BIOECOLOGY OF THE ORTHOPTERA SPECIES FROM NASLVACEA, NORTH OF THE REPUBLIC OF MOLDOVA

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Abstract. The taxonomic composition, ecological and spatial distribution of orthopterans was studied in steppe region (associations of *Andropogon* with *Acacia*) from the Naslavcea. The village is situated on the right bank of the Dniester River basin, Edinet district. In order to collect individuals, there were used direct collection and sweeping. In total, 19 species of grasshoppers were identified; ten of them can be regarded as characteristic for steppe.

Keywords: Orthoptera, fauna, steppe, Naslavcea.

Rezumat. Bioecologia ortopterelor din stepa Naslavcea, Nordul Republicii Moldova. Compoziția taxonomică, distribuția ecologică și spațială a ortopterelor a fost studiată în regiunea de stepă (asociații de *Andropogon* și *Acacia*) din împrejurimele Naslavcei. Satul este situat în partea de nord a ţării, pe malul drept al râului Nistrului, raionul Edineț. Pentru a colecta de indivizii au fost folosite colectarea directă și prin filetare. În total, au fost colecate 19 de specii de ortoptere, zece dintre ele pot fi considerate ca fiind caracteristice pentru sectoarele de stepă.

Cuvine cheie: Orthoptera, fauna, stepă, Naslavcea.

INTRODUCTION

Orthoptera is one of the main groups of insects in the steppe communities, playing a major role in the regulation of the primary productivity of ecosystems as well as in soil formation (STEBAEV, 1968).

The petrophytic substrate ecosystem of the searched area consists from Limestone Mountains. They are present in the northern part of Moldova along the Prut River and its tributaries (from Lipcani to Brăneşti) as rocky ridges and conglomerates ("Toltre"), which are ancient coral reefs of the Tortonian Sea.

The limestone also spread like a wide strip in the northeast along the Dniester River and its tributaries: from Naslavcea to Bender. Sarmatian limestones and "Toltre" are unique features of the landscape. Biological diversity of these ecosystems are represented by mosses and lichens, with typical steppe and forest vegetation (total of 252), and various groups amphibians (10-15 species). Petrophytic forests are located along rivers, the Dniester, the Răut Ichel, the Vilia, the Draghişte and the Rakovăţ, and in open areas form zones of steppe vegetation. Some biotope we can met in Naslavcea, whose fauna of Orthoptera insects we have studied during two years.

This study is important because Orthoptera insects are a major component in the food chain species of birds and amphibians species (BELOVSSKY & SLADE, 1993).

MATERIALS AND METHODS

Study site

Studies were carried out in the first part of August 2011 and 2012 in the surroundings of Naslavcea village in a forest-steppe region with associations of *Andropogon* and *Acacia* (Fig. 2). This place is situated on the right bank of the Dniester River, in the north of the Republic of Moldova, Edinet district, its geographical coordinates being 48° 28' 2" North, 27° 35' 4" East (Fig. 1).

The general character of the relief is determined by the presence of the low hills, which alternate with plateaus that succeed in waves. Land fragmentation is determined by the substratum, which is generally formed by various loess, loamy deposits easily displaced and driven by water flow, usually forming narrow valleys with flat slopes. The searched territory has a lithological substratum, which consists in porous limestone rocks and the valleys are narrow and steep.

Sampling methods

The insects were collected using the sweep net. From the studied areas, there were taken 300 samplings in each year and netting sampling method involved the use of 50 sweeps by 6 times. Samplings were carried out beginning from 9 am till 11 am.

The sampled insects were mounted at the laboratory and identified to families and species. A part of the specimens are deposited in the Entomological Museum of Institute of Zoology of ASM.

Data analyses

The specimen identification was made according to external morphology and genitalia using identification different keys (IORGU & IORGU, 2008; HARZ, 1975; BEI-BIENKO, 1964).

The species nomenclature and classification were made according to the site Orthoptera of Europe.

The zoogeographic elements were established on the evidentially of the work of BEI-BIENKO (1952, 1964) and IORGU & IORGU (2008). At processing of mathematical and statistical analysis of the entomological material was made by means of the program PAST (HAMMER 2012).

Figure 1. The emplacement of Naslavcea (Google Earth).

