

THE SPATIAL STRUCTURE OF ORTHOPTERAN COMMUNITIES FROM THE SCIENTIFIC RESERVE “CODRII” FROM THE REPUBLIC OF MOLDOVA

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Abstract. The present work is designed to study diversity and abundance of Orthoptera in the Scientific Reserve “Codrii” from the Republic of Moldova. During this study, a total of 48 species belonging to eight families were collected. There were identified the following families: Bradyporidae, Conocephalidae, Meconematidae, Phaneropteridae, Tettigoniidae, Gryllidae, Gryllotalpinae, Tetrigidae and Acrididae. Acridoidea was the most abundant family found in this study area with 24 species.

Keywords: Orthoptera, fauna, life form, scientific reserve “Codrii”.

Rezumat. Structura spațială a cenozelor de ortoptere în Rezervația Științifică “Codrii” din Republica Moldova.

Lucrarea de față este concepută pentru a studia diversitatea și abundența ortopterelelor în Rezervația Științifică “Codrii” din Republica Moldova. Pe parcursul acestui studiu, au fost colectate 48 de specii care aparțin la opt familii: Bradyporidae, Conocephalidae, Meconematidae, Phaneropteridae, Tettigoniidae, Gryllidae, Gryllotalpinae, Tetrigidae și Acrididae. Acridoidea a fost suprafamilia cea mai abundentă – cu 24 specii de insecte ortoptere.

Cuvine cheie: Orthoptera, fauna, formă vitală, Rezervația Științifică „Codrii”.

INTRODUCTION

The conservation of biodiversity throughout the world is of critical importance to the human population and indeed to the constancy of the whole world. Biological and anthropogenic factors and their intensification have more and more fragmented natural and semi-natural elements. Because of these factors, the number of a lot of flora and fauna species is in decline. Even if Orthoptera insects are one of the diverse and numerous orders from the class Insecta, notwithstanding, these species are highly sensitive to environmental changes such as grazing and abandonment (MARINI *et al.*, 2010; SCHIRMEL *et al.*, 2010).

In woods, grassland ecosystems and not only, faunal surveys revealed that Orthoptera are among the most conspicuous insects. These insects often constitute one of the dominant groups of arthropods and key organisms for diversity, abundance and biomass as they are the main arthropod consumers (CURRY, 1994) and food source for vertebrates (e.g. birds or lizards) (STAHI & ANGHELOVA, 2009; BELOVSSKY & SLADE, 1993).

MATERIAL AND METHODS

Field work

The Scientific Reserve “Codrii” was founded in 1971 for conservation of some representative sectors of old woods from the centre of the Republic situated on the “Moldavian Central Plateau” or “Podișul Central Moldovenesc” (in Romanian). So, the reserve is located in the Centre of the Republic of Moldova, Strasheni district, 49 km away from Kishinev city (geographical coordinates: 47°04', 47°01', latitude; and 28°20', 28°30', longitude; the altitude ranges between 130 and 382.5 m in the region with moderate continental climate). The reserve includes different zones: the protective zone, the buffer and transit zone. The total surface of the reserve is 5,177 ha, of which 5,073 ha are occupied by wooden plants (POPUȘOI, 2008; Ariile Protejate din Republica Moldova, 2012).

The flora of the study area is characterised by “Codrii” and is represented by more than 1,000 species of plants, of which about 60 have the statute of rare species and 23 are included in the Red Book of the Republic of Moldova. The wooden vegetation is composed by species belonging to genera: *Fraxinus* L., *Carpinus* L., *Sorbus* L., *Quercus* L., *Carex* L., *Aegopodium* L., *Stellaria* L. and other genera (POSTOLACHE, 1995).

About its fauna, we can say that here prevail species belonging to Central and West Europe – 52 species of mammals, 151 species of birds, 8 species of reptiles, 10 species of amphibians and more than 8,000 species of insects (MANIC *et al.*, 2006).

Methods of collecting

The study was conducted in the third part of July and in the first ten days of September months of 2009 in the Scientific Reserve „Codrii”.

The grasshoppers were collected by sweep net or by hand, additional faunal data were also obtained by using pitfall traps.

The pitfall traps (glass jar, opening diameter 8 cm, filled with 4% solution of formaldehyde with addition of ethylene glycol and few drops of detergent) were used to study fissurobiont and burrowing geobiont species. The pitfall traps were arranged on three transects parallel in-between (interval between them was 10 m) and the distance between traps was 2 m. The exposition period lasted by 10 days in July and September, but the traps were checked every day.

