homogen darstellten. Die Faunengemeinschaft weist die grösste Ähnlichkeit mit jener des nördlichen Präillyricum (d.h. Mecsek- und Villányer Gebirge in Südungarn) auf.

Introduction

In spite of the increasing data available on the Orthoptera fauna of Central Europe, the inventory status of the regions varies significantly. This is the case in the Praellyrian region, of which the northern part (i.e., the Mecsek and the Villány Hills in southern Hungary) is relatively well studied compared with adjacent areas in Croatia and Serbia. In the present study the Orthoptera fauna of the Žumberak-Samoborsko gorje Nature Park (northwest Croatia) is investigated in order to obtain a checklist and to describe Orthoptera-assemblages of characteristic habitat types of the area.

Sites and methods

The Nature Park was established in 1999 and is situated in northwest Croatia, near the Slovenian border (Fig. 1). The park lies between the Dinaric carbon plateaus (*Dinaricum*) and the Inner Dinaric area (*Superdinaricum*). The whole area is hilly with altitudes varying between 180 and 1178 m (Sveta Gera in Žumberak Mts.).

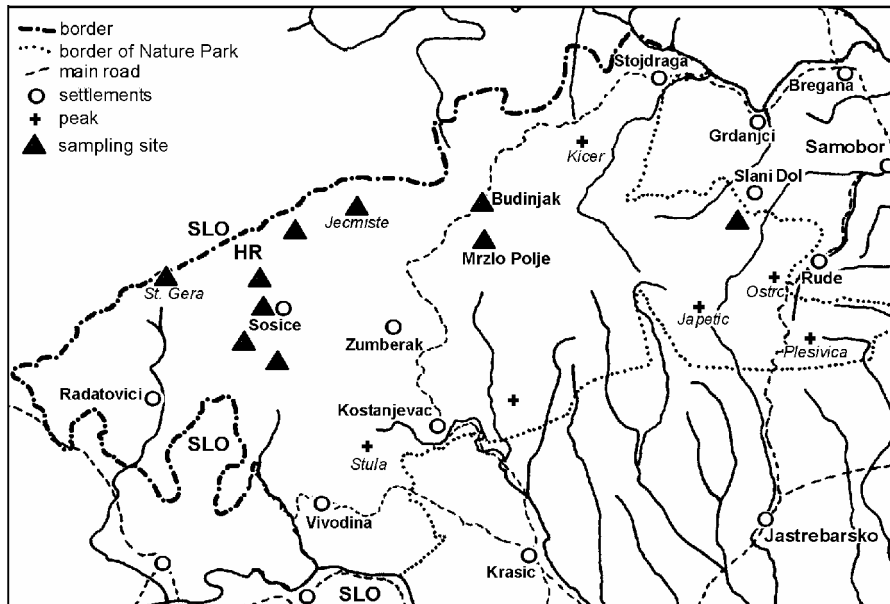


Fig. 1: Map of the Žumberak-Samoborsko gorje Nature Park with the location of the sampling areas in 2003.

The larger part of the area is mostly covered by beech forests. Besides woodlands, several types of grasslands can be found (i.e. pastures, meadows, and hayfields). Most of them have originated from and are maintained by human activity (mowing, and grazing). Dry grasslands and shrubs can be found in lower areas and on southern slopes, while mesic grasslands and hayfields are characteristic for higher altitudes. Wet grasslands can be found along streams, valley floors and in dolines (dolina). In this study, Orthoptera-assemblages of 16 sampling sites in 10 sampling areas with different vegetation (Table 1) were sampled by sweep-net (200 net strokes per sites) completed with direct search. The sampling was conducted from 13th to 15th of August 2003.

HARZ (1957, 1969, 1975) was used for the identification, and nomenclature follows HELLER et al. (1998). The collected material was placed in the Department of Evolutionary Zoology and Human Biology, University of Debrecen. The classification into faunal types and life forms follows RÁCZ (1998). For the characterisation and comparison of assemblages two types of Whittaker's index (S/α and its variant S/α_{max}) (WHITTAKER 1960) and Sorensen index were used. The similarity structure was analysed by hierarchical cluster analysis using the Ward-Orlóci fusion algorithm. The difference of species numbers, proportion of faunal types and life forms among habitat types were analysed with Kruskal-Wallis one-way analysis of variance (ANOVA). The Mann-Whitney U test was used to compare groups.

