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BIODIVERSITY OF WEEVILS (CURCULIONOIDEA) ON MEADOWS IN THE KRAGUJEVAC BASIN

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Adult weevils were collected in the Kragujevac basin on valley meadows, damp meadows, swampy meadows, upland meadows, artificial meadows, meadows with shrubs, uncultivated land, and ruderal vegetation over several years of work (primarily during the period 1987-1995). There were 1453 weevil finds in 180 registrations. Altogether 3061 specimens (including 1457 males) were collected, and 278 species of the families Attelabidae, Apionidae, and Curculionidae were identified.

After detailed comparison, weevils found in the indicated meadow biotopes were separated into assemblies linked with the biotopes.

In addition to a comparative survey of quantitative indices (number of registrations considered, number of finds, number of recorded species, number of specimens by sex and overall), diversity was also analyzed on the basis of life forms and the spectrum of nutrition.

The Shannon biodiversity index was used as the indicator of assembly stability. Assemblies adhered to the following order: valley meadows, damp meadows, uncultivated land, ruderal vegetation, meadows with shrubs, artificial meadows, upland meadows, swampy meadows.

The order of assemblies with respect to biodiversity as expressed through the Simpson index was a little different: uncultivated land, valley meadows, meadows with shrubs, damp meadows, artificial meadows, upland meadows, ruderal vegetation, swampy meadows.

KEY WORDS: Curculionoidea, biodiversity, meadows, Kragujevac, Serbia.

INTRODUCTION

The enormous diversity of forms of weevils (it is freely estimated that more than 60,000 species have been described to date) enables them to exist in nearly all of our planet's ecosystems where plants live (except the oceans) (BURRINI *et al.*, 1988; ZIMMERMAN, 1991-1993; CALDARA & O'BRIEN, 1995). This makes their ecological significance inestimable and renders knowledge about their fauna important from many standpoints. In

countries where the weevil fauna has been extensively investigated, they occupy a central place in environmental and biodiversity studies (MAJZLAN & HOLECOVA, 1986; SPRICK & WINKELMANN, 1993; WANAT, 1993; HOLECOVA, 1994; MAZUR & WANAT, 1994). Detailed quantitative and qualitative analysis of weevils in some parts of Poland commited WANAT, 1993, KNUTELSKI, 1993, KNUTELSKI & SKALSKI, 1993, CHOLEWICKA-WISNIEWSKA, 1994, in Slovakia ROUBAL, 1940, HOLECOVA, 1991A,B, 1992, 1993A,B,C,D, in Germany SPRICK, 1990, SIMON & WINKELMANN, 1993. In former Yugoslavia ecological analysis of coleoptera-communities was made rarely (DURBEŠIĆ, 1986; PEŠIĆ, 1993).

The main purpose of collection and comparative analysis of weevils on meadows in the Kragujevac basin over a period of eight years (1987-1995) was to form a more complete picture of the state of their fauna in open habitats.

In view of the phytophagic nature of these insects, knowledge of plant life in the investigated regions is especially important.

The Kragujevac basin lies in the zonobiome of Submediterranean-Balkan forests (LOPATIN & MATVEJEV, 1995), which through human action has been for the most part transformed into an agricultural region or infertile bare and rocky ground. Vegetation in the vicinity of Kragujevac has been considered in greatest detail by VELJOVIĆ (1967). According to him, the natural plant cover of the Kragujevac region occupies only about 35% of the surface. It is made up of forest vegetation (23%), meadow vegetation (12%), and swamp vegetation (on an insignificant surface area).

Meadow vegetation in the vicinity of Kragujevac is secondary vegetation. It arose through human clearing of forests (by cutting and burning) and is maintained by mowing and grazing. This vegetation represents a transition between the xerothermic meadow vegetation in Eastern Serbia and the mesophilic meadow vegetation in Western Serbia. Its constituents are plants of the families Fabaceae and Poaceae, the latter predominating on drier terrains.

On the basis of elevation above sea level and floristic composition, two groups of meadows, valley meadows and meadows of the upland type, are distinguished in the vicinity of Kragujevac.