Data analysis: The specimen identification was made according to external morphology and genitalia using different identification keys (KIS, 1976, 1978; KNECHTEL & POPOVICI-BĂZNOȘEANU, 1959; IORGU & IORGU, 2008; HARZ, 1975; BEI-BIENKO, 1964).

The species nomenclature and classification were made according to the site Orthoptera of Europe (<http://www.orthour.org/orthoptera/orthoptera/i000241.html>).

The zoogeographical elements were established according to the work of BEI-BIENKO (1950, 1952, 1964) and IORGU & IORGU (2008). For the mathematical and statistical analysis of the orthopteran entomological material we have applied to the work of ANDREEV (2002).

RESULTS AND DISCUSSIONS

The first research of Orthoptera fauna from the Scientific Reserve “Codrii” were done in 2001, from where 20 species were published, but the presence of some species like *Podismopsis poppiusi* and others is doubtful (NICOLAESCU & DERJANSCHI, 2001). Nine new species from this reserve were published by STAHI (2007a) in another paper about the ecology of grasshoppers collected from the “Codrii” Reserve (STAHI, 2007a, b).

We have investigated the Orthoptera communities of the Scientific Reserve “Codrii” from the Republic of Moldova. This research suggests that the Orthoptera were more diverse in the inner forest while they were more abundant at the forest margin. Among the factors affecting the diversity and abundance of Orthoptera there are included: Microclimate variable (temperature, humidity and light intensity), availability of food, structural qualities, oviposition sites, suitable hiding places and the presence of predators.

As a result of the investigation during the third part of July till September of 2009 in the Scientific Reserve “Codrii” there were collected 1,102 orthopteran individuals. These orthopterans belong to 48 species that constitute 45.13% of the fauna of this order from the Republic of Moldova (STAHI & DERJANSCHI, 2010). These species belong to 28 genera and 10 families: Bradyporidae, Meconematidae and Gryllotalpinae with one species; Conocephalidae, Gryllidae and Tetrigidae – three; Phaneropteridae – five; Tettigoniidae – seven and Acrididae respectively with 24 species. The most representative superfamily is Acridoidea with 24 species and the least is Tetrigoidea – 3 species (Table 1).

Concerning the spectrum of feeding groups of Orthoptera insects from the Scientific Reserve “Codrii” just 2% (1 species) are insectivorous (I) (*Meconema thalasinum*); other species from Ensifera suborder and Grylloidea superfamily (except for those belonging to Phaneropterinae family) – 29% are omnivorous (II). All the remaining species from Caelifera suborder and Phaneropterinae family, which represent 69%, are phytophagous (III) (Fig. 1).

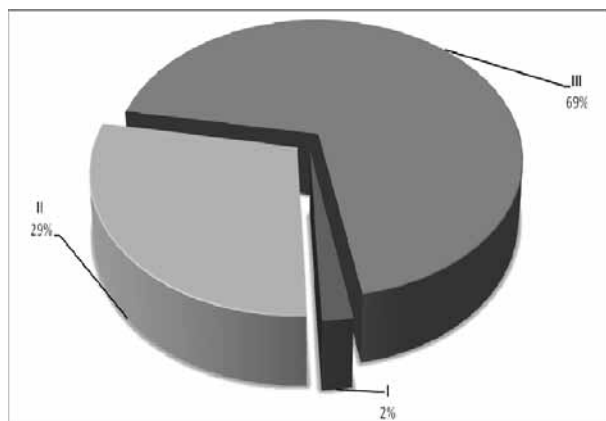


Figure 1. Percentage proportions of the Orthoptera from the Scientific Reservation “Codrii” regarding the trophic spectrum.
Figura 1. Proporțiile procentuale ale ortopterelor din Rezervația Științifică “Codrii” privind spectrul trofic.