Table 1: Short description of the 16 sampling sites in the Žumberak-Samoborsko gorje Nature Park in 2003.

habitat type	site		description	altitude
dry type	X1	Serina 1a	dry cultivated (mowed) grassland near Serina	562 m
	X2	Serina 1b	edge of the former grassland	562 m
	X3	Budinjak	dry, mowed hayfield near main road to Bregana	-
	X4	Keseri Parlovica	abandoned, dry hayfield near the Parlovica cave	-
	X5	Zmrzlo polje	steep, pastured slope with bare patches	535 m
mesic type	M1	Sosice 1	hayfield north to Osovlje peak with forest edge	685 m
	M2	St. Gera 1	peak of the St. Gera. mowed patch on the hilltop	1151 m
	M3	St. Gera 2	closed grass and edge below the top of St Gera	1105 m
	M4	Maculinea site	mesic grassland with a number of shrubs	891 m
	M5	Blazsevo brdo 1	plateau with lot of dolines and edge of a doline	877 m
	M6	Blazsevo brdo 2	slope and bottom of a doline	867 m
	M7	Ravne kale	mesic hayfield with some clumps and shrubs	958 m
wet type	W1	Serina 2a	wet closed hayfield in the bottom of a valley	683 m
	W2	Serina 2b	edge of the former grassland	683 m
	W3	Sosice 2	wet grassland in the bank of a stream near Sosice	693 m
	W4	Malinci Duboka	bottom of a deep doline with a little bog	661 m

Results

A total of 36 Orthoptera (19 Ensifera and 17 Caelifera) and one Mantodea species were recorded in the 16 sampling sites. In addition, two larvae of *Tetrix bipunctata* and *Gryllus campestris* and one specimen of *Oecanthus pellucens* were found by direct search. Table 2 shows names, authorities, life forms and faunal types of all 39 recorded species. No single site or habitat contained all the recorded species. The mesic grasslands had significantly higher numbers of species than did other types ($\chi^2 = 8.954$, $n = 16$, $df = 2$, $p = 0.011$; $U = 1.5$ $p = 0.005$; $U = 3.0$ $p = 0.042$) (Table 3). The fewest species were found in wet grasslands. Considering the number of specimens there was no significant difference between habitat types ($\chi^2 = 0.419$, $n = 16$, $df = 2$ ns). Both Whittaker's indices show that the species composition was the most heterogeneous in dry habitats. Based on Whittaker's S/α the assemblages of wet grasslands were most uniform in species composition, whereas the assemblages of mesic grasslands were most uniform based on the modified Whittaker's index (S/α_{max}). Total heterogeneity was larger than that within habitats, indicating a differential distribution of species (Table 3).

The similarity in species composition among sites was examined using the Sorensen index. In the cluster analysis sites within each habitat type clustered together, with only two 'mismatches' (two sites of mesic type) (Fig. 2).

Table 2: The Orthoptera species of the Žumberak-Samoborsko gorje Nature Park collected in August 2003. *: found additionally by direct search, **: only one specimen that escaped before correct identification.

Faunal type (RÁCZ 1998): af: African, an: Angarian, ca: Caspian, en: endemic, ext: extra, il: Illyrian, m: mountain, med: Mediterranean, pc: polycentric, si: Siberian, po: Pontic.

Life form (RÁCZ 1998): ch-chortobiont, f: fissurobiont, g: geobiont, th: thamnobiont, *italic*: on the basis of personal communication of RÁCZ I.A.

