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FLOOD AS ECOLOGICAL PERTURBATION OF EPIGEIC ANIMAL COMMUNITIES II. THE EFFECT OF FLOOD ON GROUND BEETLE ASSEMBLAGES (COLEOPTERA: CARABIDAE)

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Abstract

Author reports on the processing of the material collected by means of Barber soil-traps at four different habitats at the flood-plain of the Maros (I. dam-side, II. poplar-forest, III. willow-forest, IV. littoral scrub-willow plantation), following the flood of 1982 inundating the whole flood-plain. In the course of the studies 53 species of 18 genera belonging to the Carabidae family were collected. Using diversity and similarity studies, an analysis is given of the dynamism of the Carabidae populations, their recolonization after the flood, as well as of the reorganization of the Carabidae communities.

Introduction

One of the basic problems of ecology of our days is related to the degree to which the living being communities can be burdned, is in connection with the stability of these communities, as well as with their return to the original state following perturbation. This issue is given particular significance by the fact that these may provide direction and solution for the protection of our natural environment nowadays falling into decay more and more faster and to a significant degree as the consequence of the anthropogenic effects, as perturbating factors, furthermore, for arrangements on professional ground in respect to environmental protection and nature conservance. Due to the frequent floods, as natural perturbating effects, the biocenoses at the flood-plain of the Tisza and Maros are particularly suitable for such studies. The relevant earlier investigations were of faunistic character (VÁNKY and VELLAY 1894), BICZÓK 1936). A few authors have made mention of the effect of floods on the coleoptera communities (STILLER 1932), and of their fauna-spreading role, resp. (ERDŐS 1935). The problems of recolonization following floods and of the reorganization of the flood-plain communities have been studied by BODROGKÖZY and HORVÁTH (1979) as well as partly theoretically by GALLÉ, GYŐRFFY and HORNUNG (1982), based on the data of TANÁCS (1979).

The ground beetles are explicitly of epigeic activity, thus mainly their larvae react rather sensitively to inundation. Several authors have studied the effects of the factors which may play role in the recolonization of the ground beetles following flood as well as in the reorganization of their communities. Many studies have been carried out regarding the effect of light, temperature, soil- and air-humidity in single or in their connections (THIELE 1967, 1968, 1977, PAARMANN 1966). Based on the obtained results it could be determined that the soil- and air-humidity are decisive environmental factors in respect to the linkage of the ground beetles to habitat. Some authors have studied the possibilities of survival after floods. Certain species are capable of enduring a short period of submersion in a particular stage of ontogenesis (Palmén 1945, Tamm 1984), while others attempt to avoid the effect of floods by means of over-wintering (Krehan 1970, Palmén 1948, Tischler 1965). Vagility has great significance in settlement following flood. Kühnelt (1965) studied the activity of a few Bembidion species bound to the direct water border and found that they are even capable of flying to considerable (several km) distances. Great significance is attributed by Thiele (1977) to interspecific competition, too, in settlement and linkage to living-space.

Materials and Methods

The studies were performed over a period of three years (between 1982—1985) at the flood-plain of the Maros, about 5 km above the mouth. Following the flood of 1982 inundating the whole flood-plain 5 ethylene-glycol soil-traps from plastic cups 6 cm in diameter were placed at four different habitats well distinguishable on the basis of their plant communities. The traps were emptied at intervals of 14—28 days. Since the relief-height of the sampling sites is an essential factor from the viewpoint of inundation, this was given in proportion to the 0 point of the Szeged water standard falling the closest (Fig. 1).

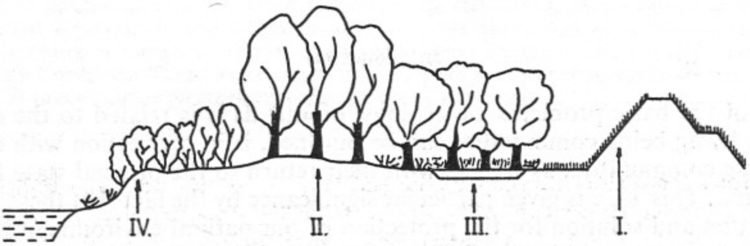

Fig. 1. Cross-section of the flood-plain with the sampling sites (I) Inner dam-side *(Agrostio-Alopecuretum ass.);* (II) Poplar-willow plantation *(Salicetum a. f. populetosum ass.);* (III) Mulberry-willow plantation *(Salicetum a. f. rubetosum ass.);* (IV) Littoral scrub-willow plantation *(Salicetum triandrae ass.)*

The comparative processing of the data of occurrence per sample was accomplished on the basis of diversity and similarity indices according to Southwood (1984).
Diversity:

$$H_{(s)} = -\Sigma\, pi \times \lg pi$$

where pi = relative frequency of the ith species

$$C_{\mathrm{Czekanowski}} = \frac{2\,\Sigma \min(X_{ij};\ X_{hj})}{\sum_j X_i + \sum_j X_h}$$

where X_i and X_h = relative frequency of the i and h species.
For the cluster-analysis of the similarity indices a TI 99/4A personal computer was used.

Results and Discussion

In the course of the studies a total of 4138 individuals were collected, — 53 species of 18 genera belonging to the Carabidae family. The data of occurrence of the 25 most frequent species were also analysed separately (Table 1).

To study the effect of the floods on syndynamic processes, it is necessary to review when floods inundated the flood-plain, to what degree and for how long at the studied period and directly prior to that (Fig. 2). In 1982 at the period prior to the first collection, there was a flood lasting about twenty days which was of such degree (717 cm on 11th January, 1982) that it inundated areas II., III. and IV. Later on there were only floods of 450—550 cm, only disturbing the communities of sampling sites III. and IV.

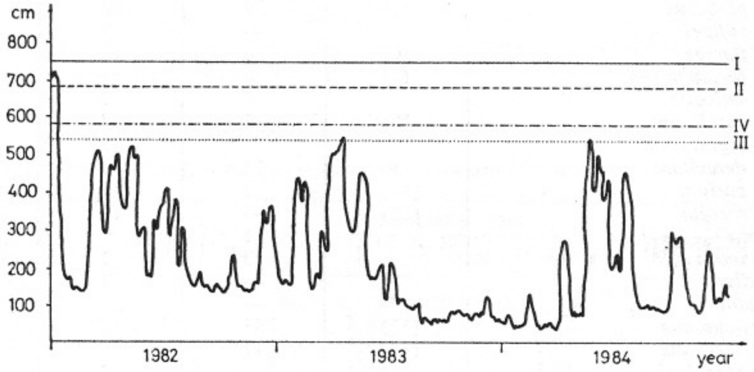

Fig. 2. Development of the floods at the studied period and directly before. I. II. III. and IV: relief-height of sampling sites

It follows from the character of the soil-trap — as relative trap-method — that far-reaching consequences cannot be drawn from the obtained data in respect to the composition of the flood-plain zoocenoses. Nevertheless, it could be determined that at sampling sites II., III. and IV. which are covered by forests, the ground beetles are the dominant elements of the epigeic carnivorous communities (Table 2).

After the flood inundating the whole flood-plain the changes in diversity differed at the different sampling sites (Table 3). Year by year there was a decrease in the diversity at the dam-side (I.) serving as a place for temporary shelter. At the areas (II., III. and IV.) where the communities were greatly disturbed before the studies by the flood of almost 720 cm, an increase was experienced in the species diversity of the ground beetles. This could be explained by the fact that at the time of the greater flood the ground beetles fleeing to the dam-side gradually resettled at the flood-plain and their occurrence at the dam-side became more and more incidental.

The CZEKANOWSKI indices calculated for comparing the species composition of the four different habitats (Table 4), and the dendograms constructed on the basis of these (Fig. 3) are supportive of the fact that the ground beetle community caught at the dam-side differs from the rest. In the years following the flood a process of differentiation commenced at the II., III. and IV. habitats, in the course of which the composition of the ground beetle communities of the IV. waterside began to differ from that of the II. and III. forest communities.

Table 1. *List, individual number of collected species and code-number used in the cluster-analysis regarding the 25 more frequent species*

Species	Code number	Number of Collected individuals		
		in 1982	in 1983	in 1984
Carabus cancellatus	(1)	12	8	14
C. granulatus	(2)	169	123	51
Leistus rufescens		—	—	3
Elaphrus riparius	(3)	46	34	17
Clivina fossor	(4)	31	4	4
Dyschirius globosus	(5)	39	52	33
D. rufipes		—	2	—
Asaphidion flavipes	(6)	6	15	99
Bembidion foraminosum	(7)	6	1	—
B. laticolle		1	2	2
B. ustulatum	(8)	3	8	16
B. biguttatum		—	2	1
B. dentellum	(9)	13	3	—
B. varium	(10)	7	11	2
Patrobus atrorufus	(11)	—	10	5
Amara ovata		1		—
A. eurynota		3	1	—
A. similata		—	4	—
A. familiaris		—		2
Pterostichus cupreus	(12)	31	10	3
P. vernalis	(13)	11		3
P. lepidus		—	3	—
P. niger	(14)	241	56	81
P. nigrita		—	3	1
P. anthracinus	(15)	—	30	40
P. melanarius	(16)	232	139	336
Agonum ruficorne	(17)	11	5	3
A. nigrum		—	3	3
A. obscurum	(18)	33	39	70
A. livens		—	2	7
A. versutum		—	—	1
A. assimile	(19)	863	430	273
A. thoreyi	(21)	1	—	29
Platynus (Agonum) dorsalis	(20)	7	3	4
Stomis pumicatus	(22)	3	16	27
Badister bipustulatus		3	3	1
B. peltatus		18	11	—
Chlaenius nitidulus		—	1	—
Ch. nigricornis		—	1	—
Ch. festivus	(23)	6	—	—
Anisodactylus signatus		—	2	1
binotatus		1	1	1
Harpalus affinis		2	1	—
H. rufipes	(24)	37	30	78
H. latus		—	—	2
H. griseus		—	—	1
Acupalpus meridianus		—	1	—
A. discophorus		—	3	1
A. teutonus		—	1	—
Brachinus plagiatus		—	1	2
B. crepitans	(25)	—	—	9

Table 2. *Ratio of Carabidae among the epigeic carnivores*

Predator group	Sampling sites							
	I		II		III		IV	
	X*	D%	X	D%	X	D%	X	D%
Chilopoda	38	1,60	147	2,97	361	7,47	47	3,10
Carabidae	119	5,00	2025	40,93	1216	25,16	778	52,71
Formicoidea	927	38,92	169	3,42	150	3,10	14	0,95
Arachnoidea	1298	54,49	2607	52,69	3105	64,26	637	43,16
Total:	2382		4948		4832		1476	

* X: individual number; D%: dominance

Table 3. *Changes in diversity in the studied years*

Year	Sampling sites			
	I	II	III	IV
	Diversity H(S)			
1982	1,57	1,82	1,62	1,64
1983	1,23	1,89	2,28	1,64
1984	1,18	1,96	2,33	2,04

Table 4. *Similarity between sampling sites calculated with the Czekanowski index*

	Sampling sites			
	I.	II.	III.	IV.
I.	—	0,01* 0,04 0,11	0,03 0,05 0,02	0,02 0,02 0,11
II.		—	0,43 0,39 0,60	0,52 0,17 0,22
III.			—	0,49 0,16 0,23

* the upper values are the data of 1982, the median values of 1983, the lower values of 1984.

Based on the data of occurrence of the 25 more frequent species a cluster-analysis was calculated as the result of which different species-groups could be separated, corresponding to the communities of the four habitats (Fig. 4).

I. sampling site: *Carabus cancellatus, Harpalus rufipes,* a few herbivorous species (*Amara* spp.) not found in the figure because of their rarer occurrence.

II. sampling site: *Bembidion dentellum, Pterosticsuh cupreus, Agonum assimile, Asaphidion flavipes, Dyschirius globosus, Pterostichus niger, Brachinus crepitans.*

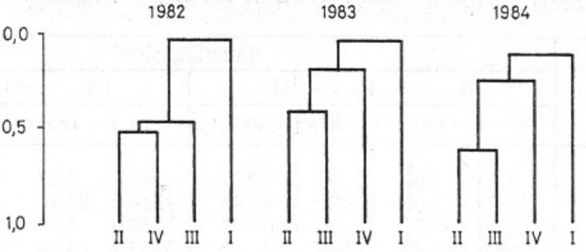

Fig. 3. Dendrograms prepared on the basis of the similarity indices calculated for the Carabidae-communities of the four different habitats. I, II, III. and IV: sampling sites

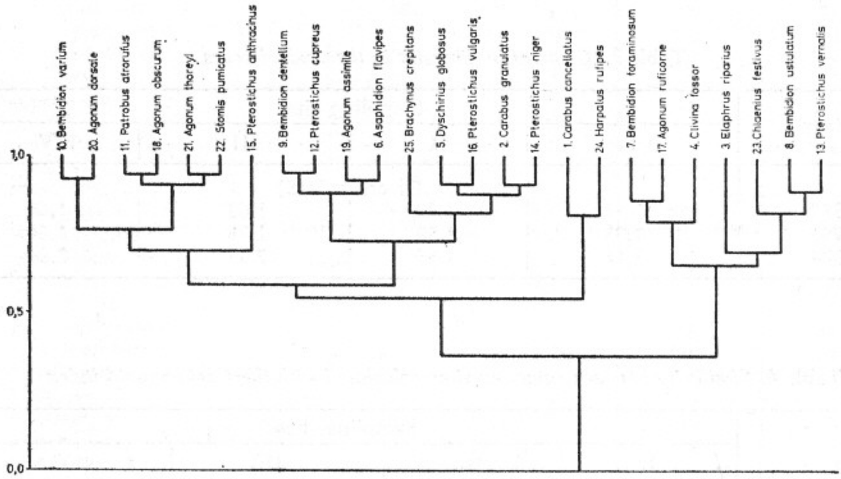

Fig. 4. Dendrogram prepared on the basis of the similarity indices calculated from the data o occurrence of the 25 most frequent species

III. sampling site: *Bembidion varium, Platynus (Agonum) dorsalis, Patrobus atrorufus, Agoum obscurum, Agonum thoreyi, Stomis pumicatus, Pterostichus anthracinus.*
IV. sampling site: *Bembidion foraminosum, Agoum ruficorne, Clivina fossor, Elaphrus riparius, Chlaenius festivus, Bembidion ustulatum, Pterostichus vernalis.*

Upon examining the development of the similarity indices expressing the degree of joint occurrence of the species in the course of the years (Table 5), it can be seen

If, for example, we choose the similarity value of 0.6 — indicating a tighter connection — as the limit value for the joint occurrence, species-groups can be differentiated in all three years. It is interesting to study to what extent the composition of the developing species-groups differs and shows similarity, respectively, in the years following the flood (Table 6).

Upon comparing the groups of the previous years with the year of 1984 (which can be characterized by well developed species communities being the farest from the greatest flood, thus presumedly the least influenced), it can be found that in 1982 — directly after the flood — there were only 14, while in 1983 there were 22 connec-

Table 5. *Number of tight joint occurrences and the number of species occurrtng tightly together in the studied years*

	1982	1983	1984
Values of the Czekanowski index	Number of joint occurrences		
0,9<	6	8	9
0,8<	11	14	15
0,7<	15	14	17
	Number of species occurring together		
0,9<	12 faj	11 faj	14 faj
0,8<	17 faj	18 faj	22 faj
0,7<	19 faj	18 faj	22 faj

that in case of the values above 0.8 and 0.9 there is an increase from year to year in the number of species-pairs repeatedly and tightly occurring jointly. If considering that not only jointly occurring species-pairs, but also species-triads and species-groups, resp., can be segregated, it follows from this that not only the number of joint occurrences increases, but also the number of jointly occurring species (Table 5).

Table 6. *Correspondence of the species-groups of the previous years to the species-groups of the year 1984*

1982		1983		1984
Species—groups				
20—19—24—9—7—17		1—24		6—12—1—25—11—5——19—16—17—20
23—6—13—3—8—4		15—17—7—20—10		2—22—18—21—13——4—14—15
18—5—12—16—21——10—2—14		4—22—18—11—2——16—5—9—14—6—19		7—3—10—8
		12—18		
Correspondence to 1984				
12—5	2—18	6—11	2—22	
12—16	2—21	6—5	2—18	
5—16	2—14	6—19	2—4	
19—17	21—18	6—16	2—14	
19—20	18—14	11—5	18—22	
17—20	21—14	11—19	22—4	
13—4	3—8	11—16	22—14	
		5—19	18—4	
		5—16	18—14	
		19—16	4—14	
		17—20	7—10	

* the species belonging to the code-numbers are found in Table I.

tions corresponding to those of the year 1984; i.e. there were two species in the same linkage-group.