Figure 2. The sight of the vegetation of the forest steppe Naslavcea (original).

RESULTS

During the years 2011 and 2012, there were performed subject researches of the diversity of insects from Orthoptera order from the limestone grasslands communities in the north, near the Naslavcea village. As a result of the study, there was collected a total of 161 individuals belonging to 19 species and 6 families during these two years. In the summer of 2011, there were collected 89 specimens from Orthoptera order belonging to 16 species, 10 genera and 5 families. In the summer of 2012, there were collected only 72 individuals of 13 species, 7 genera and 5 families.

Tabel 1. Fauna of Orthoptera insects from Naslavcea and their bio-ecological particularity.

No.	Taxon	Ecological preference		Geographical distribution	Naslavcea				Frequent
		Biotope	Vital form		2011		2012		
					♀♀	♂♂	♀♀	♂♂	
Suborder ENSFERA Superfamily TETTIGONIOIDEA KRAUSS, 1902 Family Bradyporidae Genus *Ephippiger* BERTHOLD, 1827									
1.	*Ephippiger ephippiger* (FIEBIG, 1784)	4-5	B	Central-South-European	3	2	1	1	7
Family **Conocephalidae Genus *Ruspolia* SCHULTESS SCHINDLER, 1898**									
2.	*Ruspolia nitidula* (SCOPOLI, 1786)	1-3	A	Mediterranean-African	0	0	1	0	1
Family **Phaneropterinae Genus *Leptophyes* FIEBER, 1853**									
3.	*Leptophyes albovittata* (KOLLAR 1833)	3-4	D	South-East-European	3	1	3	3	10
Genus *Phaneroptera* SERVILE, 1831									
4	*Phaneroptera falcata* (PODA, 1761)	2-3	C	Eurosiberian	2	2	2	1	7
5.	*P. nana* FIEBER, 1853	5	C	Circum-Mediterranean	1	2	6	0	9
Family **Tettigoniidae KRAUSS, 1902 Genus *Metrioptera* (WESMAËL, 1838)**									
6.	*Metrioptera roeselii* (HAGENBACH, 1822)	1-2	A	Eurosiberian	2	1	0	0	3
Superfamily **Grylloidea LAICHARTING, 1781 Family Gryllidae LAICHARTING, 1781 Subfamily Oecanthinae BLANCHARD, 1845 Genus *Oecanthus* SERVILLE, 1831**									
7.	*Oecanthus pellucens* (SCOPOLI, 1763)	3-4	B	Central Asian-Mediterranean	15	10	1	1	27
Suborder **Caelifera Superfamily Acridoidea MACLEAY, 1821 Family Acrididae MACLEAY, 1821 Subfamily Calliptaminae TINKHAM, 1940 Genus *Calliptamus* SERVILLE, 1831**									
8.	*Calliptamus italicus* (LINNAEUS, 1758)	4-5	E	Holopalaearctic	0	1	0	0	1
Genus *Chorthippus* FIEBER, 1852									
9.	*Chorthippus apricarius* (LINNAEUS, 1758)	3	A	Eurosiberian	7	2	2	0	11

10.	*Ch. biguttulus* (LINNAEUS, 1758)	3-5	G	Central-Asian-Mediterranean	5	3	5	10	23
11.	*Ch. brunneus* (THUNBERG, 1815)	3-5	G	Holopalaearctic	0	0	2	2	4
12.	*Ch. dorsatus* (ZETTERSTEDT, 1821)	2-3	A	Eurosiberian	2	1	0	0	3
13.	*Ch. loratus* (FISCHER VON WALDHEIM, 1846)	5	A	Ponto-Mediterranean	2	0	0	0	2
14.	*Ch. macrocerus* (FISCHER VON WALDHEIM, 1846)	5	A	Pontic	8	7	5	1	21
15.	*Ch. mollis* (CHARPENTIER, 1825)	4-5	A	Euro-Asian-Palaearctic	2	0	6	7	15
Genus *Euchorthippus* TARBINSKII, 1925									
16.	*Euchorthippus declivus* (BRISOUT, 1848)	5	E	Central-European	0	0	3	5	8
17.	*E. pulvinatus* (FISCHER VON WALDHEIM, 1846)	5	A	Central-Asian-Mediterranean	0	1	2	2	5
Subfamily Oedipodinae WALKER, 1871 Genus *Aiolopus* FIEBER, 1853									
18.	*Aiolopus thalassinus* (FABRICIUS, 1781)	1-3	A	Holopalaearctic	1	2	0	0	3
Genul *Oedipoda* SERVILLE, 1831									
19.	*Oedipoda caerulescens* (LINNAEUS, 1758)	5	F	Holopalaearctic	0	1	0	0	1
TOTAL INDIVIDUALS					**53**	**36**	**39**	**33**	**161**
					89		**72**		
SPECIES					**16**		**13**		**19**
DOMINANCE					**0.1387**		**0.1196**		**0.09502**
SIMPSON					**0.8613**		**0.8804**		**0.905**
SHANNON H					**2.325**		**2.313**		**2.575**
EQUITABILITY					**0.8384**		**0.9017**		**0.8744**
FISHER ALPHA					**5.69**		**4.633**		**5.6**