Valley meadows are developed on habitats of cut-back *Querceto-Fraxinetum serbicum* Rud. and *Saliceto-Populetum* Raj. forest communities. They belong to three associations: *Trifolio-Agrostidetum albae* Veljovic, *Trifolio-Cynosuretum cristati* Veljovic and *Agropyreto-*

Festucetum pratensis Veljovic. Upland meadows occupy the western, southwestern, and southern parts of the Kragujevac basin. They arose on habitats of cut-back upland forests, primarily of the *Quercetum confertae-cerris* Rud. climatogenic community. They can be divided into two associations: *Trifolio-Chrysopogonetum grylli* and *Agrostido-Andropogonetum ischaemi* Veljovic.

MATERIAL AND METHODS

For purposes of the present study, adult weevils in the Kragujevac basin were collected primarily during the period 1987-1995 on valley meadows, damp meadows, swampy meadows, upland meadows, artificial meadows, meadows with shrubs, uncultivated land, and ruderal vegetation.

Valley meadows (primarily *Agropyreto-Festucetum pratensis* Veljovic) are the best represented form of natural biotope in the Kragujevac basin. In keeping with this fact, material for the present study was collected from the greatest number of points on such meadows: Šumarice (at a number of places), Erdeč, Divostin, Drača, Vinjište, Petrovac, Desimirovac, Beloševac, Ždraljica, and Žeželj.

The damp meadows from which weevils were collected (essentially the associations *Trifolio-Agrostidetum albae* Veljovic and *Trifolio-Cynosuretum cristati* Veljovic) accompany water courses or lakes. Collecting was done at the following localities: Šumarice, Drača, Grošnica, environs of the Grošnica Reservoir, and Grbice. These meadows are also mowed.

The swampy meadows analyzed are in direct contact with the lake in Šumarice and the Grošnica Reservoir. Phytocenologically, they could be defined as *Caricetum vulpinae-ripariae* (drier meadows in transition to meadows of the damp type) and *Agrostideto-Juncetum effusi* (periodically flooded).

Upland meadows are drier and lie at greater elevations above sea level. They contain steppe elements (like the association *Chrysopogonetum-Festucetum vallesiacae* Veljovic). For purposes of the present study, such meadows were investigated at a number of localities: Gornje Komarice, Adžine Livade, Grbice, Bešnjaja, Žeželj, and dry slopes flanking the Grošnica Reservoir.

Meadows with shrubs are a transitional form of habitat occurring mainly on the edges of forests. They were investigated at the localities

Šumarice and Žeželj.

Artificial meadows are man-made communities of cultivated fodder plants formed on plowed ground. In the Kragujevac basin, this for the most part means *Trifolium*, *Medicago*, *Lotus*, and *Lathyrus*. These meadows are mowed as many as three times a year. Weevil colonies on such meadows were examined at the following localities: Šumarice, Stanovo, Erdeč, Grošnica, Dragobraća, and Grbice.

Uncultivated land was examined from the aspect of weevil colonies only in Šumarice.

Ruderal vegetation, i.e., roadside plants, constitute a habitat specific for weevils. For purposes of the present study, adults were collected from them at virtually all localities: Šumarice, the racetrack, Erdoglija, the city, Stanovo, Erdeč, Grbice, Drača, Grošnica, the Grošnica Reservoir, Tresnjevak, Adžine Livade, Bresnica, Ždraljica, Žeželj, Desimirovac, Bukurovac, Bešnjaja, and Gornje Komarice.

Specimens were captured for the most part using the technique of mowing. The insects sought were often procured by carefully searching plants or the surface of the ground around them.

Following taxonomic analysis, detailed ecological analysis was performed from a number of aspects:

-establishment of the status of each weevil assembly in regard to number of registrations, finds, species, specimens (males and females);

-elaboration of the picture of diversity of recorded weevil assemblies in terms of life forms I (phanerognaths - with a long snout and adelognaths - with a short snout) and II (thamnobionts - way of life linked with arboreal plants and hortobionts - way of life linked with herbaceous plants) and the spectrum of nutrition (monophages, oligophages and polyphages);

-comparative analysis of the biodiversity of weevil colonies (assemblies) by biotopes through the general diversity index of Shannon and Weaver and Simpson's diversity formula (SCHWERDTFEGER, 1975).

For some species the literatural data about their life form II and feeding are absent.

The formulas and definitions used were discussed in detail in previous paper of the author (PEŠIĆ, 1997).