The increase in the number of joint occurrences and jointly occurring species, as well as the yearly increasing conformity of the species-groups refer to the fact that a structural process starts after the flood, and also presumably the regeneration of the co-existence pattern characteristic to the longer flood-free period. The few species *(Carabus granulatus, Pterostichus niger, Agonum obscunum, Agonum assimile, Pterostichus melanarius, Platynus (Agonum) dorsalis, Dyschirius globosus)* which showed relatedness during all three years are presumably capable of tolerating well the identical effect of flood — showing certain resistance — and the cause of their tolerance is with all probability their great vagility, extreme opportunism, or their other r-strategic nature.

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Árvizi perturbáció ökológiai hatása epigeikus állatközösségekre.
II. Árvíz hatása futóbogár együttesekre

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Kivonat

A szerző a Maros hullámterén, az egész hullámteret elborító 1982-es árvizet követően négy különböző habitátban (I. gátoldal, II. nyárerdő, III. füzeserdő, IV. partmenti bokorfüzes) Barber féle talajcsapdával gyűjtött anyag feldolgozását közli. A vizsgálatok során a Carabidae család 18 genusának 53 faját sikerült begyűjteni. Diverzitási és szimilaritási vizsgálatokkal elemzi a Carabidae populációk dinamizmusát, az árvíz utáni rekolonizációt, a Carabidae közösségek újraszerveződését.

Poplava, kao ekološka smetnja životinjskim zajednicama iznad zemlje II.
Delovanje poplave na zajednice strižibuba (Coleoptera: Carabidae)

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Abstract

Autor pritazuje materijal sakupljen Barber klopkama u plavnom prostoru Maroša-posle 1982. godišnje poplave-iz 4 različitih mesta (I. nasipna strana, II. topolina šuma, III. vrbak, IV. žbunasti vrbak duž obale).

Tokom istraživanja sakupljeno je 53 vrste iz 18 genusa familije Carabidae.

Sa metodom diverziteta i similariteta analizira dinamizam populacija Carabidae, posle-poplavnu rekolonizaciju i ponovno organizovanje zajednice Carabidae.

Тормозящее экологическое воздействие наводнений на надпочвенные сообщества животных
II. Влияние наводнений на сообщества дровосеков

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Резюме

Автор сообщает результаты обработки материала, собранного с помощью ловушки типа Барбер, на территории поймы реки Марош после наводнения в 1982 году в четырех различных зонах (I. склоны дамб, II. осиновый лес, III. ивняк, IV. береговые заросли ивового кустаника). В ходе исследований собраны 53 вида 18 родов семейства Carabidae. С помощью дивергенции и исследования симиларитета анализированы динамизм популяций Carabidae, реколонизация после наводнения и восстановление сообщества Carabidae.

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THE TREND OF THE COMPOSITION OF THE WILD-BEE POPULATION ON ANTHROPOGENIC EFFECTS IN THE BIOTOPES OF THE KISKÖRE STORAGE-TANK REGION AT THE TISZA-VALLEY

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Abstract

Studies were performed along the middle-Tisza reach, at the region of the Kisköre storage-tank in the years 1976—77 and 1979—80. The area of the storage-tank was inundated in 1978 by means of damming up the water. Prior to and after damming up the water, apart from the trend of the composition and density relations of the wild-bee population, studies were conducted in respect to the consequences of certain human impacts. The anthropogenic effects were the damming up of the water and the inundation of the meadows of the storage-tank following the building of the dam-system; the partial re-sowing of the grasslands and newly established dam-system with high protein-containing lucerne, red clover and five-finger papilionaceae. The number of recordings was 102, the appreciated wild-bee material was composed of 3716 individuals.

1. On the effect of damming up the water, a modification was manifest with the disappearance of the flood-plain in the species composition of the wild-bee population of the dam sides. The similarity of the species according to locality was found to be moderate in the quantitative and qualitative appreciations. A slight change was manifest in the species diversity and quantitative relations of the wild-bee populations upon the effect of damming up the water.
2. The discontinuance of reapings has negative influence on the composition and density of the wild-bee population in the grassland communities of the fill slope.
3. The re-sowing of the dam sides with papilionaceae is beneficial to the enrichment of the economically valuable *Andrena, Halictus, Lasioglossum, Eucera, Bombus, Megabombus* and *Pyrobombus* species.

Introduction

The development of the composition of the wild-bee population was studied in 10, regularly in 8 terrestrial biotopes of the Kisköre storage-tank in 1976—77 prior to, and in 1979—80 after the damming up of the water. The damming up of the water was in 1978. Following the inundation of the area of the storage-tank the level height of the water raised to 1,5 m. Approximately an area of 127 km^2 became covered with water in the storage-tank. Besides the recordings on composition and density, the aim was to determine the degree to which certain human impacts affect the wild-bee populations. The effects were the damming up of the water as well as the inundation of the meadows of the storage-tank following the building of the dam-system, the partial re-sowing of the grasslands and newly established dam-system with high protein-containing lucerne, red clover and five-finger papilionaceae. The studied areas are in general untreated with pesticides.

Materials and Methods

A special method was required for determining the composition and density of the population of wild-bees in the grassland communities. From several methods and possibilities the zone method (Balogh 1953, Banaszak 1980) as well as its variant applied for agrocultures are already known (Benedek 1970, Benedek et *al.* 1975). In case of the grassland communities this had to be modified so as to have it acclimate to the different plant communities, the changing flower coverage per area unit, and to the phytomass manifest in certain aspects.

The recording method was the following: every flower-visiting Apoidea insect was collected singly with butterfly-net for 3 minutes progressing at an even pace at a 1 m wide, 50 m long zone of the dam side. In such manner the composition and density of the wild-bee population were determined within 50 m²/3 minutes on one occasion. The zone recording within 50 m²/3 minutes was repeated 10 times at the same site both at the water side and the saved side. The collections lasted 60 minutes at 20×50 m², totally 1000 m². The places of the 50 m² recording areas were at the dam basement, centre and top at both the water- and saved sides, adapting to the plant communities. The number of recordings at both sides of the fill slope was close to similar at the same sites at the different level heights of the dam. Owing to technical difficulties, the studies were massed according to flowering aspects along the middle-Tisza reach. Recordings for determining the density and composition of the Apoidea were performed at several localities on one day. This does not distort the composition and density data of the wild-bee population since — similarly to the conclusion of Móczár (1954) — the flower-visiting Apoidea populations of a grassland community are characterized by high species number and low individual number. Thus, notable differences are not observable in the daily population motion of the wild-bee species.

The studied sites were Tiszavalk, Poroszló, Sarud, Tiszanána, Kisköre, Tiszafüred-Tiszaörvény, Tiszaszölős, Tiszaderzs, Abádszalók and Tiszacsege.

The collected Apoidea material was composed of 3716 individuals. Prior to the damming up of the water 1770 wild-bees were collected in the course of the 52 recordings, while following the damming up of the water 1946 individuals were collected during 50 recordings.

The species similarity of the population of wild-bees was appreciated by means of the Jaccard similarity index:

$$I_s = \frac{c}{a+b-c}$$

where a = number of every species occurring before damming up the water
b = number of every species found after the damming up of the water
c = number of common species occurring before and after the damming up of the water

The quantitative development of the population of wild-bees was estimated with the Renkonnen index. Huhta (1979) studied 16 such formulae. The formulae

$$PS = \sum_{i=1}^{s} \min(p_{1i}; p_{2i})$$

belongs to the similarity indices the best expressing the succession changes, where PS stands for the degree of similarity, p_{1i} is the % of the ith species prior to damming up the water and p_{2i} is the % of the ith species following the damming up of the water.

Based on the Shannon—Weaver function, the species diversity of the flower-visiting wildbee-population (May, 1973) as well as the structural degree of the populations were also appreciated.- The evenness (J), therefore, can be calculated from the quotient of the logarithm of two of the components; the species abundance as well as the diversity (H) and the species number (S) (Pielou 1969)

The Shannon—Weaver function is

$$H = \sum_{i=1}^{s} \frac{n_i}{N} \ln \frac{n_i}{N}$$

where n is the occurrence (= individual number) of the ith species; N is the occurrence (= individual number) of the total number of species

$p_i = \frac{n_i}{N}$ is the probability of finding (selection), or a simple form is

$$H = \sum_{i=1}^{s} p_i \ln p_i$$

The evenness was appreciated with the following formula:

$$J = \frac{H}{\ln S}$$

where S stands for the number of species,
H for the diversity value.

The maximal diversity (Pielou 1969) is given by the logarithm of the species number.

The diversity, maximal diversity and evenness were appreciated from the data of 1976, 1977, 1979 and 1980 with the help of computer, using different programmes.

The development of the Apoidea community on the effect of damming up the water was appreciated according to flight dynamic distribution and climatic tolerance. According to flight period the wild-bee species can be classed among 4 main groups (Benedek 1968), being one generation old species with short and medium flying period, two generations old species with long flying period and continuously reproducing species with long flying period.

Based on the works of Pittioni and Schmidt (1942) and Móczár (1948) the wild-bee species can be classed among five groups according to climatic tolerance. These groups are: stenoecic eremophilous, euryoecic eremophilous, hypereuryoecic intermediary, euryoecic hylophilous and stenoecic-hylophilous. In the course of th appreciation, definitions on many wild-bee species were adopted from the works of afore-mentioned authors, while a number of species were reconsidered or classified according to climatic tolerance. This was done on the basis of author's own experiences pertaining to one and a half decades, according to his recordings on the character of habitat and climate.

Results and Discussion

1. Effect of damming up the water on the composition and quantitative relations of the population of wild-bees

The number of species appreciated along the middle-Tisza reach at the study areas of the Kisköre storage-tank in 1976—77 prior to, and in 1979—80 following the damming up of the water was as follows:

Tiszavalk	37 species	(n= 3)
Poroszló	106 species	(n=17)
Sarud	75 species	(n=16)
Tiszanána	44 species	(n=14)
Kisköre	100 species	(n=16)
Tiszafüred-Tiszaörvény	112 species	(n=12)
Tiszaderzs	46 species	(n=7)
Abádszalók	109 species	(n=16)
Tiszaszölős	78 species	(n=10)

On one occasion prior to damming up the water, recording was performed at Tiszacsege, too, however, the obtained data were not appreciated in lack of studies at this site after the damming up of the water.

a) Appreciation of the population of wild-bees according to species composition

Following the damming up of the water, the composition of the wild-bee population changed at the dam and flood-plain at the region of the Kisköre storage-tank along the middle-Tisza reach. The Apoidea disappeared from the flood-plain due to the water coverage. Based on the Jaccard similarity index, the species composition of the wild-bee population at the study sites concentrated on was appreciated:

I_s values:

Poroszló	0,336	$n_{d.e.}=9$	$n_{d.u.}=8$
Kisköre	0,300	$n_{d.e.}=9$	$n_{d.u.}=7$
Sarud	0,395	$n_{d.e.}=8$	$n_{d.u.}=8$
Abádszalók	0,336	$n_{d.e.}=8$	$n_{d.u.}=8$
Tiszafüred-Tiszaörvény	0,257	$n_{d.e.}=5$	$n_{d.u.}=7$

Annotation: $n_{d.e.}$ = number of recordings prior to damming up the water
$n_{d.u.}$ = number of recordings following the damming up of the water

The numbers of recordings at the listed sites were similar values both prior to and after the damming up of the water. The moderate similarity values based on the index values were resulted by the constant occurrence of the *Andrena, Halictus, Lasioglossum, Chalicodoma, Eucera, Bombus, Megabombus* and *Pyrobombus* species.

b) Quantitative appreciation of the wild-bee population according to species

Using the Renkonnen index, the similarity value was found to be 57.72% before and after the damming up of the water. The similarity was moderate regarding the quantitative appreciation of the wild-bee population according to species. This datum proves that in respect to the quantitative appreciation according to species, the population of wild-bees did not undergo any essential changes after the disappearance of the flood-plain. The species of the *Hylaeus, Hoplitis, Heriades, Chelostoma, Pseudoanthidium, Coelioxys, Epeolus, Triepeolus, Nomada* genera either disappeared after the damming up of the water, or their ratio within the population decreased. This can firstly be explained by the disappearance of their biotope, the flood-plain and their foster-plants. On the contrary, the number as well as quantitative ratio within wild-bee population of the economically significant wild-bee species showed an increase following the damming up of the water. On the effect of damming up the water an increase was manifest in the ratio within population of the important pollinating wild-bees, such as certain *Andrena, Halictus, Lasioglossum, Megabombus* and *Pyrobombus* species. After the damming up of the water there was a slight change in the climatic relations at the environs of the Kisköre storage-tank. Owing to the high specific heat value of the storage-tank's water mass the climate became more balanced. A more even water balance became characteristic to the soil of the dams following the damming up of the water. As a consequence, better drought-resistance was manifest for the re-sown papilionaceae at the dam section of the storage-tank and as the result of the insolation, the seared vegetation became less at the dam sections of Eastern, South-eastern exposure. The more favourable climatic conditions resulted more even meadow and weed communities, upon the effect of which the pollinating wild-bee species became more abundant. The vegetation period of the *Trifolium* and *Medicago* species became longer along the storage-tank as the consequence of damming up the water, on account of which it became possible to reap the papilionaceae on 3—4 occasions yearly. The appropriate moisture content of the soil quickened the formation of nectar in the foster-plants of the wild-bee populations.

The diversity (H), maximal diversity (H_{max}) and evenness (J) values were as follows:

1976 S=131 H=3.9840 HM=4.87520 J=0.817
1977 S= 85 H=3.8940 HM=4.44265 J=0.876
1976—1977 S=161 H=4.1630 HM=5.08140 J=0.819
1979 S= 95 H=3.7490 HM=4.55388 J=0.823
1980 S=118 H=4.0210 HM=4.77068 J=0.843
1979—1980 S=153 H=4.1030 HM=5.03044 J=0.816

Analysing the diversity values in the course of the study years, as well as before and after damming up the water, it could be concluded that notable deviation was only manifest in the first year following the damming up of the water. In 1980, two years after damming up the water, the diversity value approximated the earlier findings. Besides such high species number, the diversity value can be judged as being acceptable. The diversity value prior to the damming up of the water was only 0.06 higher than after the damming up of the water. This fact can be appreciated in such a way that the species diversity and quantitative relations of the wild-bee population changed only slightly upon the effect of damming up the water.

The value of evenness only showed a minimal decrease (0.003) on the effect of damming up the water. Analysing the evenness values, it could be concluded that the population of wild-bees could be judged as being homogeneous during the study years, as well as before and after the damming up of the water.

The quantitative data according to species of the flowervisiting wild-bee population was appreciated upon the effect of damming up the water, according to flight dynamics and climatic tolerance (Tables 1., 2).