Legend: Eco-forms: 1 – hygrophilous, 2 – hygro-mesophilous, 3 – mesophilous, 4 – meso-xerophilous, 5 – xerophilous; Life forms: A – chortobiont, B – gramineous chortobiont, C – sedge-chortobionts, D – facultative chortobiont, E – geo-chortobiont, F – openly-living geophilous.

RESULTS AND DISCUSSIONS

In the samples collected in the summer of 2011 the subdominant species were *Oecanthus pellucens* with 25 specimens and *Ch. macrocerus* with 15, and the dominant one were: *Chorthippus apricarius* - 9 sp., *Ch. biguttulus* - 8 sp., and *Ephippiger ephippiger* with 5 specimens (Fig. 3). In the evidence collected in the summer of 2012, there prevailed some species: *Ch. biguttulus* with 15 specimens, *Ch. mollis* - 13, *Euchorthippus pulvinatus* - 8, and *Leptophyes albovitatta* and *Phaneroptera nana* with six specimens each.

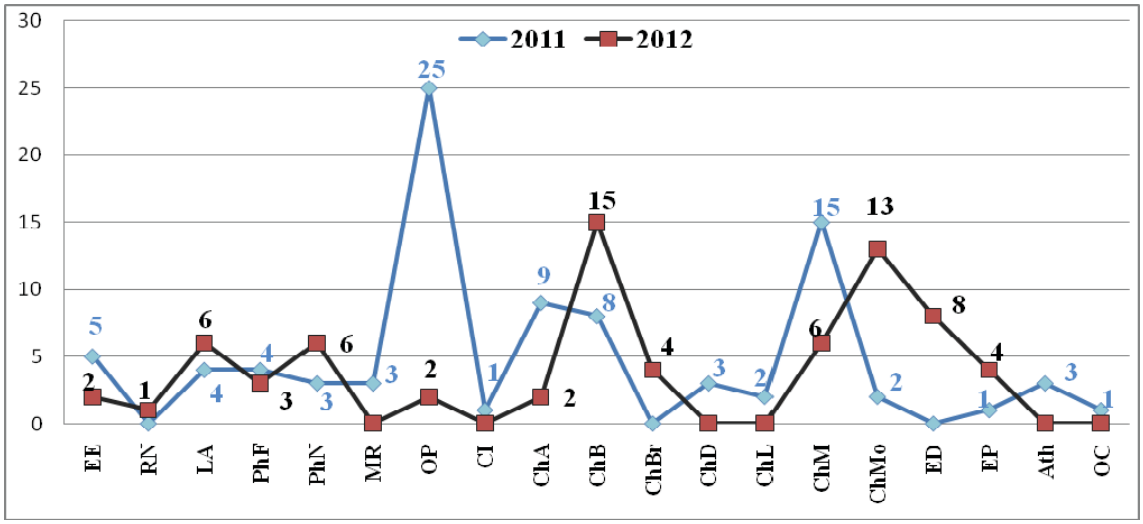

Figure 3. The dominance of Orthoptera species collected in Naslavcea forest steppe in 2011-2012 years.