RESULTS AND DISCUSSION

The faunistic list of weevil species found constitutes the basis of the entire investigation. Overall during the indicated period, there were 1453 weevil finds containing 3061 specimens (including 1457 males) in 180 registrations on valley meadows, damp meadows, swampy meadows, upland meadows, artificial meadows, meadows with shrubs, uncultivated land, and ruderal vegetation in the Kragujevac basin. Two hundred and seventy-eight species belonging to the families Attelabidae, Apionidae, and Curculionidae were identified.

Table 1 presents a survey of the number of registrations, finds, and recorded species and specimens (by sex as well). In connection with the conspicuously smaller number of registrations on swampy and upland meadows, it should be noted that this is not the result of subjective error on the part of the investigator, but rather represents the actual proportion of occurrence of these biotopes in the vicinity of Kragujevac. The small number of species recorded is not only a consequence of the reduced number of samples, but also a result of the state of these biotopes. Quantitative superiority of weevil assemblies in valley and damp meadows is entirely to be expected, on account of the wealth of their phytocenoses and greater yield of plant mass.

Table I
Number of registrations, finds, and recorded species and specimens, males and females

	biotope / habitat	nr. reg.	nr. finds	nr.species	nr. mal.	nr. fem.	nr.specim.
1.	valley meadows	59	571	171	572	648	1220
2.	damp meadows	24	254	115	280	255	535
3.	swampy meadows	4	15	13	15	16	31
4.	upland meadows	8	81	52	84	91	175
5.	meadows with shrubs	20	86	58	71	98	169
6.	artificial meadows	16	140	63	151	164	315
7.	uncultivated land	10	110	65	68	100	168
8.	ruderal vegetation	39	196	104	216	232	448
	totally	180	1453	278	1457	1604	3061

The assembly of weevils of valley meadows is the richest (1220 specimens belonging to 171 species). The assembly of weevils of damp meadows ranks second in terms of size and stability. The second place belongs to damp meadows, and the third one to ruderal vegetation. The weevil assembly of swampy meadows is the smallest (only 13 species with 31

specimens) and least stable of all meadow assemblies.

The numbers of found weevil species and specimens on upland meadows and meadows with shrubs are rather similar.

In size of the weevil assembly, artificial meadows are almost three times poorer than valley meadows and twice as poor as damp meadows (Tab. I). The artificial, simplified structure of the plant association (made up mainly of fodder plants) has determined this weevil assembly.

The weevil assembly of uncultivated land is somewhat richer than the assembly on artificial meadows with respect to the number of species, but nearly twice as poor in regard to the number of specimens (Tab. I).

The diversity of recorded assemblies with respect to life forms and the spectrum of nutrition is summarized in Tab. II, III and IV.

Table II
Biodiversity of recorded weevil assemblies according life form I by biotopes

		Life form I			
		nr. adelognaths		nr. phanerognaths	
	biotope / habitat	sp.	specim.	sp.	specim.
1.	valley meadows	31	211	140	1009
2.	damp meadows	17	61	98	474
3.	swampy meadows	0	0	13	31
4.	upland meadows	7	16	45	159
5.	meadows with shrubs	16	65	42	104
6.	artificial meadows	13	110	50	205
7.	uncultivated land	10	39	55	129
8.	ruderal vegetation	13	38	91	410

All species found on swampy meadows are phanerognaths. Explanation could be that adelognaths usualy have developing underground, but on this meadows presence of water disturbs it. On other meadows the presence of adelognaths varied from 12.5% in ruderal habitats, to 27.6% on meadows with shrubs

On valley meadows thamnobionts make up 11.7% (20 species).

On damp meadows hortobiont species (87%) clearly predominate, as on other meadows.

Table III
Biodiversity of recorded weevil assemblies according life form II by biotopes

		Life form II			
		nr. hortobionts		nr. thamnobionts	
	biotope / habitat	sp.	specim.	sp.	specim.
1.	valley meadows	140	1123	20	68
2.	damp meadows	96	487	15	40
3.	swampy meadows	11	29	2	2
4.	upland meadows	49	172	2	2
5.	meadows with shrubs	39	93	15	62
6.	artificial meadows	58	307	5	8
7.	uncultivated land	59	157	5	10
8.	ruderal vegetation	91	417	6	13

Two species (15.4%) on swampy meadows are thamnobionts whose development and nutrition are linked with valley willow groves or ash forests (*Stereonychus fraxini*), fragments of which intrude into swampy meadows.