Table 1. *Results of the flight-dynamic appreciation*

Swarming groups	Prior to the damming up of the water		After the damming up of the water	
	ind.	%	ind.	%
Species with short flying period	220	12.43	153	7.86
Species with medium flying period	590	33.33	383	19.68
Continuously reproducing species with long flying period	306	17.29	559	28.73
Bivoltine species with long flying period	622	35.14	838	43.06
Unappreciated species	32	1.81	13	0.67
TOTAL	1770	100.00	1946	100.00

Table 2. *Appreciation according to climatic tolerance*

Groups according to climatic tolerance	Prior to the damming up of the water		After the damming up of the water	
	ind.	%	ind.	%
Stenoecic eremophilous	233	13.16	226	11.61
Euryoecic eremophilous	827	46.72	866	44.50
Hypereuryoecic intermediary	568	32.09	700	35.98
Euryoecic hylophilous	115	6.50	151	7.76
Stenoecic hylophilous	1	0.06	—	—
Unappreciated species	26	1.47	3	0.15
TOTAL	1770	100.00	1946	100.00

A lower ratio within population was manifest for the wild-bee species whit short flying period (Table 1). One part of the species with short flying period belonging to the *Melitta, Megachile, Hoplitis, Osmia, Heriades, Chelostoma, Anthidiellum, Anthidium, Pseudoanthidium, Coelioxys, Stelis, Epeolus, Triepeolus, Pasites, Ammobates* genera disappeared from the population, or their quantitative ratio became lower on the effect of damming up the water. It also became apparent from the data that there was a marked decrease in the individual number of the species with medium flying period. At the flood-plains, a fifty percent decrease was evidenced in the ratio of the *Chalicodoma ericetorum* population, which species collects pollen and nectar on the flower of the *Lathyrus tuberosus,* and is characteristic to the Chalicodomae in its nest-building activities (GROZDANIC—MUCALICA 1968). The number of the species belonging to the *Anthidium, Tetralonia* genera became fewer on the effect of the damming up of the water. In case of the group of species with medium flying period, the ratio of the *Tetralonia ruficornis,* T. *salicariae* species decreased markedly. This can mainly be explained by the repression of the coverage of their foster-plants, the *Lythrum salicaria* and *L. virgatum,* owing to the daming up of the water. These species have no economical significance in the pollination of the agrocultures in our country. The quantitative development of the Eucera species was found to differ. There was a considerable decrease in the ratio of the *Eucera tigrifacies* and *E. tuberculata,* while an increase was manifest in the ratio of the *Eucera clypeata, E. interrupta* and *E. longicornis* having significance in the pollination of the *Medicago sativa*, *Trifolium pratense* and *Vicia* species. The nectar and pollen production — as energy source — of the flood-plain, flowering meadows and weeds, — fallen short after the inunadtion and unfavourable hydrological relations,— became compensated to a certain extent by the pollen- and nectar supplies of the species of the Papilionaceae, Labiatae and Cruciferae plant families found at the dam sides. The quantitative ratio of the wild-bee species with short and medium flying period showed a decrease after the damming up of the water, owing to the worsening of their essential conditions.

The continuously reproducing species with long flying period, with the exception of the *Hylaeus,* were taxa of great flight radius and energy turnover. It was firstly the individual number of the economically valuable bumble-bees that was found to increase.

There was an increase in the number of bivoltine species with long flying period, as the *Andrena, Halictus, Lasioglossum.* In case of the latter two groups the abundance following the damming up of the water was entirely unambiguous, developing as the result of continuous feeding, and good nesting possibilities for offspring care, provided by the dams. In the course of his studies, author often dug out the nests of *Andrena, Halictus, Lasioglossum, Bombus* and *Megabombus* species from the soil of the fill slopes.

The high specific heat of the water mass has compensating effect on the mesoclimatic relations. The quantitative ratio of the species showing extreme climatic tolerance was found to decrease. The same was experienced in case of the groups fond of heat. The ratio of the species of indifferent spread and greatly fond of humidity showed a slight increase after the damming up of the water (Table 2).

2. Effect of reaping on the development of the wild-bee populations

Reaping means partial intervention in the primary production of the plant communities of the dam-system and the flood-plain regions of higher relief. Under relatively settled weather conditions, the natural grassland communities can be reaped on 2—3 occasions; the cenosis re-sown with Papilionaceae 3—4 times annually. After 1—2 weeks, the temporal regularity of reapings ensures the variedness of the weeds and flowery meadows combined with Gramineae. The wide spectrum of foster-plants is beneficial to the species richness of the flower-visiting wild-bee population as well as to the great density of certain species.

The lack of the first, or later reapings resulted the narrowing down of the species composition of the flowery meadows and weeds at the fill slope. The coverage of the virulent weeds, like the *Carduus acanthoides, C. nutans,* later the *Pastinaca sativa* and the *Erigeron canadensis* became greater. By means of their continuous coverage, these plants exterminate the fosterplants for the wild-bee species at the fill slope. They provide food for many *Halictus, Lasioglossum, Bombus, Megabombus* and *Pyrobombus* species mainly at the time of the peak blooming of the *Carduus,* as the consequence of their attracting effect. After their withering they dry up and the bee pastureland character of the fill slope completely ceases. Accordingly, the Apoidea populations disappear in lack of food. Author experienced that there was no reaping at the region of Tiszaderzs at a section of 500—600 meters. By the second half of July, a continuous *Carduus* coverage developed at the water- and saved side of the fill slope. At the time of peak blooming there was an abundance of Papilionaceae-pollinating wild-bees, like the *Halictus simplex, H. maculatus, Lasioglossum malachurum, Bombus terrestris* and *Pyrobombus lapidarius* species.

At Tiszaderzs the populations of wild-bees collected during the studies on July 9 and August 10, 1976 were compared. The species similarity was appreciated with the Jaccard index, the quantitative ratios of the population's species composition with the Renkonnen index:

$I_s=0.12$ $PS=18.19$

The lack of even the first, possibly the second reaping resulted slight similarity in species composition (I_s). As the consequence of no reapings, such economically significant wild-bee species as the *Andrena labialis* and the *Megachile centuncularis* were not active in the grassland communities of the fill slopes. The quantitative similarity of the wild-bee population was also found to be slight ($PS=18.19$). In spite of no reapings, the *Andrena favipes, Halictus simplex, Pyrobombus lapidarius* and certain *Osmia* species were constant elements of the population even regarding the low similarity value.

The lack of reapings exerted negative influence on the composition and density of the wild-bee population in the grassland communities of the fill slope. At the time of peak blooming the virulent weeds distracted one part of the economically significant wild-bee species from the Papilionaceae cultures of the back areas.

3. The re-sowing with Papilionaceae of the grassland communities at the dam sides and their effect on the composition of the wild-bee population

For increasing the protein content of the hay, the grassland communities at several sections of the fill slope along the Kisköre storage-tank were re-sown with Papilionaceae. These were the *Medicago sativa, Trifolium pratense, T. repens,* and at places the *Lotus croniculatus* and *Vicia* species at sections of 200—300 meters.

The species composition of the wild-bees and their quantitative similarity were appreciated at the fill slope re-sown with the *Medicago sativa* and *Trifolium pratense* Papilionaceae, at the same sites, between the recording timepoints, in the course of the succession.

At Sarud the fill slope was re-sown with *Medicago sativa* Papilionaceae at a 1.5 km long section. The recordings were made prior to the reapings (June 10, July 9, August 22, 1980). The development of the similarity values for the composition and quantity of the wild-bee population between the study timepoints was as follows:

I. Comparison	II. Comparison	III. Comparison
June 10—July 9	July 9—July 22	August 22—September 22
I_s=0.071	I_s=0.150	I_s=0.226
PS=9.45	PS=32.770	PS=46.610

It is apparent from the data series that the composition and quantitative similarity of the wild-bee population increased during the flying period. The *Halictus simplex* and the *Megabombus sylvarum distinctus* were constant-dominant elements at the *Medicago sativa* flower-level during the vegetation period, prior to the reapings.

The *Hylaeus annularis, Halictus maculatus*, *Pyrobombus lapidarius, Bombus terrestris* were busy as additional species at the studied area, in varying numbers. By the middle of Summer, however, the *Halictus simplex*, *Pyrobombus lapidarius, Megabombus sylvarum distinctus* wild-bee species became the most significant flower-visitors of the fill slope.

In the region of Abádszalók, a 1.5 km long section of the dam was almost continuously re-sown with the *Trifolium pratense* Papilionaceae plant. The recording time-points before the reapings were May 26, July 8, Auguszt 9, September 26, 1976.

The similarity values for the species composition and quantity between the study time-points developed as follows:

I. Comparison	II. Comparison	III. Comparison
May 26—July 8	July 8—August 9	August 9—September 26
I_s=0.093	I_s=0.140	I_s=0.074
PS=22.22	PS=32.69	PS=10.87

In this case the recordings were performed before the damming up of the water. The population of wild-bees of the Trifolium pratense was the richest in species before the II. reaping. Following the III. reaping the values of similarity (I_s, PS) showed a decrease as the result of aridity and insolation.

In the course of the recordings performed in 1976, the quantitative similarity (PS) for the species composition pertaining to July 8 and August 9 can be regarded as an average with the value of 32.69. Every other similarity value was low, referring to the fact that the additional species showed considerable changes on the flower of the re-sown Trifolium pratense every 30—40 days.

The *Andrena flavipes, A. ovatula* species proved to be constant-dominant flower-visitors at the fill slope prior to the reapings, in the grassland communities and on the *Trifolium pratense* Papilionaceae plant. The *Melitta leporina, Andrena labialis, Halictus maculatus*, *H. subauratus, Anthidium oblongatum* and the *Bombus terrestris* species were significant flower-visitors both in the grassland communities and on the re-sown Papilionaceae at the time of peak blooming.

The re-sowing of the Papilionaceae is beneficial to the enrichment of the economically valuable wild-bee populations. The grassland communities of the dam side with the Papilionaceae re-sown in sections provide continuous supplies of pollen and nectar. The unperturbed soil of the dam side ensures undisturbed offspring care for the species of the *Eucera* and *Tetralonia* genera. The flowering meadows and the weeds at the fill slope and flood-plain, as well as the blooming agrocultures of the back areas provide the possibility of competition for the wildbees. Even in our country autogamy is hindered because of the flower structure of several meadows, weeds and agricultural plants (Knuth 1899, Troll 1967, Free 1970). Accordingly, the role of wild-bees in the entomogamic pollination of the plants is indispensable. This is especially important in case of the wild-bee populations swarming from the flood-plain and fill slope — as bee pasture-land — to the agrocultures of the back areas.

* * *

1. On the effect of damming up the water, changes were manifest in the composition of the population of wild-bees along the middle-Tisza reach, at the region of the Kisköre storage-tank at the dam and the flood-plain.
   a) The similarity of the species according to locality was found to be moderate based on the index values.
   b) The similarity of the wild-bee population also showed an average regarding quantitative appreciation according to species.

   Slight changes were manifest in the species diversity and quantitative relations of the wild-bee population upon the effect of damming up the water.

   There was a decrease in the ratio within population of the wild-bee species with short and medium flying period.
2. The discontinuance of reapings has negative influence on the composition and density of the population of wild-bees in the grassland communities of the fill slope. At the time of peak blooming the virulent weeds distract one part of the economically important wild-bee species from the Papilionaceae cultures of the back areas. After their withering the dam side no longer has bee pasture-land character, since as the consequence of their great coverage till mid-Summer, the flowery meadow and other nectar- and pollen-producing weeds die out.
3. The re-sowing of the dam sides with Papilionaceae is beneficial to the enrichment in the economically valuable *Andrena, Halictus, Lasioglossum, Eucera. Bombus, Megabombus, Pyrobombus* species.

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A vadméh közösségek összetételének alakulása antropogén hatásokra a Kiskörei tározó térségének biotopjaiban

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Kivonat

A Kiskörei tározó térségében a védőtöltésen és a hullámtéren a vadméh közösség összetétele duzzasztás hatására megváltozott. A fajok lelőhelyenkénti hasonlósága, az index értékek alapján közepes volt. A vadméh közösség hasonlósága faj szerinti mennyiségi értékelésben közepes.

A vadméh közösség duzzasztás hatására történő faji sokrétűsége és mennyiségi viszonyai kismértékben változtak. A rövid és közepes rajzásidejű vadméh fajoknak a közösségen belüli aránya mérséklődött.

A kaszálások elmaradása negatívan befolyásolja a töltésrézsű gyeptársulásaiban a vadméh közösség összetételét és sűrűségét. A virulens gyomnövények csúcsvirágzás idején elvonják a mögöttes területek pillangós kultúráiról a gazdaságilag jelentős vadméh fajok egy részét.

A töltésoldalak pillangósokkal való felülvetése elősegíti a gazdaságilag értékes *Andrena, Halictus, Lasioglossum, Eucera, Bombus, Megabombus, Pyrobombus* fajok feldúsulását.

Promene sastava zajednica divljih pčela pod uticajem antropogenih faktora u biotopima akumulacije Kisköre

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Abstrakt

Na području akumulacije Kisköre došlo je do promene sastava zajednica divljih pčela, kako na odbrandbenim nasipima, tako i u plavnoj zoni. Sličnost vrsta divljih pčela po staništima na osnovu indeksa vrednovanja, kao i kvantitativni sastav njihovih zajednica je osrednji.

Pod uticajem akumulacije u neznatnoj meri je promenjen kvantitativni i kvalitativni sastav zajednica. Unutar zajednica odnosi vrsta sa kratkim i osrednjim rojenjem su postali ujednačeniji.

Izostanak košenja na padinama nasipa ima negativan efekat na sastav i gustinu populacija divljih pčela u travnatoj fitocenozi dolme. U periodu cvetanja virulentne korovske biljke, sa kultura leptirnjača okolnih područja, privlače deo privredno značajnih vrsta divljih pčela. Zasejavanje padina nasipa leptirnjačama doprinosi razvoju populacija privredno značajnih vrsta, kao sto su: *Andrena, Halictus, Lasioglossum, Eucera, Bombus, Megabombus, Pyrobombus*.

Изменение состава сообществ диких пчел под влиянием деятельности человека в биотопах на территории Кушкерейско водохранилища

Л. Танач

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Резюме

На территории Кишкерейского водохранилища, созданного в бассейне среднего течения Тисы, на защитной дамбе и на затоп — ленной площади изменился состав сообщества диких пчел под влиянием поднятия уровня воды. Сходство видов по месту обнаружения, исходя из значений индекса, оценивалось средним. Сходство сообщества по видам, исходя из количественного анализа, было среднее. В связи с поднятием уровня воды условия видового разнообразия и количественные характеристики изменились незначительно. Снизился удельный вес в сообществе видов диких пчел, имеющих средние и короткие сроки роения.

Отсутствие сенокоса отрицательно влияет на состав и численность популяций в сообществах травяного покрова дамб. В период кульминации цветения сорняки отвлекают часть видов диких пчел от бобовых культур на ближайших участках. Посев трав Papilionaceae на склонах дамб способствует распространению полезных для народного хозяйства видов *Andrena, Halictus, Lasioglossum, Eucera, Bombus, Megabombus, Pyrobombus*

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THE SYRPHID FAUNA *(Diptera)* OF THE TISA BASIN IN YUGOSLAVIA

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(Received November 30, 1986)

Abstract

The investigations into the syrphid fauna were conducted along by the Tisa river, in 1984 and 1985. The number of 91 species was collected, out of which 12 represent new records from the Province of Vojvodina and the 2 species *(Posthosyrphus latilunulatus* (COLL.) and *Platycheirus angustatus* ZETT.*)* are new for Yugoslavia. The fauna composition is discussed on the basis of plant communities developed in the Tisa Basin, according to the distribution type, and according to the mode of larval development.

Introduction

Syrphids represent a very large and a diverse group of dipterous insects. Diversity is shown in the appearance of adults and in biology and ecology of these species. Adults feed on pollen and nectar and due to their abundance represent, from early spring to late autumn, an important group of pollinators of various plant species. In relation to the larval development, numerous are the aphidophagous species being important in the biological control of aphids, species with the saprophagous larvae playing a significant role in matter cycling, phytophagous and coprophagous species, and finally a group of species with unknown process of development.

In Yugoslavia, the syrphids represent a relatively well investigated group of insects (380 species). It should be emphasized however, that such a great number of species recorded is the result of the investigations performed in the regions characterized by a great diversity of the ecosystems present. Consequently, the fauna of syrphids is also rich and diverse. With regard to the Province of Vojvodina for instance, the regions of the Fruška Gora Hill (GLUMAC 1959) and the Vršačke Mountains (ŠIMIĆ, VUJIĆ 1984) have been investigated systematically. The syrphid group of this particular area surrounding the Tisa river in Yugoslavia has not been the subject of investigations until now. Our investigations were performed within the joint project of Hungary and Yugoslavia entitled, "The Investigations Into the Tisa River" and the preliminary results on the syrphids from the Tisa Basin are presented.

The insects were collected from early spring till late autumn of 1984 and 1985. The number of 25 localities in a narrow belt surrounding the Tisa river (from the

Hungarian border to the mouth of the river) (Fig.1) was included in the investigations. The samples were collected by using the entomological net and deposited in the collection of the Institute of Biology in Novi Sad.