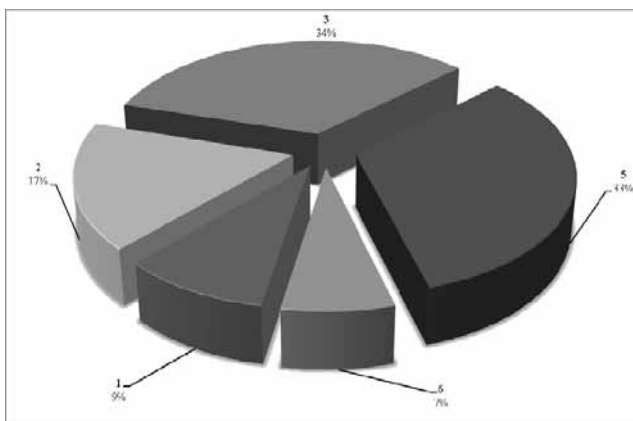


Figure 2. The proportions of ecological forms of the orthopterans from the Scientific Reserve “Codrii”.
Figura 2. Proporția formelor ecologice ale ortopterelor din Rezervația Științifică “Codrii”.

The presence and assemblage of orthopteran species are distinctly different depending on the habitat types. This depends on the orthopteran habitat preference, which is determined by the species adaptation to habitat structure, microclimate and disturbance intensity (SAMWAYS, 1997; SZOVENYI, 2002). The samplings of orthopteran specimens were carried out on dry and humid meadows, in wood, groves and glades; we have also studied the plains in the immediate proximity, which have been abandoned for more than 15 years. As a result, in this reserve, there was observed that, regarding the eco-forms of grasshoppers, there prevailed mesophilous and mesoxerophilous species with 31%, after these xerophilous with 17% and hygro mesophilous – 14%, while the last 7% are hygrophilous (Fig. 2).

The majority of grasshopper species are not specialised in food plants and constantly feed on a variety of grasses (PICAUD *et al.*, 2003). Nevertheless, the orthopterans may differ in their preference for different grass species (INGRISCH & KÖHLER, 1998). Most (43%) of Orthoptera species from the reserve are chortobiont, especially those from *Stenobothrus*, *Chorthippus* and *Omocestus* genera. This species can be found in meadows and pastures, where

spontaneous Gramineae prevailed. Also, a lot of the collected species, 17% and 16%, are geo-chortobiont and respectively chorto-geobiont (Fig. 3). Also, in this reserve, there are present fissurobiont and burrowing geobiont species which represent 4% (*Gryllus campestris* and *Melanogryllus desertus*) and 2% (*Gryllotalpa gryllotalpa*) (Fig. 3). These three species were collected by pitfall traps.

Table 1. The diversity, ecology and sinecological analyses of Orthoptera species from the Scientific Reserve "Codrii".
Tabel 1. Diversitatea, ecologia și analiza sinecologică a ortopterelor din Rezervația Științifică "Codrii".