	Faunal type	Life form
Ensifera		
<i>Phaneroptera falcata</i> (Poda, 1761)	si-pc	th
<i>Leptophyes albovittata</i> (Kollar, 1833)	po-med	th
<i>Leptophyes boscii</i> Fieber, 1853	ext-med	th
<i>Polysarcus denticauda</i> (Charpentier, 1825)	po-med	ch
<i>Ruspolia nitidula</i> (Scopoli, 1786)	af	th
<i>Tettigonia viridissima</i> Linnaeus, 1758	si-pc	th
<i>Tettigonia cantans</i> (Fuessly, 1775)	po-ca	ch-th
<i>Decticus verrucivorus</i> (Linnaeus, 1758)	an	ch-th
<i>Platycleis</i> sp.**	-	-
<i>Metrioptera brachyptera</i> (Linnaeus, 1761)	si-pc	ch
<i>Metrioptera bicolor</i> (Philippi, 1830)	an	ch
<i>Metrioptera roeselii</i> (Hagenbach, 1822)	po-ca	ch
<i>Eupholidoptera chabrieri</i> (Charpentier, 1822)	<i>n-med</i>	<i>th</i>
<i>Pholidoptera dalmatica</i> (Krauss, 1899)	<i>ill-m</i>	<i>th</i>
<i>Pholidoptera aptera</i> (Fabricius, 1793)	ext-med-m	th
<i>Pholidoptera fallax</i> (Fischer, 1853)	po-med	ch
<i>Pholidoptera griseoptera</i> (De Geer, 1773)	po-ca	th
<i>Pachytrachis gracilis</i> (Brunner v. Wattenwyl, 1861)	po-med	th
<i>Ephippiger ephippiger</i> (Fiebig, 1784)	po-med	th
<i>Oecanthus pellucens</i> (Scopoli, 1763)*	po-me	ch-th
<i>Gryllus campestris</i> Linnaeus, 1758*	af	fi
Caelifera		
<i>Odontopodisma decipiens</i> Ramme, 1951	po-med	ch
<i>Micropodisma salamandra</i> (Fischer, 1853)	<i>ill</i>	<i>ch</i>
<i>Psophus stridulus</i> (Linnaeus, 1758)	an	g-ch
<i>Chrysochraon dispar</i> (Germar, 1834)	an	ch
<i>Euthystira brachyptera</i> (Ocskay, 1826)	an	ch
<i>Stenobothrus lineatus</i> (Panzer, 1796)	an	ch
<i>Stenobothrus nigromaculatus</i> (Herrich-Schaffer, 1840)	an	ch
<i>Stenobothrus stigmaticus</i> (Rambur, 1838)	po-ca	ch
<i>Omocestus rufipes</i> (Zetterstedt, 1821)	an	ch
<i>Chorthippus biguttulus</i> (Linnaeus, 1758)	po-ca	ch
<i>Chorthippus eisentrauti</i> Ramme, 1931	en	ch
<i>Chorthippus albomarginatus</i> (DeGeer, 1773)	si-pc	ch
<i>Chorthippus dorsatus</i> (Zetterstedt, 1821)	si-pc	ch
<i>Chorthippus parallelus</i> (Zetterstedt, 1821)	an	ch
<i>Euchorthippus declivus</i> (Brisout 1849)	n-med-pc	g-ch
<i>Gomphocerippus rufus</i> (Linnaeus, 1758)	an	ch
<i>Arcyptera fusca</i> (Pallas, 1773)	an	ch-g
<i>Tetrix bipunctata</i> (Linnaeus, 1758)*	si-pc	ch
Mantodea		
<i>Mantis religiosa</i> (Linnaeus, 1758)	-	-

Table 3: Basic characteristics of Orthoptera-assemblages by habitat type in the Žumberak-Samoborsko gorje Nature Park in 2003.

	Dry grasslands and edges	Mesic grasslands and edges	Wet grasslands	Total
No of sites	5	7	4	16
Total species (S)	17	26	13	36
Mean species/site (α) (SE)	5.8 (1.3)	10.9 (3.3)	6.8 (1.5)	8.3 (3.3)
Whittaker's S/ α	2.9	2.4	1.9	4.61
S/ α max	2.1	1.5	1.6	2.1
No. of specimen	75	123	57	255
Mean specimen/site	15.0	17.6	14.3	15.9