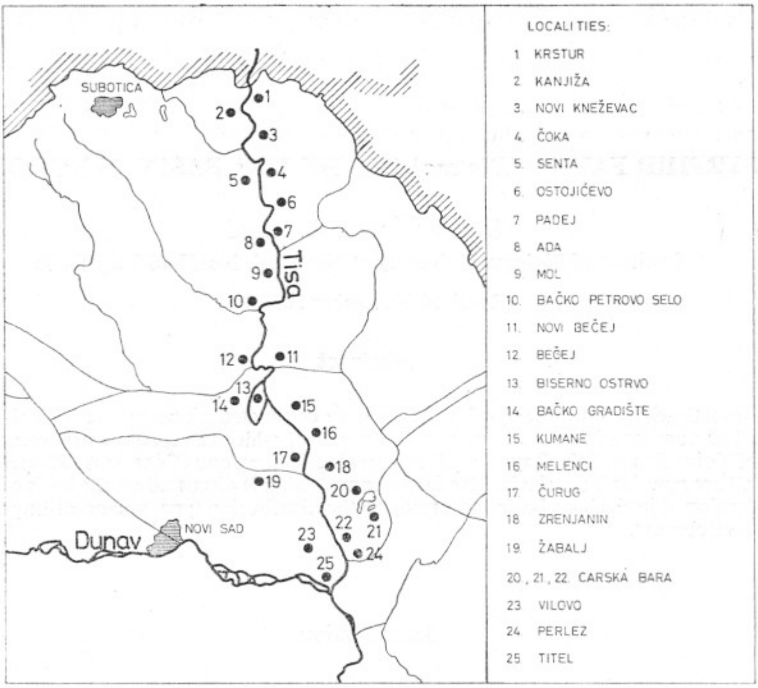

Fig. 1. Syrphidae collecting stations in the Tisa-valley

Results and Discussion

In the region under consideration the number of 91 species (Tab. 1) was found, out of which the 12 were recorded for the first time for the Province of Vojvodina:

Cheilosia melanura BECKER
Eumerus strigatus (FALLEN)
Ferdinandea nigrifrons EGGER
Lathyrophthalmus quinquelineatus FABRICIUS
Merodon distincta PALMA
Pipiza fasciata MEIGEN
Pipiza festiva MEIGEN
Platycheirus clypeatus (MEIGEN)
Platycheirus fulviventris (MACQUART)
Platycheirus peltatus (MEIGEN)
Triglyphus primus LOEW
Xylota tarda MEIGEN
The 2 species are new for Yugoslavia:
Posthosyrphus latilunulatus (COLLIN)
Platycheirus angustatus ZETTERSTEDT

By comparing our results with the data presented by TÓTH (1979) on the Hungarian portion of the Tisa Basin (Tab. 1) the two groups of species are distinguished:

I A common group of species (70 species) recorded from the Tisa Basin in Hungary and Yugoslavia.

II A differential group of species (29 species from Hungary and 21 from Yugoslavia).

Today, a broader region surrounding the Tisa river in Yugoslavia is a cultivated steppe and flood control is established. As a consequence, the autochthonous plant communities declined. Since the syrphids live in a close conjunction with the plant canopy, during their life span, plant communities have a great influence upon the presence and distribution of these species. Therefore, our results are discussed on such a basis.

1. Within the natural communities the most numerous are the alliances of white willow forests of the association *Salicetum albae-amygdalinae* SLAVNIĆ, 1952 (SLAVNIĆ 1952). When compared with other habitats investigated, the largest number of species (74, i.e. 81% of total species found) is concentrated in these communities. Predominant are the species of the forest habitats on wetlands. These are the species of the genera *Pipiza, Pipizella, Cheilosia, Platycheirus, Scaeva, Syrphus,* and *Posthosyrphus,* as well as a great number of species of the subfamily Eristalinae. The 2 species that are new for Yugoslavia and the 8 out of 12 being new for the Province of Vojvodina are found only in these habitats.

2. At certain localities, characterized by somewhat higher humidity, the fragments of the community *Scirpeto-Phragmitetum* KOCH, 1926 (SOÓ 1964—68) are found. These are, in fact, reed communities with the unfavourable living conditions for most syrphids. Only 25 species (27% of total species found) was collected. A characteristic is the presence of the species demanding wetlands. These are the species of the genera *Liogaster* and *Chrisogaster* with their larvae developing in tissues of the aquatic plants, as well as the species of the genera *Parhelophilus, Eristalis, Eurinomyia,* and *Myiatropa* with the larvae belonging to the aquatic, saprophagous group.

3. Outside the embankments, on the Chernozem Soil on loess plateaus, the communities of the alliance Festucion rupicolae Soó 1940 (Soó 1964—68) are found. The number of 30 species (33% of total found) was collected at these localities. The poverty of the number of species is evident also in this region although the finding of the samples of the genera *Merodon* and *Eumerus,* representing a characteristic of this community type, is worth mentioning. Their presence is conditioned by the presence of the bulbous plants that are required in the process of development of larvae of species of the genera mentioned.

4. In the halophylous communities of the alliance Beckmanion erucaeformis Soó 1933 (Soó 1964—68) in more wet habitats, the number of 23 species (25% of total number) was recorded. Although the number of the collected species is limited, a group of characteristic species is distinguished such as *Pelecocera latifrons, Heringia heringi,* and *Chrysogaster viduata,* as well as the species having their larvae among the aquatic saprophagous.

5. In the pasture communities of wet habitats of the alliance Agropiro-Rumicion crispi NOEDHAGEN 1940 (SOÓ 1964—68) the number of 24 species (27%) was collected. Besides the widespread species, important are the findings of the species *Triglyphus primus* and *Lathyrophthalmus quinquelineatus* that are found only in this community type and represent the new species for the Province of Vojvodina.

6. Finally, in planted, Euramerican poplar forests, the syrphid fauna is the poorest both qualitatively and quantitatively. Only 19 species was collected (21% of

total number). All of them are characterized by wide distribution. (Holarctic, Palearctic).

By analysing the percentages of species found in the region under consideration, according to the distribution type (Fig. 2), the presence of species from 6 zoogeographic regions is established. Predominant are the species widespread in Europe. A comparison of these species with those recorded for Yugoslavia brings to view the apparent absence of North European species. Also, the percentage of species widespread in Mediterranean and South Europe is reduced to more than a half. On the other hand, in the fauna of the region considered, the species characterized by the widest distribution are presented in a considerably higher percentages. This fact points to a relatively unfavourable conditions for the development of a rich and diverse syrphid fauna.

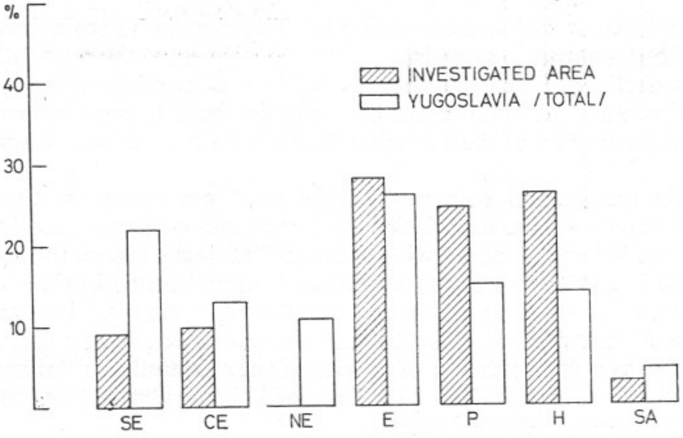

Fig. 2. Groups of species according to the type of distribution

By comparing the results obtained on the percentages of species occurring in the region investigated, according to the type of larval development (Fig. 3), the following conclusions are drawn:

— the percentages of zoophagous, terrestrial saprophagous, coprophagous, and the species with unknown process of larval development are almost equal;

— the percentage of species having the phytophagous larvae (the genera *Cheilosia*, *Merodon*, and *Eumerus*) is half of that observed for the species reported for Yugoslavia;

— opposite is the situation with the species having the aquatic, saprophagous larvae, i.e. the species predominating in the region investigated.

Conclusions

Of the total of 91 species found, the 2 are new for Yugoslavia and the 12 are recorded for the first time from the Province of Vojvodina.

A relative poverty of the syrphid fauna in the Tisa Basin in Yugoslavia, as compared with other regions investigated within this country, is due to the uniformity of habitats, as well as to a remarkable anthropogenic influence.

The highest percentage of species (81%) is recorded in the natural communities

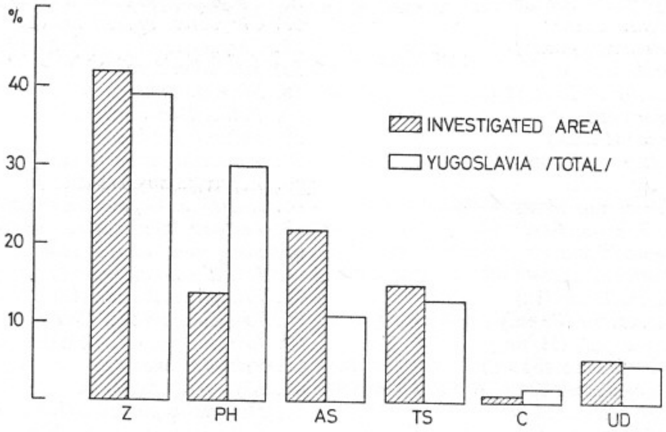

Fig. 3. Groups of species according to the type of larval development

of the alliance of white willow forests of the association Salicetum albae-amygdalinae SLAVNIĆ.

With regard to the distribution, the highest percentages within the fauna of the Tisa Basin in Yugoslavia are recorded for the syrphid species widespread in Europe.

By analysing the species present on the basis of the type of larval development, an evidently low percentage of phytophagous species due to the absence of adequate habitats is observed. On the contrary, an extremely large number of species having the aquatic, saprophagous larvae is recorded.

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List of species

+ differential species

1. *Pipiza fasciata* MEIG.
2. *Pipiza festiva* MEIG.
3. *Pipizella maculipennis* (MEIG.)
4. *Pipizella varipes* (MEIG.)+
5. *Pipizella virens* (FIZ.)
6. *Pipizella* sp.+
7. *Heringia heringi* ZETT.
8. *Liogaster metalina* FABR.+
9. *Chrysogaster viduata* L.+
10. *Triglyphus primus* LOEW
11. *Cheilosia flavipes* PANZ.+

12. *Cheilosia imperfecta* Beck.$^{+}$
13. *Cheilosia intonsa* Loew^{+}
14. *Cheilosia melanura* Beck.$^{+}$
15. *Cheilosia ruralis* (Meig.)$^{+}$
16. *Cheilosia scutellata* (Fall.)$^{+}$
17. *Cheilosia soror* (Zett.)$^{+}$
18. *Neoascia dispar* (Meig.)
19. *Neoascia podagrica* (Fabr.)
20. *Paragus bicolor* Fabr.
21. *Paragus haemorrhous* Meig.
22. *Paragus tibialis* Fall.$^{+}$
23. *Baccha elongata* (Fabr.)
24. *Pelecocera latifrons* Loew
25. *Melanostoma mellinum* (L.)
26. *Melanostoma scalare* (Fabr.)
27. *Xanthandrus comptus* (Harr.)
28. *Platycheirus albimanus* (Fabr.)
29. *Platycheirus angustatus* Zett.
20. *Platycheirus clypeatus* (Meig.)
31. *Platycheirus fulviventris* (Macq.)
32. *Platycheirus peltatus* (Meig.)
33. *Xanthogramma citrofasciatum* Deg.
34. *Xanthogramma ornatum* (Meig.)
35. *Scaeva lapponica* (Zett.)$^{+}$
36. *Scaeva pyrastri* (L.)
37. *Scaeva selenitica* (Meig.)
38. *Posthosyrphus latifasciatus* (Meig.)$^{+}$
39. *Posthosyrphus latilunulatus* (Coll.)$^{+}$
40. *Posthosyrphus luniger* (Meig.)
31. *Metasyrphus corollae* (Fabr.)
42. *Syrphus ribesii* L.
43. *Syrphus vitripennis* Meig.
44. *Dasysyrphus albostriatus* (Fall.)
45. *Episyrphus auricollis* (Meig.)
46. *Episyrphus balteatus* (Deg.)
47. *Episyrphus cinctellus* (Zett.)$^{+}$
48. *Sphaerophoria menthastri* (L.)
49. *Sphaerophoria rueppellii* (Wied.)
50. *Sphaerophoria scripta* (L.)
51. *Chrysotoxum bicinctum* (L.)
52. *Chrysotoxum cautum* (Harr.)
53. *Chrysotoxum festivum* (L.)
54. *Chrysotoxum vernale* Loew
55. *Microdon devius* (L.)
56. *Microdon mutabilis* (L.)
57. *Volucella bombylans* L.
58. *Volucella inanis* (L.)
59. *Volucella pellucens* (L.)
60. *Volucella zonaria* (Poda)
61. *Eristailnus sepulchralis* (L.)
62. *Lathyrophthalmus aeneus* (Scop.)
63. *Lathyrophthalmus quinquelineatus* Fabr.$^{+}$
64. *Eristalis arbustorum* (L.)
65. *Eristalis nemorum* (L.)
66. *Eristalis pertinax* (Scop).
67. *Eristalis pratorum* Meig.
68. *Eristalis tenax* (L.)
69. *Myiatropa florea* L.
70. *Helophilus pendulus* (L.)
71. *Helophilus trivittatus* Fabr.
72. *Mesembrius peregrinus* Loew
73. *Parhelophilus frutetorum* (Fabr.)
74. *Parhelophilus versicolor* (Fabr.)
75. *Eurinomyia lineata* (Fabr.)
76. *Eurinomyia lunulata* (Meig.)
77. *Cerioides conopoides* L.
78. *Merodon clavipes* Fabr.$^{+}$
79. *Merodon distincta* Palma^{+}
80. *Merodon spinipes* (Fabr.)
81. *Eumerus strigatus* (Fabr.)
82. *Eumerus tricolor* Meig.
83. *Eumerus tuberculatus* Rond.
84. *Ferdinandea cuprea* (Scop.)
85. *Ferdinandea nigrifrons* Egg.$^{+}$
86. *Ferdinandea ruficornis* Fabr.$^{+}$
87. *Tropidia scita* Harr.
88. *Syritta pipiens* (L.)
89. *Xylota nemorum* Fabr.
90. *Xylota segnis* (L.)
91. *Xylota tarda* Meig.

Zengőlegyek (Syrphidae, Diptera) a Tisza jugoszláv szakaszán

Šimić Smiljka és Vujić, A.

Biológiai intézet, Újvidék

Kivonat

A kutatások során előkerült 91 zengőlégy faj közül Vajdaságra 12, Jugoszláviára nézve pedig kettő bizonyult új fajnak. Az ország más tájegységeihez viszonyítva a jugoszláv Tiszaszakasz aránylag szegényes zengőlégy faunája az egyhangú élőhely és az erőteljes antropogén hatás következménye.

A 81 %-os zengőlégy fajgazdaság a Salicetum albae-amygdalinae Slavnić erődtársulásra jellemző. A zengőlégy fajok elterjedése tekintetében a Tisza mentén az Európára jellemző fajok a leggyakoribbak.

A lárvatípusok tekintetében, a megfelelő élettér hiányában kifejezetten kevés a növényevő fajok jelenléte, a nagyszámú akvatikus szaprofág fajokkal szemben.

Syrphidae (Diptera) potisja u Jugoslaviji

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Institut za biologiju, Novi Sad

Abstrakt

Od ukupno zabeležene 91 vrste, dve vrste su nove za Jugoslaviju, a 12 za Vojvodinu.

Relativno siromaštvo faune sirfida u potisju Jugoslvije u odnosu na ostala istraživana područja u našoj zemlji je posledica uniformnosti staništa i izraženog antropogenog uticaja.

Najbogatije vrstama (81 %) su prirodne zajednice sastojine šume bele vrbe asocijacije *Salicetum albae-amygdalinae* Slavnić, 1952.

U pogledu rasprostranjenja najvećeg udela u fauni potisja u Jugoslaviji imaju vrste sirfida rasprostranjene u Evropi.