Just two (3.8%) weevil species on upland meadows are thamnobionts (*Otiorhynchus fullo*, which according to published data can be linked with *Quercus*, *Crataegus*, *Prunus spinosa*, and *Syringa vulgaris*; and *Rhynchaenus fagi*, whose development is linked exclusively with *Fagus sylvatica*, but whose feeding is linked with *Quercus* and *Crataegus* as well). It is the smallest thamnobionts presence registered on examined meadows.

Table IV
Biodiversity of recorded weevil assemblies according spectrum of nutrition

		Spectrum of nutrition					
		nr. monophages		nr. oligophages		nr. poliphages	
	biotope / habitat	sp.	specim.	sp.	specim.	sp.	specim.
1.	valley meadows	18	94	123	843	22	259
2.	damp meadows	11	56	85	421	16	54
3.	swampy meadows	1	9	12	22	0	0
4.	upland meadows	6	16	42	145	3	13
5.	meadows with shrubs	7	17	36	89	14	52
6.	artificial meadows	7	14	47	252	9	49
7.	uncultivated land	8	13	45	114	11	40
8.	ruderal vegetation	11	26	75	359	13	48

As we expected, the bigest presence of thamnobiont forms (25.9% of species) is registered on meadows with shrubs.

Thamnobionts constitute 7.7% (five species) of weevils assembly on uncultivated land.

In ruderal habitats thamnobionts are few (six species or 5.8%).

With respect to nutrition on valley meadows eighteen species (10.5%) are monophagous, while 22 (12.8%) are polyphagous.

On damp meadows 11 species (9.5%) are monophagous, and 16 species are polyphagous.

All species founded on swampy meadows are oligophagous, with the exception of the eudominant *Mogulones symphyti*, a monophagous form linked with the plant *Symphytum officinalisi*.

Only 5.8% (three species) are polyphagous on upland meadows. This the smallest value in comparison with other examined meadows shows the higher level of nutrition specialization in this weevil assembly.

The bigest presence of poliphagous weevils is on meadows with shrubs (24.1% of species, 30.8% of specimens). But in the same time there live rather big number of monophagous species (12.1%).

Seven weevil species (11.1%) on artificial meadows are monophagous, while nine (14.3%) are polyphagous. *Smicronyx jungermanniae* is especially interesting oligophagous, because its way of life is linked with the parasitic plant genus *Cuscata*.

Assembly of weevils on uncultivated land is linked for the most part with weed plants. Ten species (15.4%) are polyphagous. The presence of monophages is more pronounced (12.3% or eight species) than in other biotopes / habitats.

There are 11 monophagous species and 13 (12.5%) polyphagous ones on ruderal vegetation. Only on this type of vegetation two monophagous were found - *Sibinia abdominalis* linked with *Silene vulgaris*, and *Mecinus circulatus* with *Plantago lanceolata*.

Figure 1 graphically presents biodiversity values calculated according to the Shannon (H) and Simpson (D) formulas.

According the index of biodiversity, the assembly of weevils of valley

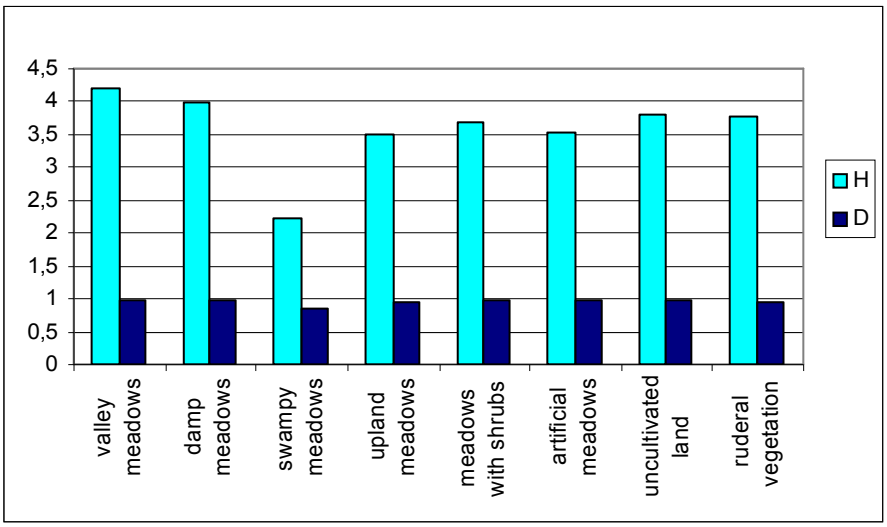

Fig. 1. Biodiversity of weevil assemblies (H = Shannon & Weaver index, D = Simpson's diversity)

meadows is the most stable (H= 4,186). In regard to values of the Shannon biodiversity index as indicator of stability, the habitats of weevil assemblies adhered to the following order: valley meadows, damp meadows, uncultivated land, ruderal vegetation, meadows with shrubs, artificial meadows, upland meadows, swampy meadows.