In the same time, we can observe that in case of the eudominant species in the summer of 2011 - *Oecanthus pellucens* and *Chorthippus macrocerus* in the summer of 2012 there were collected only 2 and respectively 6

specimens. Also, the special populations of *Ch. mollis* and *Euchorthippus declivius* increased in 2012 in comparison with 2011 from 2 to 13 specimens, and respectively from 0 to 8 specimens (Fig. 3).

If to take into account the sex ratio distribution of the Orthoptera species from Naslavcea in both years, it can be observed that the proportionality of some species like *Ephippiger ephippiger*, *Leptophyes albovitatta*, *Phaneroptera falcata* and *Chorthippus mollis* (Fig. 4).

Despite of the high temperatures registered in the summer of 2012, in the vegetation, it was collected a female of the *Ruspolia nitidula*, which is a hygrophilous to mesophilous species (Fig. 4).

In the collected species from the superfamily Tettigonioidea previously dominated the thamnobiont ones. This can be explained by the location of the investigated sector on the Dniester bank.

The *Ephippiger ephippiger* is a thamnobiont species and can be met just in bush area and in our country it is very rarely encountered.

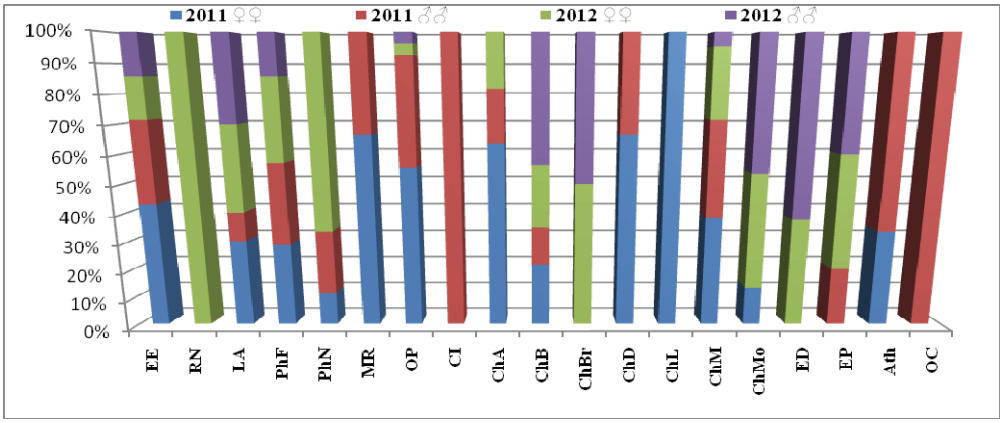

Figure 4. Sex ratio of Orthoptera insects from the forest steppe of Naslavcea.

The position of the slope and nearby forest facilitates the formation of a microclimate, which is favourable to the development of populations of grasshoppers, crickets and locusts.

The dominant species in 2011 and 2012 were: *Oecanthus pellucens* - 25 and 2 (27 specimens in total); *Platycleis veyseli* - 5, 22 (26); *Chorthippus biguttulus* - 8, 15 specimens (23); and at least *Ch. macrocerus* - with 15, 6 and respectively 21 specimens.

All these species are very resistant to weather conditions like high temperatures and low humidity.

In general, if to talk about the dominant species from the point of view of heat preferences, there predominated the meso-xerophilous and xerophilous species by 11 each (31 percents). This shows us that the investigated sector is mainly xerophilous namely typical steppe vegetation is present (Fig. 5).

Comparing the 2011 summer with 2012 according to the number of individuals and collected species, this was less than in 2011, and most insects were refugees in forest bands where vegetation was preserved.

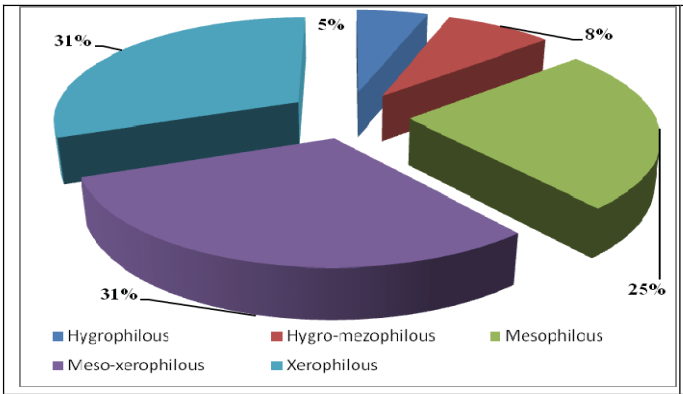

Figure 5. Preferences towards moisture of the orthopterans from the forest steppe of Naslavcea.