Analizirajući prisutne vrste u odnosu na tip larvalnog razvića uočava se izrazito mala zastupljenost fitofagih vrsta kao rezultat nepostojanja adekvatnih staništa i nasuprot tome, izuzetno veliki broj vrsta čije su larve akvatični saprofagi.

Сирфы (Syrphidae, Diptera) в югославских низовьях Тисы

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Резюме

Из обнаруженных 91 вида сирфов ранее не регистрированы на территории Воеводины 12 видов, в Югославии — 2 вида. Относительно бедная по сравнению с другими районами страны фауна сирфов обусловлена однообразием места обитания и усиленным воздействием человека.

Лесное сообщество типа *Salicetum albae- amygdalinae* Slavnić характеризовано 81 процентным разнообразием признаков видов сирфов. В отношении распространения видов сирфов в пойме Тисы чаще всего встречаются виды, характерные для Европы.

С точки зрения типов личинок, в связи с отсутствием благоприятной среды, наличие травоядных видов незначительно по сравнению с многочисленными видами, обитающими в воде, в иле.

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FROM THE LIFE OF TISZA-RESEARCH WORKING COMMITTEE, WHICH HAS BECOME INTERNATIONAL

Tisza-Research Conference XVII (1986)

Compiled by

GY. BODROGKÖZY

Department of Botany, Attila József University, Szeged, Hungary

I. Lecture on studies from the Tisza reach in the Soviet Union

KOMENDAR V. I. and FODOR I.:

Effect of the changing upper forest border on the development of the floods

The present contribution is in connection with the complex studies performed at the upper boundary of the river Tisza, thus it is rather timely. As the result of the many years' negative farming the natural upper forest border moved down by 50—200 m, due to which the ecological balance became disturbed in the zone of the sub-Alps. It is known that the Black and White Tisza begin in the high mountains. Accordingly, it is clear why great attention should be paid to farming done on a scientific base. The only way out of this situation is to restore the upper border of the forest. For this purpose, in 1959 experimental plantations were raised at the Runa polonina at the height of 1200—1450 m. With this contribution, we wish to throw light upon the results obtained.

II. Reports on the Hungarian Tisza reach

VÁGÁS. I.:

Hydrological questions concerning the catchment area of the river Tisza

The intense Tisza-management of the past century at the lowland region of the river brought about changes in the hydrological relations. The building of high dams made higher water levels possible. By stopping the spread of the floods by means of speeding up the flow of the waters, the level of the Summer shallow waters also became lower.

Since there are no extremities in the water course over longer periods and relatively dry or relatively humid periods are present for several years, occassionally many tend to conclude on changes in climate or water course. A few years of either dry or humid period may be enought for many to consider this state a permanent change, and to extrapolate the doubtless effects exerted on the living world without sufficient reason.

The changes in water course caused by the managements, however, produced a statistically uniform condition of the water course, which may include strong extremities of both directions. On the other hand, it is also incidental to this statistical character that in case the statistical "runs" of either the dry or humid years are of long duration and expressed, they may become the basis for misleading conclusions without the consideration of the complete secular series of the study data.

The secular uniformity of the water course at the catchment area of the river Tisza is thus against such assumptions which would generalize the irreversible changes in the living world due to hydrological causes.

ANDÓ, M.:

Surface-structural relations of the area between Alpár and Tőserdő

The flood-plain between Alpár and Tőserdő is a regional unit of complex structure geomorphologically and genetically. During the preliminary studies concerning the "Alpár storagetank", it could well be reflected that the composition of the surface-close sediments refers to sometimes Danube- and sometimes to Tisza-origin.

It is known that the mineral and chemical structure of the surface-close sediments may considerably determine the chemical composition of the prevailing underground water, and through this the appearance of the natural vegetation occurring there.

Therefore, this essay gives a complex geographical review firstly on the stages of surface development, the layer structures, surface relieves as well as the condition of the underground waters.

HEGEDŰS, MÁRIA:

Hygienic quality of the living waters at the Alpár basin

In 1986, in accordance with the Tisza-research plan of work, the hygienic quality of the living waters at the Alpár basin was studied at eight sampling sites. The following results were obtained:

— The water quality at the bridge and the middle of the backwater at Bokros, Lake Sulymos, and the backwater at Lakitelek was found to be of II. class "slightly polluted" quality based on annual mean values.
— The water quality of the backwater at Alpár, the Kubik pit and the Égeres marsh proved to be of III. class "polluted" quality.
— Only the backwater at Lakitelek was found to be of IV. class "strongly polluted" quality at the region of the research station.
— Salmonella bacteria were isolated from 1000 ml of water sample from only two sampling sites on one occasion. The isolated serotype was S. infantis strain from both water sample.
— It was concluded that the quality of the surface waters of the basin changed unfavourably in the "Summer" period. The most likely cause of the change was that the different bacteriological parameters of the study spectrum indicated enhancement in the degree of organic matter decomposition.

KISS, I.:

Soil-algae from the Alpár basin

In the future, the Tisza-III-river barrage and its large storage-tank will be built at the Alpár basin of the Tisza-valley. This prompted author to perform studies apart from the algae of the water also on the algal world of the soils, starting from 1975. Special attention was paid to the species producing "soil bloom" (flos humi), showing an increase in number on occasions.

So far, the soil-colouring increase of 31 blue-alga (Cyanophyta) and 9 green-alga (Chlorophyta) species was detected at the meadow, pasture and plough-land areas of the Alpár basin. Their frequency in time and space showed great divergencies. 4 species of the *Nostoc* genus and 3 species of the *Phormidium* and *Schizothrix* were found. From the green-algae the most frequent were the *Chlorococcum humicolum,* the *Coccomyxa dispar, Hormidium flaccidium* and the *Palmella miniata.* On the dark green soil surface of a drying up puddle, a *Chlamidomonas* species was observed to transform into protococcoid stage. The traces of the blue-algae were detectable below the surface of the soil as well. At the area under turf-cutting the *Stigonema turfaceum* manifested bluish-gray colouring even at soil level of 6—7 cm.

In respect to the future technical establishments, the phenomena deserves attention that at the clefty, clayey loess-wall in the vicinity of the village Tiszaalpár at the Alpár basin, generally well visible, perpendicular, blackish or brown stripes appear. On May 20, 1984, here the *Nostoc muscorum* was the predominant constituent from the algal communities of the blackish bluish-green patches of 37 stripes. At the same time, the *Hormidium flaccidum* multiplied with great variedness in appearance in the dark green patches of 28 vertical stripes. The blackish colouring of the stripes can be led back to humus substances, and the brown to the trivalent iron content of the detritus. A common observation is that prior to the rainy weather these patches of algal mass production become brighter and more striking. On such occasions the enhanced ionization of the atmosphere may be of favourable effect.

KISS, I.:

Simultaneous appearance of algal mass-productions in the dead-Tisza at Tőserdő and in Lake Balaton in the Summer of 1982

The increased eutrophication caused so to say dramatic changes in the algal world of the dead-Tisza neighbouring Lakitelek-Tőserdő, and simultaneously also in that of Lake Balaton in the Summer of 1982. The joint characteristic of these changes was the disappearance of the *Ceratium hirundinella* rather characteristic to Lake Balaton from the algal communities of both biotopes, and the increased number of another species, causing water-bloom. In the dead-Tisza, on August 4, 1982, the *Euglena Ehrenbergii* coloured the complete water surface dark green, which phenomenon was still observable in October. At the whole area of Lake Balaton, a nitrogen-binding blue alga, the *Anabaenopsis Raciborskii*, produced enormous mass-production in August and September, 1982. Besides this species, in 1983 L. VÖRÖS from Tihany observed the reappearance of the *Ceratium hirundinella,* which had disappeared in the previous year. This, however, was not so in the backwater, in fact, even the remaining *Peridinium palatinum* disappeared here. The biotic and abiotic factors apparently seemed to be more unfavourable and of explicitly antagonistic nature at this site.

The mass-productions developed simultaneously in the dead-Tisza and Lake Balaton, thus the question can rightly be raised as to the role played by the atmospheric effects. The weather fronts are capable of drawing several hundred kilometre distances simultaneously under the same atmospheric effects. It is not impossible that here the atmospheric ionization as well as the formation of nitrogen-oxides also played role. The negative or positive ionization preponderance of the atmosphere has equally favourable influence on the life processes of the plants by affecting the enzymes. The nitrogen-oxides get washed into the soil or the water with the precipitation, where they may serve as plant-nutrients.

GÁL, D.:

The zooplankton of the biocenosis of Lake Sulymos located at Lakitelek, in the year 1986

The qualitative and quantitative changes in the zooplankton of Lake Sulymos were studied in the course of 1986 by means of monthly collections.

During the studies a total of 38 species were found (Protozon 14, Rotatoria 18, Entomostraca 6 species).

With the exception of the Spring months, the dominant species is the Rotatoria in respect to both species- and individual number.

In the Winter months the total individual count is around 300 ind/litre. The *Keratella cochlearis* is a dominant species (172 ind/l). The characteristic species of the Winter months, the *Notholca acuminata,* also appears (27 ind/l).

In Spring there is a considerable increase in the total individual number, reaching even 900 ind/l. In March a significant increase is manifest in the number of the naupliar larvae (284 ind/l), and with its mass appearance (651 ind/l), the *Megacyclops viridis* practically colours the water green in April.

The total individual number decreases to a certain extent in the Summer months (400—500 ind/l). There is a significant increase in the number of the Testacea species, and although their individual count is not too high, their total individual number approximates that of the Rotatoria species due to the decrease in the number of this species. The predominant species are the *Colurella colurus* and the *Arcella gibbosa.*

In the Autumn months an increase is manifest again in the total individual number (600—700 ind/l), firstly owing to the mass appearance of the Cladocera *(Moina rectirostris, Alona rectangularis).*

SZALMA, E.:

Chemical analysis (RFA) of the sediment-, water- and plant-samples of reed-grass vegetations at the Tiszaalpár basin

The distribution and appearance of the aquatic plants of higher order in lakes and backwaters are partly determined by the geochemical properties of the site, the chemical state of the water body, and partly by the changes taking place during the metamorphosis of the water. At three sample areas — Lake Sulymos at Lakitelek-Tőserdő, dead-Tisza at Alpár, backwater at Bokros —, in the vegetation period, sediment-, water- and plant-samples were taken monthly from the cenoses of the Lemno-Potamea and Ptamogetonetea association classes, and the element-contents analysed.

Whithin the three sample areas the highest amount of S, Mn and Fe was found in the sediment-samples from Lake Sulymos. At places at the dead-Tisza area at Alpár the quantitative data of the K showed maximum values. In the sediment-samples from the backwater at Bokros the Si, Ca and Ti were found in large quantities.

Consequential upon the geochemical properties of the sample areas, the various water-bodies showed sharp differentiation from each other based on their element-contents. From the plant stands of Lake Sulymos the S, K, Ca, Mn and Fe contents of the *Nymphaea alba* were lower than typical. The Ca uptake from the sediment was the least in case of the *Nymphaea alba*. The *Hottonia palustris* was found to take up Fe from its environment rather energetically, and its S, K, and Mn accumulation was also significant. The *Potamogeton pectinatus* reed-grass species accumulated S and Ca from its environment in large quantities. The alkali metals and alkali earth metals were taken up by the *Stratiotes aloides* species in considerable amounts. From the plant stands of the dead-Tisza at Alpár, the *Nymphoides peltata* accumulated K, Ca and Mn to the greatest degree. Among the species of the *Lemno-Utricularietum* association, the submerse *Myriophyllum verticillatum* manifested maximal values of S and Ca at the beginning of the Summer aspect, and of Mn and Fe at the end of the vegetation period. From the plant stands of the backwater at Bokros the *Ceratophyllum demersum* reed-grass species took up the K, S and Fe ions rather energetically from its environment. The *Wolffia arrhiza* reed-grass species growing at the same place and forming a separate association accumulated the Mn ions from its environment to a considerable degree.

BAGI, I.:

Problems of succession and zonation in river-bed Nanocyperetalia plant associations

Nowadays the attitude is all the more assumed in succession-research that the zonation and succession stages of the vegetation can only be correlated with each other on a large scale or not in that manner either. This situation is observable in the development of the spatial-temporal pattern of the river-bed littoral vegetation, too.

In the bed section which can be characterized by the *Dichostylidi-Gnaphalietum, Cypereto-Juncetum* initial plant associations, the zonation of the vegetation does not represent the steps of succession; the Nanocyperetalis stands of the upper relief are in successional relationship with the Bidention associations developing at the areas higher than the flood-plain littoral levels, and those found at the lower relieves with the Agropyro-Rumicion associations. Accordingly, the Agropyro-Rumicion vegetation of the lowest river-bed zones represents a higher succession degree as compared to the Bidention stands found above it. The diversity of the temporal and spatial processes of the vegetational changes can also be verified with multivaried methods as well as with the application of the NUMATA kind of "degree of succession" index. The diversity also has vegetation-dynamic causes, besides the non-continuous spatial changes of the environmental parameters.

BODROGKÖZY, GY.:

Vegetation map of the reconstructed plant-cover at the Kisköre Storage-tank of the Tisza-valley prior to its filling up

The 127 km^2 large Storage-tank was the greatest floodplain of the Tisza-valley. The variegated relief relations of the area led to the development of an exuberant living world and hereby characteristic scenic fundamentals. Its aquatic, marsh-, meadow and forest biocenoses reflect the biocenoses of the earlier Tisza-valley. This is why it became necessary to record these for the succeeding generations, by means of preparing the vegetation map of the area, which was done with the help of sketches originating from the period prior to the building of the Storage-tank.

The backwaters had extremely abundant hydatophyton stands, especially in the region of Tiszafüred. Here the water-chestnuts had particular predominance besides the *Nymphaeetum* stands. The *Nymphoidetum peltatae*: islands being rare at other places were similarly blooming. In the older backwaters filling up by biogenic and mineralogenic means, and which often dried out, the Potamion species components of the great reed-grass capable of accommodating to amphibic habitude also subsisted.

From the hydato-helophyta forming the littoral zone, the water-dropwort *(Rorippo-Oenanthetum)* and cat-tail *(Sparganietum)* populations were followed by the vast stands of the helophyton sedges, mostly the *Caricetum gracilis, C. acutiformis-ripariae,* rarely the *Caricetum vesicariae.* The majority of the present Storage-tank area was dominated by the hygrophyton-like meadow foxtail grasslands, the *Agrostio-Alopecuretum, Lythro-Alopecuretum,* in the associations of which the protected *Gentiana pneumonanthe* rare in the Tisza-valley could also be found, particularly at the marshy areas. The *Chrysanthemum* variants were also striking.

Its forest communities were formed mainly from the willowpoplar groves *(Salicetum albae)* of secondary origin and without character. The only diversification was the green curtains of the *Vitis riparia,* creeping up several metres high.

SZITÓ, A.:

The sediment-fauna of the river Tisza and its tributaries based on the longitudinal-segment studies of 1986.

Samples were collected between September 15—30. The stations, time-points and methods were the same as in 1979. The following conclusions could be drawn, based on the selections and individual countings performed on the spot:

The amount of annelids with few bristles (Oligochaeta) was invariably low above the Szamos, only a few individuals were found, however, their number at the whole studied reach below the Szamos even surpassed 2—10 folds of the earlier values. The density of the Chironomidae larvae increased to a greater extent as compared to the Oligochaeta.

From the mollusks, the snails were first found 500 m below the Szamos in a rather high — 132 ind/m^2 — amount. Their individual number, incidence showed an increase at the entire reach compared to the earlier findings. Mussels were found for the first time at the area above the Bodrog. The rarity of young individuals at the whole length of the river Tisza was a striking phenomenon. The individual number and frequency of the mussels were found to be decreased mainly at the regions of

Szolnok, Csongrád and Szeged. Earlier, the samples frequently contained crayfish, too, on this occasion, however, none were found.

Apart from the higher organic matter content of the sediment, the increase in the density of the Oligochaetae and Chironomidae may have been caused by the gathering of the individuals withdrawing with the water due to the extremely low water level. At the same time, the decreased individual number and incidence of the mussels — mainly in the city regions — refer to unfavourable environmental effects as well.