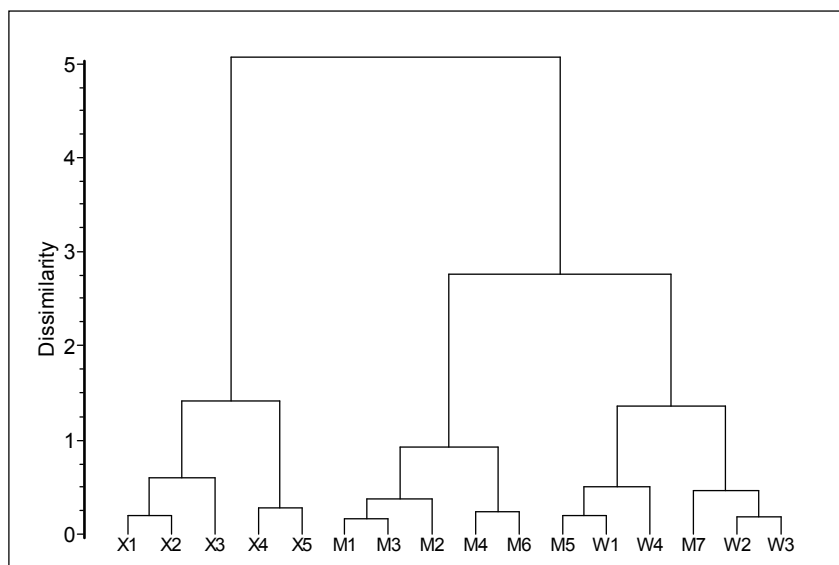


Fig. 2: Dendrogram of samples taken in Žumberak-Samoborsko gorje Nature Park in 2003 (Sorensen, Ward's method). (X: samples from dry, M: samples from mesic, W: samples from wet type of habitat).

Five species, *Phaneroptera falcata*, *Leptophyes bosicii*, *Euthystira brachyptera*, *Chorthippus dorsatus* and *Chorthippus parallelus* occurred in all types of grasslands. Twenty-one of 36 species occurred in only one type of habitat. Except for *Stenobothrus lineatus* and *Odontopodisma decipiens*, all of these species were rare or scattered in their habitats (Table 4). A far larger number of species were characteristic on mesic grasslands (12) than on the wet type (2), whereas the dry type grassland was intermediate (7). Six species occurred both in mesic and wet grasslands, while mesic and dry grasslands shared four species. *Eupholidoptera chabrieri* could be found both in wet and dry grasslands but was absent in mesic habitats (Table 4). This result may be due to sampling error since detection probability was low for this species because of its mostly nocturnal activity.

The studied fauna consisted of different Mediterranean (eg. Ponto-, North-, extra-Mediterranean) and Siberian (Siberian-policentric and Angarian) faunal elements. The relative frequencies of these two major groups did not show significant differences between habitat types ($\chi^2 = 1.698$, $n = 16$, $df = 2$ ns) (Table 5).

The studied assemblages could be characterised by a high relative frequency of chorthobiont species. The proportion of thamnobiont species was relatively high in the dry grasslands. The proportion of life forms did not differ significantly among habitat types (Table 5).

Table 4: Distribution and proportion of sites occupied by species in different habitat types of Žumberak-Samoborsko gorje Nature Park in 2003. (Numbers of sites occupied by species are in parentheses. c: constancy in occupied habitat(s)).

Occurrence	Dry grasslands, shrubs and edges (5 sites)	Mesic grasslands and edges (7 sites)	Wet grasslands (4 sites)
Common (c > 0.7)	<i>Chorthippus parallelus</i> (12)		
	<i>Chrysocraon dispar</i> (9)		
	<i>Stenobothrus lineatus</i> (5)		
Frequent (c: 0.5-0.7)	<i>Euthystira brachyptera</i> (11), <i>Chorthippus dorsatus</i> (8)		
	<i>Metrioptera bicolor</i> (5), <i>Chorthippus biguttulus</i> (7)		
	<i>Metrioptera roeselii</i> (6), <i>Micropod. salamandra</i> (6) <i>Odontopod. decipiens</i> (4)		
Rare (c < 0.5)	<i>Phaneroptera falcata</i> (7), <i>Leptophyes bosicii</i> (6)		
	<i>Decticus verrucivorus</i> (4)		
	<i>Pholidoptera fallax</i> (4), <i>Pholidop. griseoptera</i> (5)		
	<i>Pachytrachis gracilis</i> (2) <i>Ch. albomarginatus</i> (2) <i>Gomphocerippus rufus</i> (2)	<i>Metriop. brachyptera</i> (3) <i>Psophus stridulus</i> (2) <i>Arcyptera fusca</i> (2) <i>Ephippiger ephippiger</i> (2) <i>Stenoboth. stigmaticus</i> (2)	
Scattered (found only in one sampling site by habitat type)	<i>Omocestus rufipes</i> (2)		
	<i>Leptophyes albovittata</i> (1) <i>Euchorthippus declivus</i> (1) <i>Chorthippus eisentrauti</i> (1) <i>Platycleis sp.</i> (1) <i>Eupholidoptera chabrieri</i> (1)	<i>Tettigonia cantans</i> (1) <i>Polysarcus denticauda</i> (1) <i>Pholidoptera dalmatica</i> (1) <i>Pholidoptera aptera</i> (1) <i>Stenobothrus nigromaculatus</i> (1)	<i>Ruspolia nitudula</i> (1) <i>Tettig. viridissima</i> (1) <i>Eupholidoptera chabrieri</i> (1)
No. of species	17	26	13