Diversity is significantly greater when species have approximately equal representation than when one is clearly dominant (KREBS, 1978). For this reason it is sometimes better to use the Simpson formula. By this order of registered weevil assemblies is a little different: uncultivated land, valley meadows, meadows with shrubs, damp meadows, artificial meadows, upland meadows, ruderal vegetation, swampy meadows.

The position occupied by assemblies from swampy as well as upland meadows in both series warns of their unstable and threatened status.

The main conclusion is that in order to maintain and repair the current state of the weevil fauna, apart from conducting stepped-up research, it would also be well to establish more serious control over all human undertakings in natural meadow biotopes around Kragujevac.

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БИОДИВЕРЗИТЕТ СУРЛАША (CURCULIONOIDEA: ATTELABIDAE, APIONIDAE I CURCULIONIDAE) НА ЛИВАДАМА У КРАГУЈЕВАЧКОЈ КОТЛИНИ

Снежана Пешић

Извод

Осмогодишње (1987-1995) сакупљање и упоредна анализа адултних сурлаша на ливадама у крагујевачкој котлини су као основни циљ имали формирање потпуније слике о стању њихове фауне на отвореним стаништима.

У 180 снимака је било 1453 налаза адултних сурлаша. Укупно је сакупљено 3061 јединка (1457 мужјака) и идентификовано 278 врста из фамилија Attelabidae, Apionidae и Curculionidae.

Констатована насеља сурлаша су издвојена у асамблеје везане за истраживане биотопе. Поред упоредног прегледа квантитативних показатеља (број учињених снимака, број налаза, број констатованих врста и број јединки по половима и укупно), анализирана је разноврсност по животним формама и спектру исхране.

Квалитативно и квантитативно најмоћнија (1220 јединки из 171 врсте) и истовремено најстабилнија је асамблеја сурлаша долинских ливада.

По величини и стабилности друга је асамблеја сурлаша влажних ливада. Еудоминантне врсте су само *Nanophyes marmoratus* и *N. helveticus* везани за биљке рода *Lythrum*. Ова асамблеја има велику сличност са асамблејом долинских ливада.

Све врсте нађене на мочварној ливади су фанерогнати. По животној форми само две врсте су тамнобионти, развићем и исхраном везани за долинске шуме врбе (*Apion minimum*), односно јасена (*Stereonychus fraxini*), чији се преостали фрагменти умећу у мочварне ливаде.

Најкарактеристичнија по саставу врста је асамблеја сурлаша брдских ливада (21,1% врста је специфично искључиво на биотопима брдских лива-

да наден).

Асамблеја сурлаша ливада са жбуњем је у ширем истраживању показала прелазни карактер између ливадских и шумских (храстове) асамблеја у крагујевачкој котлини. О томе говори и изражено присуство тамнобионтних врста (25,9%). Осим тога ова асамблеја има у односу на остале ливадске и највишу полифагност (24,1% врста).

Вештачка, упрошћена структура биљне основе вештачких ливада је диктирала ниски квалитет асамблеје сурлаша.

Асамблеја сурлаша парлога представља занимљиво насеље, претежно везано за коровске биљке. Отуда је и најсличнија са асамблејом са рудералне вегетације. Присуство монофага је израженије него у другим асамблејама.

Шенонов индекс биодиверзитета (коришћен као показатељ стабилности асамблеја) је опадао по биотопима следећим редом: долинска ливада, влажна ливада, парлог, рудерална вегетација, ливада са жбуњем, вештачка ливада, брдска ливада, мочварна ливада. Према биодиверзитету израженом кроз Симпсонов индекс добивен је унеколико другачији редослед: парлог, долинска ливада, ливада са жбуњем, влажна ливада, вештачка ливада, брдска ливада, рудерална вегетација, мочварна ливада. Очигледно да су најнестабилније, тј. људским активностима најугроженије асамблеје природних брдских и мочварних ливада.

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