SZITÓ, A.:

The number of Chironomidae larvae and the nutrient-supply in certain basins of the Kisköre Storage-tank at the Tisza-valley

Based on the average density of the Chironomidae, the productive capacity of the different basins was as follows:

The highest larval density at the area of the storage-tank was found in the Small-Tisza, meaning — mainly in knowledge of the environmental demands of the dominant species — that the sediment is the richest in mineral- and organic matter at this region from the whole area of the Storage-tank. To clarify the nutrient source further — first of all sedimentchemical — studies are necessitated.

From the different basins, the nutrient-supply is the most favourable at the Valk- and Poroszló-basins, to where the water of the banked up river reaches, depositing alluvium. In the Valk-basin the larval density is the greatest at the mouth of the irrigation canal, and is also similar at the nearby areas.

In the Abádszalók-basin a considerably lower amount of larvae was found, the Sarud-basin forms a transition between the Poroszló- and Abádszalók-basins, the lowest larval density was manifest at the banked up Tisza-reach and in the low water samples.

Based on the data obtained so far, it is concluded that at present the accumulation of toxicants in the sediment of the storage-tank and the banked up Tisza-reach is not of such degree that would endanger the existence of the macrozoobenthos or would cause a perceivable reduction of their individual number.

AVASI, Z.:

The effect of flood perturbation on flood-plain Carabidae populations

Throughout three years following the 1982 flood raising above 700 cm and inundating the whole flood-plain, Barber soil-traps were placed at four specific habitats characteristic to the Maros flood-plains (I. Inner dam-side — *Agrostio-Alopecuretum* association, II. Aspen grove — *Salicetum a.f. populetosum* association, III. Willow grove — *Salicetum a.f. rubetosum* association, IV. Littoral dwarf willow grove — *Salicetum triandrae* association), in order to study the effect of the flood on the Carabidae populations.

Based on diversity and similarity studies, it could be concluded that the flood raising above 700 cm caused a significant disorganization of the Carabidae communities. After the subsidence of the inundation, a characteristic process of structuralism, stabilization takes place, in the course of which the species endeavour to develop a characteristic coexistence-pattern similar to the previous one. Though this process is influenced by the annually occurring 550—600 cm high overflows, only the greater floods, appearing every few years and inundating the complete flood-plain, are capable of hindering the development of a structurally permanent, stable Carabidae community. The areas functioning as a refuge — thus the dam-sides, too — play an important role in the reorganization of the communities.

TANÁCS, L.:

Appreciation of the bee-like communities found at the dam and flood-plain of the river Tisza, according to zoogeographic spread, climatic tolerance and flight dynamics

During the processing of the more than ten-thousand individuals collected in the course of the ten-years studies, a total of 293 species were demonstrated. Almost half of the bee-like species of the Carpathian-basin occurred in the studied meadow- and grassland-communities. The relative wildbee species-richness of the stands developed as the result of the favourable coexistence of the environmental factors.

The wildbee community was appreciated according to zoogeographic spread, climatic tolerance and flight-dynamic classification:

a) In the terrestrial biotopes along the river Tisza the most significant were the Palaearctic (57 species, 19,45%) and the European species (33 species, 11,26%). In case of the Mediterranean and European types, a considerable ratio was shown by the Northern Mediterranean (49 species, 16,72%), Holomediterranean (39 species, 13,32%), Ponto-Mediterranean (21 species, 7,17%) and the Central European species (14 species, 4,78%).

b) According to the distribution of the species regarding climatic tolerance, the euryoecic eremophilous species had the highest ratio (122 species, 41,64%). The stenoecid hylophilous species were only few in number (3 species, 1,02%).

c) The species forming the largest part of the community at the dam-system and flood-plain of the river Tisza were those with medium flying period (109 species, 37,20%).

The bivoltine species with long flying period constituted a considerable proportion (84 species, 28,67%). Only about 1/5 of the community was formed by the species with short flying period (56 species, 19,11%). The wildbee species with continuous and long flying period had a smaller ratio within the community (28 species, 9,56%).

GASKÓ, B.:

On the spread of the cylindrical straw-beetle (*Theophilea cylindricollis* pic)

The cylindrical straw-beetle is a protected animal since 1st July, 1982. The ideal value of a single individual is 10 000 Ft. The beetle belongs to the problematic species. At its locality in Hungary known so far, it has strong populations, or at least they are not endangered directly. It seems the enhanced protection of this animal can rather be led back to the few background information at disposal at the time of decreeing the protection.

At the beginning of our Century, the one and only place of occurrence of the

Theophilea was mentioned by WINKLER (1924—1932) as being the Caucasus. TILL 1976, there was no ecological basis to this zoogeographic datum.

The other essential obstacle was the wrongly published foster-plant. The cylindrical straw-beetle, in contrast to its name — is not capable of developing in the stalk of grain crops. The corn-stalks could at most be suitable nutrient source for the development of the Cerambycida larvae till the beginning of ripening. In knowledge of the swarming, this period is too short.

The Hungarian literary data on the Ponto-Mediterranean species (KASZAB 1971, HORVATOVIĆ 1978, 1979, 1980, SZALÓKI 1976) were limited to Transdanubia. The species is held to be explicitly xerophyll be HORVATOVIĆ (1980), which is not supported by the studies performed at the flood-plains of the rivers Tisza and Maros. However, it is highly frequent at areas of cooler microclimate, thus from the lower third of the dam till the Salicetum albae-fragilis zone, and also in the border-communities of the wider inner clearings.

Its spread can also be influenced by the fact that the Theophilea cylindricollis continues ripening feeding. This has also been observed in case of several Euphorbia species.

BÁBA, K.:

Data to the succession of aquatic mollusks in the Tisza-valley

Based on studies performed at the Tisza-valley, a comparison was drawn between the aquatic mollusk groups and the succession of the plant communities. The relations of 14 aquatic plant communities from 94 sites were studied on the basis of 41 species and 11.023 living individuals. The studies originated from biotopes expanding from the marsh-meadows till the fenwoods and belonging to the lake succession series.

The condition of the various succession phases was studied on the basis of cluster analysis and their diversities, and the appreciation was based on trophic patterns.

The marsh-meadow succession series in characterized by the increase in the ratio of the saprophage elements and the decrease in the herbivorous elements. The arid marsh-meadow series is characteristic of an increase in the herbivorous elements. The two feeding types in both groups are in complementary relationship.

In the two variants of the lake succession series the trophic patterns differ at the moderately and suddenly deepening riverside sectors. At the suddenly deepening riverside sectors the increase of the herbivorous elements is in complementary relationship with the decrease in the saprophage elements. At the moderately deepening riverside sectors the succession is characterized by the preponderance of the omnivorous elements. The marsh-lake represents a transitional type. In the backwater at Tőserdő being under cultural effect, the ubiquist saprophage snails indicate eutrophication. Besides the decrease in species- and individual number, the cultural effects induce the homogenization of the snail-groups in both succession series.

FARKAS, Á.:

Comparative studies on the interspecific competition of the *Rutilus rutilus* (roach) and the *Leuciscus Idus* (ide) in the Lakitelek and Körtvélyes backwaters at the Tisza-valley

The roach and the ide are frequently occurring species at both backwaters. The backwater at Lakitelek is strongly, that at Körtvélyes is less eutrophic. Both fish species are capable of utilizing a wide spectrum of the food chain. If the amount of aliment of animel origin decreases, both fish species change over to multicellular vegetable feeding. The roach raises its food of vegetable origin to the double, the ide to the triple (BRADRAND 1985). The *Potamogeton crispus* takes a considerable share in the feeding of both fish species. Since the consumption of the roach is within a wide spectrum of foodstuffs, it is capable of living on a rather few food types. According to the studies of several authors the mesotrophic and eutrophic lakes are favourable for the existence of these fish species (HARTLEY 1947, SVARDSON 1975, PREJS 1978, BRADRAND 1984). Contrary to the roach, the ide only rarely rules the fish communities, and is generally found together with other Cyprinidae. The ide is also capable of feeding in a wide spectrum, similarly to the roach.

The purpose of the lecture is to document the feeding of the roach and ide, resp., in two environments where due to different ecological relations particular intra- and interspecific competition can be observed.

BENEDECZKY, I., ASZTALOS, B., NEMCSÓK, J. and GÁBRIEL, R.:

Effect of combined copper sulphate and methidation treatment on the liver tissue of carp

The pesticides and compound-residues getting into the fresh- and stagnant-waters of Hungary generally exert their effect jointly on the metabolic processes of the living organisms. Therefore, our aim was to analyse the joint effect of a few pesticide-combinations on the function and pathologic alterations of the liver, with the help of simultaneous biochemical and morphological studies. The experiments were performed on carps kept in aquarium. The pesticide concentrations were 2,5 mg/l in case of copper sulphate, and 1 mg/l in case of methidation. The duration of the treatment was 1, 4, 6 and 14 days.

Two weeks after the treatment focal cell necrosis was detectable light microscopically in the liver tissue. By electron microscopy, hepatocytes with light cytoplasm were frequently observed, no sEr was found in the glycogen granules and the vesicularization of the rough surfaced endoplasmic reticulum was observable. The appearance of myelin figures was often found to be in connection with the damage of the mitochondria and the Golgi apparatus, but these formations also occurred in the hyaloplasm matrix. The afore-mentioned fine structural alterations refer to the significant damage of the protein-synthesizing and energy-supply system of the hepatocytes. Owing to the facts that the isoenzyme-image of the liver also appeared in the blood serum, and there was an increase in the GOT and GlDH enzyme levels as well, unambiguous biochemical proofs are at disposal in respect to cell damage in the liver tissue ensuing upon the effect of compounds.

GYOVAI, F.:

Demographic studies on the *Rana arvalis* population at the alder grove in Tiszaalpár

The maximal density of the *Rana arvalis* population at the alder grove in Tiszaalpár in the past three years was as follows: 500 individuals in 1984, 1500 in 1985 and 3600 in 1986. The maximal biomass values were found to be 2 kg/ha in 1984, 5 kg/ha in 1985 and 20 kg/ha in 1986, being rather high values in case of small bodied vertebrates.

This year's outstandingly high biomass was presumably the consequence of the optimal meteorological factors and the food abundance. The individual biomass values, however, were found to be lower by about 25% compared to the values of the previous year.

The growth rate of the males was significantly more intensive than that of the females. The segregation of body measurement within this age-group also contributed significantly to the minimalization of the intraspecific competition, by means of the "gap-free" division of the resources.

The *Rana arvalis* population shows type III. mortality. The signs of predation are manifest in 2% of the juvenile individuals.

The size of the individual motion-zones is the function of the body measure; 5—20 m² for juveniles, 30—100 m² for adults. Accordingly, loyalty to the area, recognition of the dwelling area are demonstrable. For the time being, however, the protection and exclusive use of the individual territory cannot be proved. Considerable migration is demonstrable in case of every age-group in the Spring period.

MOLNÁR, GY.:

Study of avicenoses at the region of Tiszaalpár using quadrat-method

Author studied the composition of the bird stocks in the quadrats of alder groves, oak groves and mixed old forests at the area of Tiszaalpár-Tőserdő between the years 1981—1986.

Based on the modified I.P.A. system, it was demonstrable that the earlier quadrat-method proved insufficient in studying the avicenoses. The forests of clomax stage and diverse species have similar avicenoses and high biomass. The data from other, control areas studied in the Tisza-basin are not concordant with the results obtained at Tiszaalpár. This is in relation to the biogeographic diversities of the similar stocks, the shape of the areas, etc., also giving rise to isolate problems.

III. Reports on the studies from the Tisza reach in Jugoslavia

MATAVULJ, M., GAJIN SLAVKA, PETROVIČ OLGA and GANTAR, M.:

Indications of water quality at the Jugoslavian reach of the river Tisza, based on microbiological and enzymonological analyses

Authors review their microbiological results pertaining to the Tisza reach in Jugoslavia, based on studies performed over a four years period. Data are provided on the total bacterial plankton and heterotrophic bacteria quantities, on the distribution of the different physiological bacteria-groups, furthermore on the indicators of the T/H saprobity index as well as on the enzymatic-phosphatase and beta-glucoside activities, as indicators of the saprobity index, — at five sampling sites, using traditional microbiology techniques. In the given case the two methods coincidentally proved the classification of the Tisza water to grade II—III, and III., resp., according to the organic matter loadinsg.

During the course of the studies, comparison was made for the first time between the data obtained by traditional microbiological analysis (bacteria-quantity and

-quota) and those by the indication of the saprobity degree of the water (phosphatase activity index) as well as by beta-glucoside activity. The statistically significant positive correlation manifest by the compared parameters refers to the fact that analysis of the enzymatic beta-glucose activity of the water would promote the faster, more reliable and exact determination of the organic matter loading of surface waters.

PUJIN VLASTA, RATAJAC RUŽICA, DJUKIČ NADA, MALETIN, S. and SVIRČEV ZORICA:

Biology of feeding of a few introduced fish species in the backwater of the Jugoslavian Tisza-valley

The Dead-Tisza at Gyöngysziget developing as the consequence of the management of the river Tisza (1858) is suitable for fish-breeding of lake character. The paper gives a review of the spectrum of feeding of fish species intorduced into the Dead-Tisza *(Hypophthalmichtys molitrix* VAL., *Carassius auratus gibelio* BLOCH, and the *Lepomis gibbosus* L.*)*

In the studied period (1983—85) the phytoplankton of the Dead-Tisza was formed by the Cyanobacteria, Diatomophyta, Pyrrhophyta, Xanthophyta, Euglenophyta and Chlorophyta algalgroups, from which the predominant were the Cyanobacteria and the Diatomophyta algae. The species belonging to the Protozoa, Rotatoria, Cladocera and Copepoda groups constituted the zooplankton. The Rotatoria group was the richest in species (cc. 40 species), while the basic component of the biomass was found to be the Copepoda representatives. Their share surpassed 50%. The Chironomidae and the dominant Oligochaeta, with the value of 88,8—560 ind. m^{-2}, constituted the bottom fauna.

The main food for the hypophthalmichtys molitrix was found to be a single species of the Cyanobacteria group belonging to the *Oscillatoria* order. The other algal groups occurring in the Dead-Tisza were only sporadically present in the fish aliment. The Copepoda species also formed the regularly occurring food, while the species of the Rotatoria group from the *Keratella* and *Brachionus* genera were only sporadically manifest in the fish aliment.

The members of the Copepoda and Cladocera, then the Oligochaeta group composed the fundamental component of food for the *Carassius auratus gibelio.* The algae of the phytoplankton manifested a secondary role. The *Lepomis gibbosus* was found to be exclusively zoophage. Its food was mainly formed by the species of the benthos Chironomidae and Oligochaeta groups.

POPOVIČ ESZTER and MIKES, M.:

Helmintofauna contamination of a few frog species at the Jugoslavian Tisza-valley

In their preliminary study, authors are the first to describe the helmintofauna contamination of frogs collected from the Voivode district. The infectedness of host-animals with helminths studied so far in Jugoslavia has been reviewed by Hristovski in his series of publications from the region of Macedonia.

A report is given on the extensity and intensity of the contamination in case of 295 individuals of six frog species *(Bombina bombina, B. variegata, Bufo viridis, Rana esculenta, R. ridibunda* and *R. arvalis)*. The infectedness was studied at the level of the lung, bladder, digestive system, stomach, small intestines and rectum. The temporal as well as spatial distribution of the data collection provides possibility later on for both the faunistic processing and zoocenological appreciation of the infectedness; considering on the one hand the stage of development of the host-animals, on the other hand the effect of the seasonal changes in the living space as well as other characteristics of the biotope.

The most considerable from the different vermin-groups are the Nematoda members. The Trematoda contamination is also of relatively high degree, while the occurrence of the vermins belonging to the Cestoda, and even more so to the Acanthocephala group is insignificant.

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SEASONAL CHANGES OF PHYTOPLANKTON IN THE BACKWATER BOKROSI

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Abstract

The backwater at Bokros is one of the sampling territories of the Tisza Research Board. It can be found in the 251. river-kilometer segment of the Tisza river on the saved (right) side.

Relying on the investigations of 1984 the author determined the seasonal changes occurring in the examined water territory based upon the composition of species and on the quantity of populations. The result of the analysis of monthly taken water samples was illustrated expressed in per cents of the prevailing total organism number (Cyanophyta, Diatomae, Chlorophyta and others). She assessed the seasonal changes of biomass calculated from the volume of alga characteristic of the water territory of the backwater as well.