Table 5: Distribution of the proportion of life forms and faunal types (RÁCZ 1998) in different habitats in the Žumberak-Samoborsko gorje Nature Park in 2003.

	Dry grasslands and edges	Mesic grasslands and edges	Wet grasslands	Total
thamnobionts	20.86 %	14.66 %	22.92 %	19.48 %
thamno-chorthobionts	5.43 %	2.95 %		4.19 %
chorthobionts	71.81 %	75.41 %	77.08 %	74.77 %
geo-chorthobionts	1.90 %	6.98 %		4.44 %
Siberian	55.01 %	58.92 %	57.64 %	57.19 %
Mediterranean	44.99 %	41.08 %	42.36 %	42.81 %

Discussion

The Orthoptera fauna and assemblages of the Žumberak and Samobor Mountains are characterised on the basis of 39 species recorded in 2003. The area has a typical preillyrian Orthoptera fauna which shows similarity to the fauna of the Mecsek and the Villány Hills (south Hungary, northern Praeillyricum) (RÁCZ & VARGA 1985, NAGY & NAGY 2000) and also has a special character. The zoogeographical character of the area is formed by both Mediterranean and Continental (Siberian) effects. As a consequence of the strong mountainous character in the high altitudes, species such as *Arcyptera fusca*, *Polysarcus denticauda* and *Tettigonia cantans* appear and the proportion of Siberian elements was higher than in the northern Praeillyricum (e.g. the Villány Hills: 34.4%; NAGY & NAGY 2000). *Eupholidoptera chabrieri*, *Micropodisma salamandra* and *Pholidoptera dalmatica* reach their northern distribution in this region and some species (e.g. *Leptophyes boscii*, *Odontopodisma decipiens*) are more common than in the northern, Hungarian part of the Praeillyricum. The high proportion of chorthobiont species appeared to be correlated with vegetation structure. The relatively high ratio of thamnobionts in dry grasslands can be explained by edge effects and large numbers of bushes which provide suitable microhabitats for thamnobionts. An earlier sampling (May, June) could result in new species belonging to *Isophya* and *Poecilimon* genera because many of them (*Isophya modesta*, *I. modestior*, *I. brevipennis* → *I. camptoxypha* (HELLER et al. 2004), *Poecilimon fussi*, *P. intermedius*) occur in the northern part of Praeillyricum (NAGY & NAGY 2000, VADKERTI et al. 2003).

Differences between species assemblages were revealed by the statistical analysis. These differences reflect ecological gradients between sites and habitat types. The richest habitat type with relatively lower heterogeneity in species composition was the mesic hayfield. As a consequence of the intermediate character and the large variety of microhabitats (leaves, grasses, soil, bushes), the Orthoptera-assemblages of hayfields contain species occurring in both the dry and wet type of habitats. These vulnerable grasslands are endangered by both secondary succession and change of land use (termination of mowing and grazing). The management is essential to protect these habitats and their species-assemblages. The species composition, life form spectra and characteristic species of the Orthoptera-assemblages can be used as indicators of changes in habitat structure and of the effects of management. I hope that this study will attract attention to the Žumberak and Samobor Mountains and establish a basis for the further investigation of their Orthoptera fauna.

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