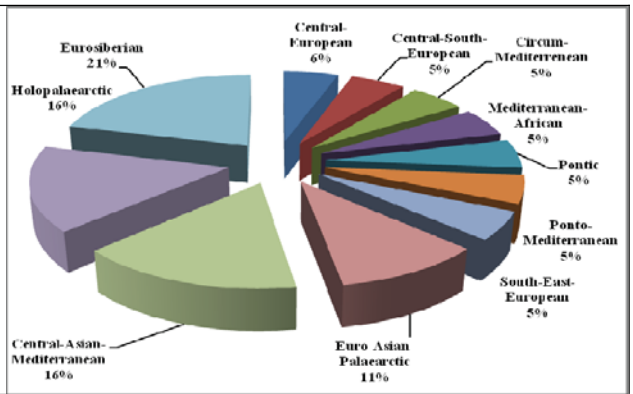

Figure 6. Geographical distribution of grasshoppers from the forest steppe of Naslavcea.

The selected point of research - Naslavcea, presents a vegetation typical for the Carpathian Mountains and forest steppe. From biological point of view, Naslavcea and its surroundings are very important for the diversity of Vegetal and Animal Kingdom. For example, from 19 collected species, 4 have Eurosiberian distribution, and 3 have

Central-Asian-Mediterranean and Holopalaearctic and 2 are Euro-Asian-Palaearctic (Fig. 6). So, nine species are Palearctic, four - Mediterranean and three - European and Central-Asian.

From the collected species during the two years, nine are chortobiont, four - sedge-chortobionts, 2 - gramineous chortobiont and herbivore chortobiont, and just one - *Oedipoda caerulescens* is openly-living geophilous. About *O. caerulescens* we can say that in 2012 this species registered a big population (transect methods) but, in this work, we have used just specimens collected by sweeping.

In general, simple evaluation of the absolute species number between samples is used most of the time as diversity measure. We also calculated Fisher's alpha diversity and Shannon diversity indices as a measure of diversity within a habitat since these indices incorporate both species richness and abundance into a single value. The Fisher alpha diversity indicated the following years: 2011 - 5.69; 2012 - 4.63 and in both years a total of 5.6. The Shannon's diversity index showed a pattern characterized by minor variations between years: 2.32; 2.3 and respectively 2.58. The Simpson and Equitability J have the same pattern with minor variations (Table 1).

Some values indices revealed that in the research years, the individuals among species were not evenly distributed during the investigation period indicating that some species were more abundant than the others were. This reflects on the difference in the efficiency of different grasshopper species to efficiently use the habitat. The abundance of individuals of a species in a given area and period of searching is dependent on various biotic and abiotic factors. In 2011, when was a very good year (temperatures, humidity) we collected 89 individuals from 16 genera, which is more than in 2012, when when water insufficiency and high temperatures were characteristic (Table 1).

CONCLUSIONS

During the investigations performed in 2011 and 2012 in steppe biotope with associations of *Andropogon* and *Acacia* near Naslavcea village, there was collected a total of 161 individuals belonging to 19 species and 6 families.

The dominant species in 2011 and 2012 were: *Oecanthus pellucens* - 25 and 2 (27 specimens in total); *Platycleis veyseli* - 5, 22 (26); *Chorthippus biguttulus* - 8, 15 specimens (23); and at least *Ch. macrocerus* - with 15, 6 and respectively 21 specimens during these two years.

From the collected species during the two years, nine are chortobiont, four – sedge-chortobionts, 2 - gramineous chortobiont and herbivore chortobiont, and just one - *Oedipoda caerulescens* is openly-living geophilous.

As a conclusion of the investigation in 2011 and 2012, the dominant species were: *Oecanthus pellucens* 27, *Platycleis veyseli* - 26, *Chorthippus biguttulus* - 23 and at least *Ch. macrocerus* - with 21 specimens.

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