	Species	N ♀/♂	N-1	N (N-1)	Log10N	N _{log10N}	Domination		Biotope	Vital form	Geographical distribution
							%	Class			
Suborder ENSIFERA											
Superfamily TETTIGONIOIDEA KRAUSS, 1902											
Family BRADYPORIDAE											
1.	<i>Ephippiger ephippiger</i>	1/1	1	2	0,30	0,60	0,18	D ₁	4-5	B	Central-South-European
Family CONOCEPHALIDAE											
2.	<i>Conocephalus dorsalis</i>	5/8	12	156	1,11	14,48	1,18	D ₂	1	A	Eurosiberian
3.	<i>Conocephalus fuscus</i>	4/6	9	90	1,00	10,00	0,91	D ₁	1-3	A	Holopaleartic
4.	<i>Ruspolia nitidula</i>	2/1	2	6	0,48	1,43	0,27	D ₁	1-3	A	Mediterranean-African
Family MECONEMATINAE											
5.	<i>Meconema thalassinum</i>	2/4	5	30	0,78	4,67	0,54	D ₁	3-4	C	Holoeuropean
Family PHANEROPTERINAE											
6.	<i>Leptophyes albovittata</i>	30/22	51	2652	1,72	89,23	4,71	D ₃	3-4	D	Central Asian-Mediterranean
7.	<i>L. boscii</i>	21/16	36	1332	1,57	58,02	3,35	D ₃	3-4	D	South-East-European
8.	<i>L. punctatissima</i>	29/32	60	3660	1,79	108,91	5,53	D ₄	3-4	D	North-European
9.	<i>Phaneroptera falcata</i>	12/19	30	930	1,49	46,23	2,81	D ₃	2-4	C	Eurosiberian
10.	<i>Ph. nana</i>	2/4	5	30	0,78	4,67	0,54	D ₁	5	C	Circum-Mediterranean
Family TETTIGONIIDAE KRAUSS, 1902											
11.	<i>Decticus albifrons</i>	2/1	2	6	0,48	1,43	0,27	D ₁	5	F	Circum-Mediterranean
12.	<i>Metriopectera bicolor</i>	8/15	22	506	1,36	31,32	2,09	D ₂	2-4	A	Eurosiberian
13.	<i>M. roeselii</i>	10/5	14	210	1,18	17,64	1,36	D ₂	1-2	A	Eurosiberian
14.	<i>Pholidoptera griseoptera</i>	8/6	13	182	1,15	16,05	1,27	D ₂	2	C	Holoeuropean
15.	<i>Platycleis tessellata</i>	6/2	7	56	0,90	7,22	0,73	D ₁	4	A	Holoeuropean
16.	<i>Pterolepis germanica</i>	2/3	4	20	0,70	3,49	0,45	D ₁	4-5	E	Ponto-Mediterranean
17.	<i>Tettigonia viridissima</i>	5/4	8	72	0,95	8,59	0,82	D ₁	2-5	C	Holopaleartic
Superfamily GRYLLOIDEA LAICHTARTING, 1781											
Family GRYLLIDAE LAICHTARTING, 1781											
18.	<i>Gryllus campestris</i>	13/23	35	1260	1,56	56,03	3,26	D ₃	3-4	H	Holopaleartic
19.	<i>Melanogryllus desertus</i>	21/15	35	1260	1,56	56,03	3,26	D ₃	4-5	H	Central Asian-Mediterranean
20.	<i>Oecanthus pellucens</i>	19/23	41	1722	1,62	68,18	3,81	D ₃	3-4	B	Central Asian-Mediterranean
Family GRYLLOTALPIDAE LEACH, 1815											
21.	<i>Gryllotalpa gryllotalpa</i>	3/0	2	6	0,48	1,43	0,27	D ₁	1-2	I	Holopaleartic
Suborder CAELIFERA											
Superfamily TETRIGOIDEA SERVILLE, 1838											
Family TETRIGIDAE SERVILLE, 1838											
22.	<i>Tetrix bipunctata</i>	5/4	8	72	0,95	8,59	0,82	D ₁	1-3	F	Eurosiberian
23.	<i>T. subulata</i>	14/10	23	552	1,38	33,13	2,18	D ₃	1	G	Holarctic
24.	<i>T. tenuicornis</i>	2/3	4	20	0,70	3,49	0,45	D ₁	2-3	F	Holopaleartic
Superfamily ACRIDOIDEA MACLEAY, 1821											
Family ACRIDIDAE MACLEAY, 1821											
25.	<i>Acrida ungarica</i>	12/8	19	380	1,30	26,02	1,81	D ₂	3-4	A	Mediterranean-African
26.	<i>Calliptamus italicus</i>	9/10	18	342	1,28	24,30	1,72	D ₂	4-5	E	Central Asian-Mediterranean
27.	<i>C. barbarus</i>	1/1	1	2	0,30	0,60	0,18	D ₁	4-5	E	Holopaleartic
28.	<i>Euthystira bracyptera</i>	2/1	2	6	0,48	1,43	0,27	D ₁	4-5	E	Central Asian-Mediterranean
29.	<i>Doclostaurus maroccanus</i>	12/8	19	380	1,30	26,02	1,81	D ₂	1-3	A	Eurosiberian
30.	<i>Chorthippus albomarginatus</i>	60/32	91	8372	1,96	180,67	8,34	D ₄	2-4	A	Central-North-European
31.	<i>Ch. apicarius</i>	4/0	3	12	0,60	2,41	0,36	D ₁	3	A	Eurosiberian
32.	<i>Ch. brunneus</i>	32/45	76	5852	1,89	145,26	6,98	D ₄	3-5	G	Central Asian-Mediterranean
33.	<i>Ch. biguttulus</i>	26/35	60	3660	1,79	108,91	5,53	D ₄	3-5	G	Holopaleartic
34.	<i>Ch. dichorus</i>	2/1	2	6	0,48	1,43	0,27	D ₁	4-5	A	Central Asian-Pontic
35.	<i>Ch. dorsatus</i>	2/4	5	30	0,78	4,67	0,54	D ₁	2-3	A	Eurosiberian
36.	<i>Ch. loratus</i>	15/9	23	552	1,38	33,13	2,18	D ₃	5	A	Ponto-Mediterranean
37.	<i>Ch. mollis</i>	7/12	18	342	1,28	24,3	1,72	D ₂	4-5	A	Euro-Asiatic-Paleartic
38.	<i>Ch. parallelus</i>	19/26	44	1980	1,65	74,39	4,08	D ₃	2-4	A	Euro-Asiatic-Paleartic
39.	<i>Ch. pullus</i>	13/7	19	380	1,30	26,02	1,81	D ₂	3	A	Central-European
40.	<i>Ch. vagans</i>	9/14	22	506	1,36	31,32	2,09	D ₂	3-4	A	Pontic
41.	<i>Omocestus haemorrhoidalis</i>	19/16	34	1190	1,54	54,04	3,17	D ₃	3-4	E	Euro-Asiatic-Paleartic
42.	<i>O. minutus</i>	5/9	13	182	1,15	16,05	1,27	D ₂	4	A	Pontic