Applying the theory of diversity the author tried to find an answer to the question: Which organisms are responsible for the small values of diversity? Evaluating this she made use of a new method (DIVDROP) as well. She supplemented her investigations with data of relative chlorophyll contents of the phytoplankton biomass.

Introduction

The research theme of those who are less engaged in theoretical problems of hydrobiology is determined by given methods of investigation. The biological research of open waters is narrowed down to a qualitative and quantitative assessment of phytoplankton composition in a given water territory (KISS 1979a, 1979b, UHERKOVICH 1965, 1978, 1978, 1979, 1981, 1982, HORTOBÁGYI 1957a, 1957b, 1959, 1960). In one year 10—12 water samples are analyzed in case of sampling with monthly frequency. Evaluation and publication of results is extensive and is not easy to survey; that is the reason why researchers mostly adopt mathematical methods now which can be applyed in this domain as well. More Hungarian authors used diversity and the cluster analyse to establish a space-time pattern of phytoplankton (NÉMETH—VÍZKELETY 1977, VÖRÖS 1981, DOBLER—KOVÁCS 1984, KOVÁCS—DOBLER 1984, KISS 1984).

The seasonal changes established with diversity can further be evaluated by the DIVDROP analysis (RAJCZY—PADISÁK 1983) and this way an answer can be found to the questien: In the course of monthly executed examinations which are the organisms influencing change of diversity described in literature?

Some Hungarian authors (HERODEK—TAMÁS 1976, BARTHA 1977, KOVÁCS—DOBLER 1984) regard phytoplankton biomass as a significant factor in determining a water's biological quality. Beside this VÖRÖS (1984) considers important the connection between phytoplankton biomass and chlorophyll.

According to our present knowledge we are able to describe the state of a lake by means of physical, chemical and biological parameters; with the help of fundamental laws of natural science we can even establish certain regularities but we cannot yet predict what species of alga becomes dominating in a given water territory at a given period of time. This can be explained by the fact that the species of alga are numerous and different and that the succession of phytoplankton is an extreemly complex oecological phenomenon. A good summary of revelant national and foreign literature is given in a study by NÉMETH—VÖRÖS: "Method and conception for algalogical monitoring of open waters".

In the case of seas and oceans three phases of phytoplankton space-time patterns of change are known (according to MARGALEF 1978):

Phase 1: The organism number of alga is high, the smallbodied great surface per volume species are dominating the swimming capacity of which is bad. The highest concentration of nutriments can be found in this phase. Regarding seasons this state is characteristic of winter and autumn.

Phase 2: Beside smaller algae the appearance of medium and bigger-sized species can be observed. The number of organisms diminishes, the number of species may increase. This is the state characteristic of spring and autumn months.

Phase 3: The big-bodied and small surface per volume species are dominating that grow slowly and swim well. The lowest concentration of nutriments and number of organisms can be found here. It is characteristic of summer and perhaps of the early autumn seasons. In course of researches of the less eutrophc territory of lake Balaton the following seasonal periods with characteristic composition of species were identified (NÉMETH—VÖRÖS 1984): In the period of winter and spring the small- and medium-sized alga is dominating. In late spring the appearence of the big-sized *Ceratium* may be observed beside these; in summer the species with bigger volume are almost entirely characteristic. In autumn — regarding size of alga — the state of late spring returns. The seasonal change of phytoplankton in this section of lake Balaton (B. Szemes, Zánka) was identical with the one explained by the MARGALEF (1978) pattern.

In the bay of Keszthely, it being the most eutrophic water space of the lake the MARGALEF pattern does not assert itself totally since eutrophization resulted in reversing succession, in this way its complete forming was hindered.

Materials and Methods

The backwater at Bokros is one of the sampling territories of the Tisza Research Board. Its independent life is only influenced by the occasional high level of Tisza. Its water is used for extensive though not intensive fishing. The water territory of the mortlake was sampled with a monthly frequency (except for August). To examine phytoplankton 200 ml of sample was settled which formerly had been conserved with lugol solution and according to expected alga-concentration it was condensed to a known volume (FELFÖLDY 1980). Algacounting was realized with the help of the agar-plate method. (NÉMETH—VÖRÖS 1984). Characteristical alga-groups were illustrated expressed in per cents of any total number of organisms.

From the qualitative and quantitative list of species of phytoplankton complexes diversity was calculated (HAJDU 1977, MARGALEF 1978) and applying the method of DIVDROP the species of alga influencing seasonal changes could be extracted. The essence of this method is that the quantity data of species in question is removed and is proportionally divided among the remaining species. A new diversity value is calculated with these new number of organisms. This way the values of a reduced index (H_{red}) are determined and the difference of two indices ($\Delta H''$) can be calculated. This $\Delta H''$ value is worth while to calculate only in case of species with a domination above 10% in the list of species.

The method is practical in essence, without theoretical considerations.

$$\Delta H''_{jk} = H''_j - H''_{red_{jk}}$$

where"j" is the number of organisms of a breed considered important in the sequence,

$\Delta H''_{jk}$ is the difference of diversity obtained by dropping out number "k" species of number "j" organisms. The values of SHANNON — diversity were compared with the values of reduced diversity calculated for the more important species as described above. According to this three important organisms could be recognized that diminshed the values of diversity calculated on the basis of number of species and organisms — the value already known from literature. (On territories of low productivity the number of species is high to the detriment of the number of organisms. Though the number of species increased in the examined water space during the investigated period of time but the number of organisms outnumbered this).

To establish the productivity of a given water-space it is not sufficent to measure the quantity of a-chlorophyll and to determine total alga-number. A more significant information is obtained if the biomass is calculated from the volume of algae living in the examined water. The valume data necessary were determined from literature and from my own measurements and the biomass per sample value was illustrated in units of mg/l.

In case of each sample the chlorophyll contents of alga-biomass was given in per cent rates (Vörös 1984).

Discussion of results

A double aim was set in investigating the backwater at Bokros. On the one hand I intended to establish the change of phytoplankton complexes in time and based upon this, the biological quality of water; on the other hand to keep track of the change with the help of a new method and to explain its motive on the basis of the composition of species and the quantity of populations.

After having analyzed the monthly taken water samples the algacomplex composition characteristic of the backwater was illustrated in per cent rates of the total organism number (Fig. 1). The following groups appear in the figure:

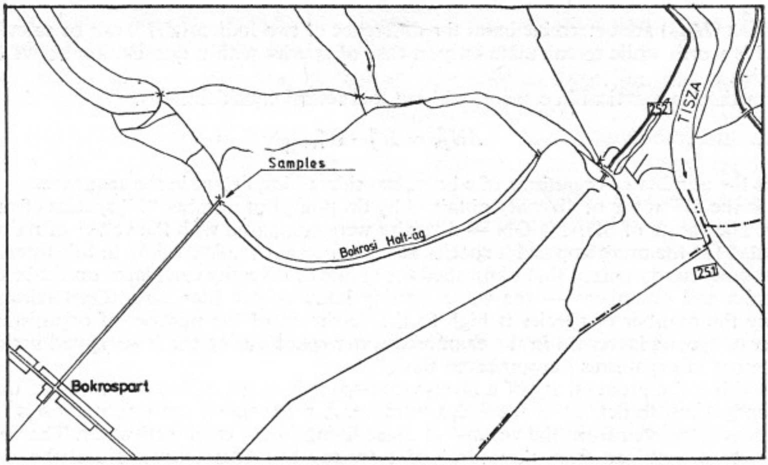
Cyanophyta, Diatomae, Chlorophyta and others: Chrysophyceae, Euglenophyta, Pyrrophyta, Xanthophyceae. During the months of January and February the presence of small-volumed blue algae (*Merismopedia* species 83 000i/l) and a flagellate green alga were dominant in the water. During the spring months (March, April) the predomination of small-volumed blue and green algae continued in the water, though the number of species and organisms of algae with greater volume increased as well.

During summer months (May—June—July) only the green algae with small volume dominated with a high organism number; this way phase 3 of the Margalef Pattern did not formulate — as it has not evolved in the eutrophic water of the Keszthely bay of Balaton.

In this period a green alga became predominant the *Catena viridis* Chod. Belonging to the order of Ulotrichales which formed flakelike colonies in the samples taken during spring and it very seldom appeared in threadlike forms described in the identification handbook (Hindak 1975, Schmidt 1977).

A nearly exact counting could be realized if 50 pieces of cells with an approximatively 1,5 μ diameter and the adjoining tiny rings were considered one unit. This condition proved to be significapt in biomass counting as well.

During September the proliferation of green algae with small body-volume decreased and the *Achnanthes minutissima* Kütz. — which had made its appearence



Map. Localization of Bokros Backwater

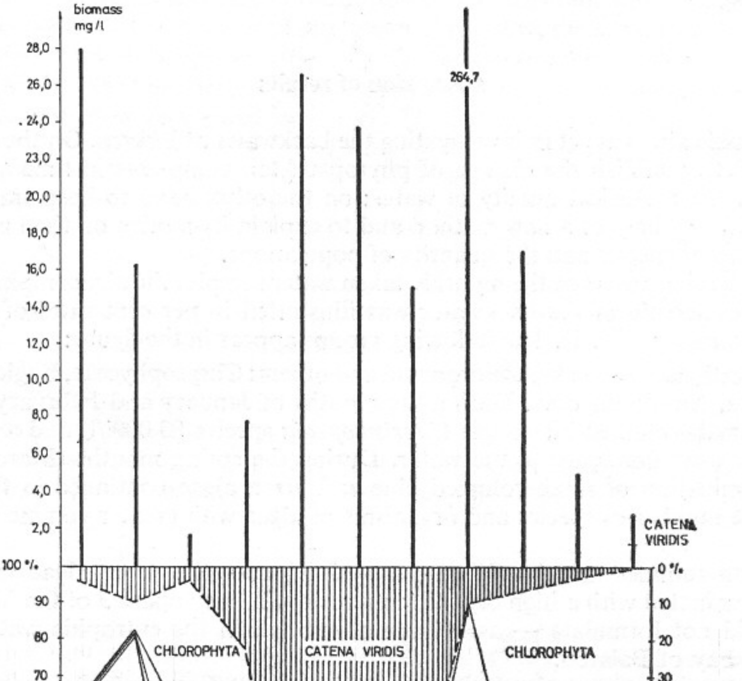


Fig. 1. Seasonal changes of phytoplankton complex

with an organism number of 55 000 i/l in June — increased with an oragnism number of 500 000 i/l.

During the months of October, November and December the *Ankistrodesmus angustus* BERN green alga was dominating.

Phytoplankton changes were kept track of with the help of SHANNON-diversity as well (Fig. 2). The phytoplankton diversity in shallow lakes with a balanced traffic of materials had a low value during winter; it was gradually increasing from spring to the end of summer and during autumn and winter it tended to have a lower value again. Diversity values calculated from quantity data of alga-complex in the backwater at Bokros diferred from the values described elsewhere. For this reason the method explained in the revelant part of this study was applied and a reduced diversity was counted for each organism that appear on the list of species and have

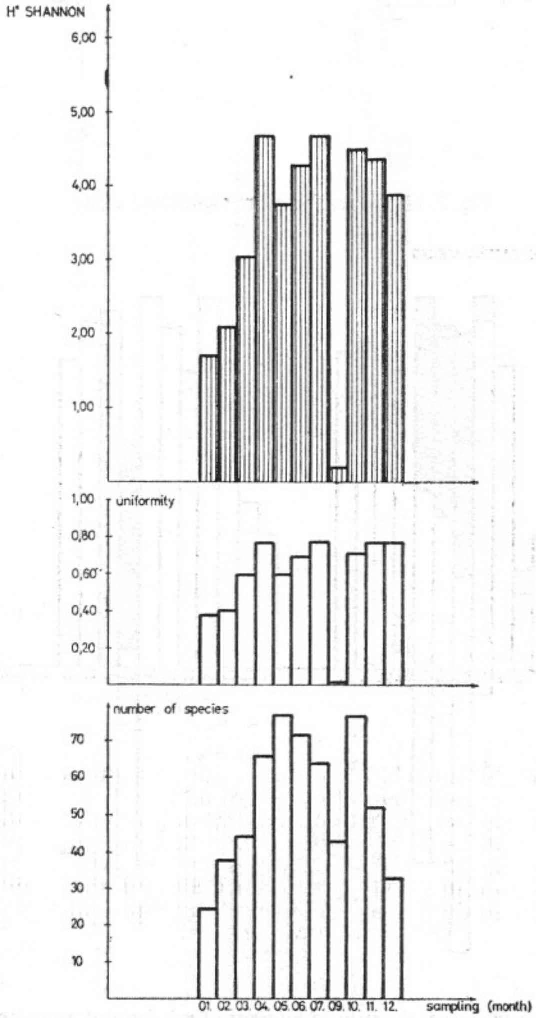


Fig. 2. Diversity of alga organism number

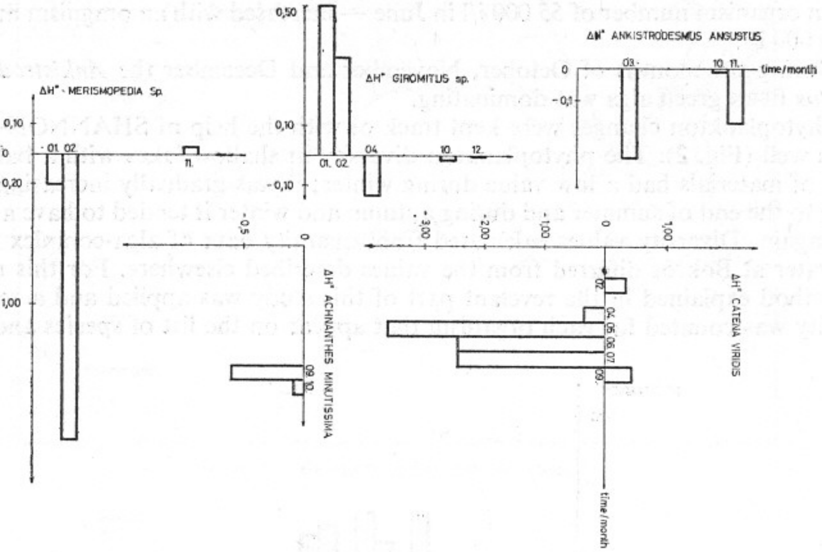


Fig. 3. H″ values for more significant algae

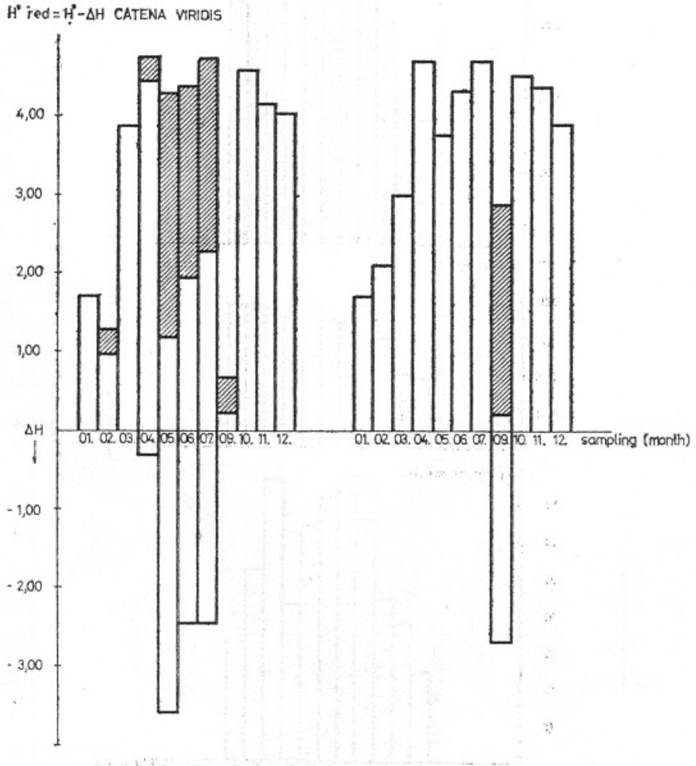


Fig. 4. Reduced diversity of number of species and organisms
Biomass diversity and the reduced H" for Achnanthes

a domination of 10%. The value of difference between the two kinds of diversities ($\Delta H''$) was illustrated (Fig. 3). The results show that each month one or more species could be found which dominated with a high organism number. Among these the one having a steadily negative ($\Delta H''$) value was the Catena viridis. On the figure based upon other considerations (Fig. 4) it can be seen that if the lowest diversity values characteristic of the months of May—June—July were combined with negative $\Delta H''$ values the results approached the state prevailing in lakes with balanced traffic of material.