43. <i>O. rufipes</i>	14/23	36	1332	1,57	58,02	3,35	D ₃	4-5	A	Holopalaearctic
44. <i>O. viridulus</i>	13/22	34	1190	1,54	54,04	3,17	D ₃	3	A	Eurosiberian
45. <i>Stauroderus scalaris</i>	26/12	37	1406	1,58	60,03	3,45	D ₃	3-4	E	Euro-Asiatic-Palaearctic
46. <i>Stenobothrus lineatus</i>	4/8	11	132	1,08	12,95	1,09	D ₁	3	A	Eurosiberian
47. <i>S. stigmaticus</i>	0/2	1	2	0,30	0,60	0,18	D ₁	2-4	G	Central-South-European
48. <i>Oedipoda caeruleascens</i>	14/18	31	992	1,51	48,16	2,90	D ₃	5	F	Holopalaearctic
TOTAL	1102	1051	44068	1,71	1667,67	100				

Legend. Life forms: A – chortobiont, B – chorto-thamnobiont, C – thamnobiont, D – thamno-chortobiont, E – geo-chortobiont, F – chorto-geobiont, G – geobiont, H – fissurobiont, I – burrowing geobiont. **Ecological forms:** 1 – hygrophilous, 2 – hygromesophilous, 3 – mesophilous, 4 – mesoxerophilous, 5 – xerophilous.

Legendă. Formă vitală: A – hortobiont, B – horto-tamnobiont, C – tamnobiont, D – tamno-hortobiont, E – geo-hortobiont, F – horto-geobiont, G – geobiont, H – fissurobiont, I – geobiont subteran. **Formă ecologică:** 1 – higrofil, 2 – higro-mezofil, 3 – mezofil, 4 – mezo-xerofil, 5 – xerofil.

The great majority of grasshoppers were collected in the meadows and forest margins, but directly in woods there were observed just the species *Ephippiger ephippiger* and *Meconema thalassinum* and also, individuals of the genera *Leptophyes* and *Phaneroptera*.

The Republic of Moldova occupies 33,700 km² and is situated in the southeastern part of Europe, at the junction of the great geobotanical regions: Euro-Asiatic, European, and Mediterranean (GHEIDEMAN, 1986). In accordance with the territorial surface, the Republic of Moldova is one of the smallest countries of Europe, but its fauna diversity is higher than in other big countries, owing to some particularities like: diversity and structure of the soils, varied relief, climates, thermal regime, rainfall amounts, hydrology and others. From these 48 species of Orthoptera order collected in the Scientific Reserve “Codrii” 24 species have Palaearctic distribution, 9 – European, 8 – Mediterranean and the last 7 – Central-Asian (Fig. 4).

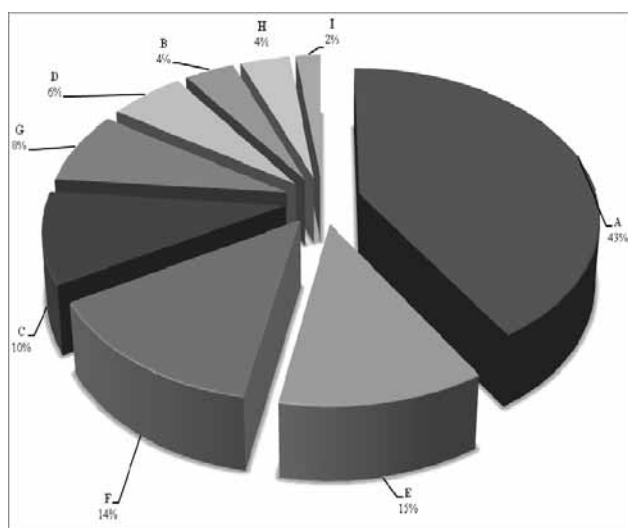


Figure 3. Proportions among life forms of orthopterans from the Scientific Reserve “Codrii”.

Figura 3. Proportia între formele vitale ale ortopterelor din Rezervația Științifică „Codrii”.

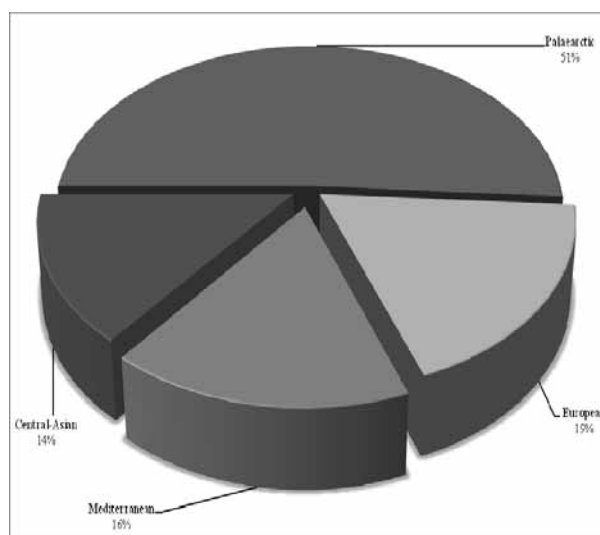


Figure 4. The zoo-geographical repartition of the Orthoptera species from the Scientific Reserve “Codrii”.

Figura 4. Repartiția zoogeografică a ortopterelor din Rezervația Științifică „Codrii”.

Following the sinecological analysis of the fauna of Orthoptera order registered in the “Codrii” the dominant species are: *Ephippiger ephippiger*, *Conocephalus fuscus*, *Ruspolia nitidula*, *Meconema thalassinum*, *Phaneroptera nana*, *Decticus albifrons*, *Platycleis tessellata*, *Pterolepis germanica*, *Tettigonia viridissima*, *Gryllotalpa gryllotalpa*, *Tetrix bipunctata*, *T. tenuicornis*, *Calliptamus barbarus*, *Euthystira bracyptera*, *Chorthippus apicarius*, *Ch. dichorus*, *Ch. dorsatus*, *Stenobothrus lineatus* and *S. stigmaticus*. These 22 species constituted 9.71% (107 specimens) from the all collected specimens (1,102 specimens).

The species *Conocephalus dorsalis*, *Metrioptera bicolor*, *M. roeselii*, *Pholidoptera griseoaptera*, *Acrida ungarica*, *Calliptamus italicus*, *Dociostaurus maroccanus*, *Chorthippus loratus*, *Ch. mollis*, *Ch. pullus* and *Ch. vagans* are recedent, holding 18.49%, (200 specimens). Also, we want to underline that *Pholidoptera griseoaptera* species was observed just in this reserve during 7 years.

The species *Leptophyes albovittata*, *L. boscii*, *Phaneroptera falcata*, *Gryllus campestris*, *Melanogryllus desertus*, *Oecanthus pellucens*, *Tetrix subulata*, *Chorthippus loratus*, *Omocestus haemorrhoidalis*, *O. rufipes*, *O. viridulus*, *Stauroderus scalaris* and *Oedipoda caeruleascens* are subdominants, holding 45.74% (504 specimens).

The species *Leptophyes punctatissima*, *Chorthippus albomarginatus*, *Ch. brunneus* and *Ch. biguttulus* are dominant, representing 26.41% (291 specimens).

Besides the diversity of Orthoptera insects from the Scientific Reserve “Codrii” we established that Simpson I_s index had a value of 0.06, the other index – Shannon I_{SH} had the value of 1.39 and the last one – the equitability index had the value of 0.24%.

CONCLUSIONS

In the Scientific Reserve “Codrii”, there were collected 48 species of Orthoptera which belong to 28 genera, ten families and four superfamilies: Tettigonioidea, Grylloidea, Tetrigoidea, Acridoidea, the last one being the most representative – 24 species.

The dominant species are: *Leptophyes punctatissima*, *Chorthippus albomarginatus*, *Ch. brunneus* and *Ch. biguttulus*.

Of those 48 species of Orthoptera, 24 species have a Palaearctic distribution, 9 – European, 8 – Mediterranean and the last 7 – Central-Asian distribution.

During the seven years of my research the *Pholidoptera griseoptera* species was observed just in this reserve.

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