During September because of the extraordinarily high organism number of *Achnanthes minutissima* Kütz. and the still significant organism number of *Catena viridis* the value of diversity was shifted to a great extent and the reduced diversity has not given an acceptable increase of value either.

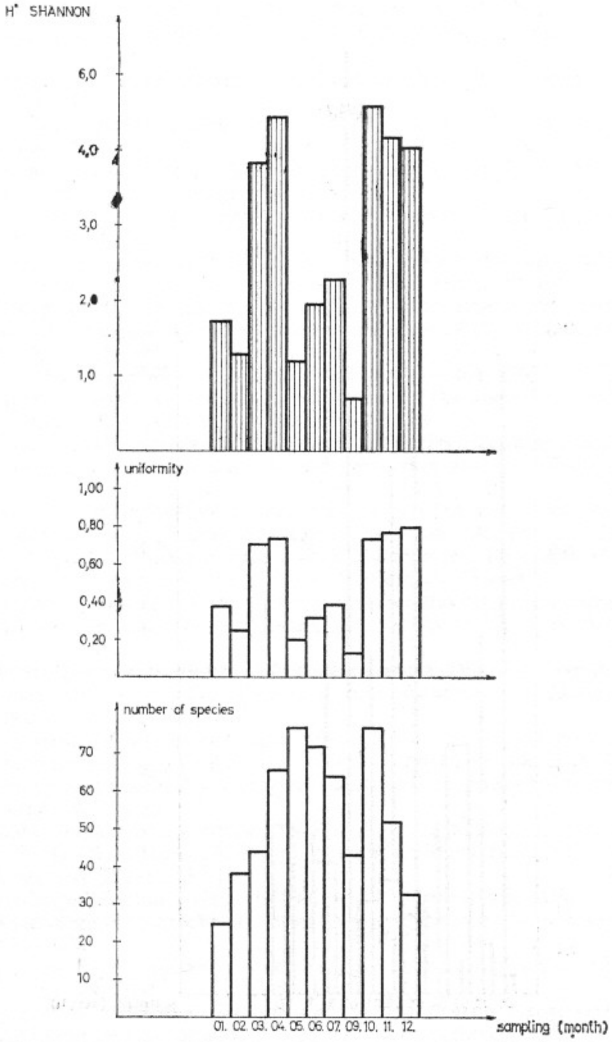


Fig. 5. Diversity of alga biomass

As next step diversity was calculated from biomass values of samples (Fig. 5) and a significantly more balanced change was experienced except for the sample taken in September. Applying DIVDROP method the negative $\Delta H''$ value obtained for *Achnanthes minutissima* significantly improved this shifted value; this way biomass determination proves to be important in establishing water quality especially in case if the domination of species appear with high organism number.

A-chlorophyll is a quantitative characteristic of phytoplankton as well but it is in a closer correlation with biomass (VÖRÖS 1984). The per cent rate change of chlorophyll contents of alga-biomass in samples of the backwater at Bokros is demonstrated in Fig. 6. In March the relatively highest chlorophyll contents could be observed alongside a minimal value of biomass; while in September just the opposite prevailed.

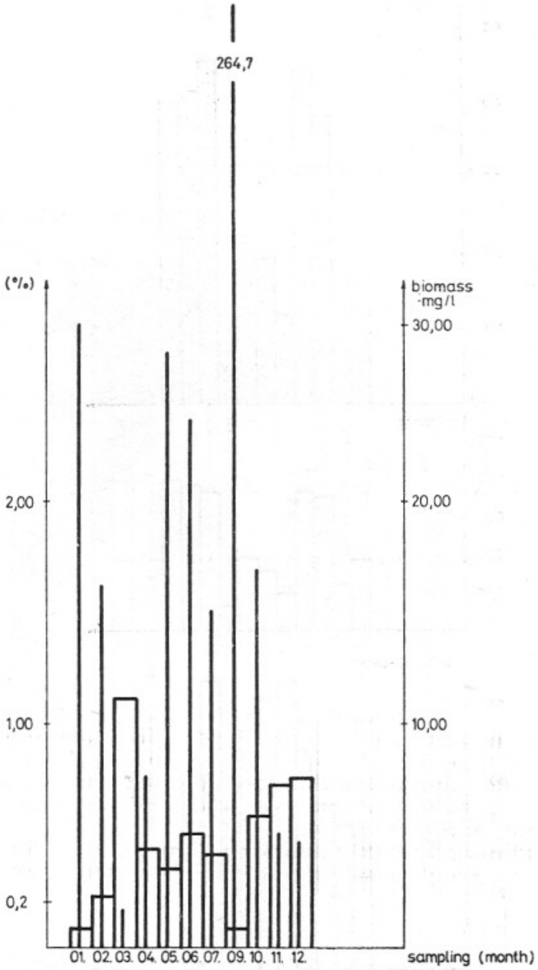


Fig. 6. Seasonal changes in the chlorophyll contents of alga biomass (%)

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A Bokrosi holtág fitoplanktonjának szezonális változása

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Alsótiszavidéki Vízügyi Igazgatóság Szeged

Kivonat

A bokrosi holtág a Tisza folyó 251 fkm-es szelvényében, a mentett (jobb) oldalon helyezdik el.

Az 1984. évi vizsgálatokat kiemelve a szerző megállapította a vizsgált víztér fitoplanktonjának szezonális változását a fajösszetétel és a populációk mennyisége alapján.

A havonta vett vízminták analízisének eredményét ábrázolta a mindenkori összesegyedszám százalékában kifejezve (Cyanophyta, Diatomae, Chlorophyta, egyéb). A holtág vízterére jellemző algák térfogata alapján számolt biomassza szezonális változását is értékelte.

A szerző a diverzitás módszerét alkalmazva keresett választ arra a kérdésre, hogy melyek azok a szervezetek, amelyek a diverzitás kicsi értékeit okozták. Ehhez a kiértékeléshez egy új módszert is (DIVDROP) felhasznált. Vizsgálatait kiegészítette a fitoplankton biomassza relatív klorofill tartalmának adataival.

Sezonsko promenjivanje fitoplanktona u mrtvaji Bokroš

DOBLER ENIKŐ
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Abstrakt

Mrtvaja Bokros na branjenoj (desnoj) obali Tise nalazi se na 261 rk. Na osnovu kvalitativnog i kvantitativnog sastava vrsta i populacija fitoplanktona istraživane vodene mase, autor je konstatovao njihovu izrazitu sezonsku promenu.

Rezultati mesečnih uzoraka prikazani su procentualno ukupnim brojem vrsta Cyanophyta, Diatomae, Chlorophyta. Procenjivanjem volumena karakterističnih algi mrtvaje izvršeno je i vrednovanje sezonskih promena biomase ispitivane deonice.

Autor je upotrebom metode diverziteta tražio odgovor i na pitanje: koji su ti organizmi, koji uzrokuju male vrednosti diverziteta. Za tu analizu korišćena je i nova metoda (DIVDROP). Istraživanja su kopletirana i podacima o relativnoj količini klorofila u biomasi fitoplanktona.

Сезонные изменения фитопланктона старицыБокроши

Энико Доблер
Водное Управление областей низовья Тисы, Сегед, Венгрия

Резюме

Старица Бокроши расположена в 251 километровом сегменте реки Тисы на охраняемом правом берегу.

Опираясь на исследования 1984 года, автор установил сезонное изменение фитоплантона исследуемого водного бассейна на основе видового состава и количества популяций.

Результаты анализа ежемесячно взятых проб воды автор выразил в процентах к общей численности особей (Cyanophyta, Diatomae, Chlorophyta, прочие). Анализировано сезонное изме нение биомассы, определенной исходя их объема характерных для водного бассейна старицы водорослей.

Методом дивергенции (диверзитета) автор выявил организмы, присутствие которых привело к малым значениям дивергенции. В ходе анализа применена новая методика (DIVDROP). Результаты исследований дополнены данными об условном содержании хлорофила в биомассе фитопланктона.

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SEASONAL DYNAMICS AND STRUCTURAL CHANGES IN THE CENOSES BELONGING TO THE PHRAGMITETEA ASSOCIATION CLASS AT LAKE SULYMOS

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Abstract

Cenological and seasonal dynamic studies were performed in the years 1985—86 at the area of the Kiskunság National Park, at Lake Sulymos running next to the Dead-Tisza at Lakitelek, in respect to the cenoses of marshy (Phragmition) and high sedgy (Magnocaricion) character.

In the initial phase of the Spring aspect, the preponderance of the Phragmition character associations is characteristic to the cenoses occurring in Lake Sulymos. High species diversity is manifest in the littoral zone, while towards the middle of the Lake the diversity shows a decrease and at the same time, there is an increase in the individual number of the species.

Correct interpretation of the seasonal dynamic as well as structural changes is possible based on the classification of the relevés. The zonality of the associations growing in the lake is only observable at the littoral zone. The development of the zonation is on the one hand caused by the relief relations of Lake Sulymos, the fluctuation of the water level and the trend of the water depth. On the other hand, it is defined by the ecological demand of the species forming the zonally appearing associations, as well as by the competition developing between them.

A succession series can be set up during the decomposition of the phytomass promoting the advancement of the eutrophication and siltation processes. According to the results the presumed succession series is: *Typhetum angustifoliae→Scirpo-Phragmitetum typhetosum→Scirpo-Phragmitetum phragmitetosum→Glycerietum maximae→Caricetum gracilis*.

The trend of the succession corresponds to the direction of the shift of the R-characteristic indicator value, it is therefore presumable that the acidity relations within the biotope have determinative significance. Based on the T, W and N-characteristic indicator values, the results of the vegetation dynamic studies can well be interpreted.

Introduction

According to the data of the potential vegetation maps about 2—4% of the Hungarian territory is covered with reeds (HORTOBÁGYI and SIMON 1981). The associations of Phragmitetea character play an important role in the protection of the aquatic ecosystems (TÓTH and SZABÓ 1962, FELFÖLDY 1986). In the course of the years human impacts have increasingly enhanced the eutrophication of our natural waters. This process is worsened by the disintegration of the reed banks growing at the side of the lakes and playing role as the closing association of the aquatic series, and as a consequence, by the establishment of foreign species, leading to the steady degradation of these communities (FELFÖLDY 1981). Among numerous natural and ecological factors, the formation of the zonation of the Phragmitetea associations is mainly determined by the development of the bank-profile and the distribution according to water demand (SEBESTYÉN 1963). The competition between the species bears great significance in the development of the zonation (BUTTERY and LAMBERT 1965).

A correct interpretation of the seasonal dynamic and structural changes of the Phragmitetea-like cenoses can be achieved with the help of the characteristic indicator values. As a result, the trend of the succession processes is traceable within the biotope depending on the degree of the eutrophication as well as the advancement of the siltation processes. Based on the classification and ordination of the relevés, conclusions can also be drawn in respect to the degree of similarity — in the statistical sense — of the different cenoses as well as regarding the environmental effects prevailing at the time of the development of the association zonations.

The studies were performed at Lake Sulymos located at the area of the KNP. According to water area-typology category the lake is of „Fertő" type (DÉVAI 1976). Its water turnover is of semistatic character. Open water surface is only observable at the beginning of the vegetation period. The enhanced marshy character of the lake is indicated by the closed stands of Phragmition and Magnocaricion cenoses found along the bank in ca. 30—50 m width.

Materials and Methods

The cenological and seasonal dynamic analysis of the higher marsh-plants found a Lake Sulymos located at the area of the Kiskunság National Park South to Tőserdő was performed in the years 1985—86. The relevés were taken monthly during the vegetation period. The results are demonstrated in a cenological table, giving the relative part-coverage of the different cenoses as well as the covering values for the populations in percentage. The cenosystematic classification of the different associations was done according to the manual of Soó (1978, 1980). The data regarding the life form of the species of the cenoses were considered on the basis of the works of ELLENBERG (1952), Soó (1980) and HUTCHINSON (1975). During the appreciation of the results, the similarity of the relevés was defined with the help of the Czekanowski-index (CZEKANOWSKI 1909), the reductions were performed using the "group average" method (PODANI 1979, 1980). The ordination of the relevés was accomplished by means of the Centroid analysis (JAHN and VAHLE 1974, LAWLEY and MAXWELL 1971, FEKETE 1981). The Sörensen-index was used for the comparison of the associations according to species composition (HORTOBÁGYI and SIMON 1981).

The indicator values (N, T, R) elaborated by ZÓLYOMI and his co-workers served as basis for the classification and ordination of the characteristic indicator values (ZÓLYOMI et *al*. 1967, Soó 1980). The "group average" reduction technique was used, starting from the similarity matrix calculated with the Renkonnen-index on the basis of the reduced part-coverage values of the plant species characterized by identical indicator values (BAGI 1984, SZALMA 1986).

The hydroecological appreciation of the cenoses (W-characteristic indicator value) was based on the work of Gy. Bodrogközy comprising 30 hydroecological categories (BODROGKÖZY 1982).

Results

According to the relevés taken in the Spring, Summer and Autumn aspects of the vegetation periods in the years 1985—86, 53 plant species were found at the area These are listed in Table 1. according to life form, cenosystematic classification and characteristic indicator values.

The cenoses occurring in Lake Sulymos are characterized by the preponderance of the Phragmition character associations at the initial stage. These are the following associations and subassociations: *Caricetum gracilis, Glycerietum maximae, Scirpo-Phragmitetum phragmitetosum, Scirpo-Phragmitetum typhetosum;* at places *schoenoplectetosum-, Typhetum angustifoliae.*

Table 1. *Cenosystematic classification, life form and indicator values of the species found at the region of Lake Sulymos in 1985—86*

Specific name		Hydroecol. category		Life form	R	T	W	N
1. *Hydrocharis morsus-ranae*	Lemno-Potamea	Hydatophyta	hd_1	MH	6	6	10	6
2. *Riccia fluitans*			hd_1	HH				
3. *Salvinia natans*	Hydrocharicion		hd_1	HH	0	8	10	6
4. *Lemna trisulca*	Lemno-Potamea		hd_2	HH	8	6	10	6
5. *Utricularia vulgaris*			hd_2	HH	5	4	10	6
6. *Potamogeton lucens*	Potamion		hd_2	HH	8	6	10	8
7. *Polygonum amph. v. aquat.*	Phragmitetea		hd_3	G-HH	0	0	8	7
8. *Stratiotes aloides*			hd_3	M-H	6	6	10	7
9. *Nuphar lutea*			hd_3	HH	5	6	10	0
10. *Hottonia palustris*		Hydato-helophyta	hhe_1	HH	6	6	10	4
11. *Sparganium erectum*			hhe_1	HH	0	6	10	5
12. *Schoenoplectus lacustris*	Phragmition		hhe_2	HH-G	7	0	9	5
13. *Butomus umbellatus*	Phragmitetea		hhe_2	HH	0	6	10	7
14. *Rumex hydrolapathum*			hhe_3	H-HH	7	6	8	7
15. *Alisma plantago-aquatica*	Phragmitetea		hhe_3	HH	0	0	10	7
16. *Saggitaria sagittifolia*	Phragmition		hhe_3	HH	7	6	10	6
17. *Iris pseudacorus*	Phragmitetea		hhe_3	G	0	4	9	7
18. *Glyceria maxima*	Phragmition		hhe_3	G-HH	7	6	9	7
19. *Bolboscoenus maritimus*	Bolboschoenion		hhe_3	HH-G	7	0	8	6
20. *Oenanthe aquatica*	Phragmitetalia	Helophyta	he_1	HH	0	6	10	5
21. *Phragmites australis*	Phragmitetea		he_1	HH	7	0	0	5
22. *Typha angustifolia*	Phragmitetea		he_1	HH	0	0	10	7
23. *Carex gracilis*	Magnocarcion		he_1	HH	6	5	8	5

Table 1.

Specific name		Hydroecol. category		Life form	R	T	W	N
24. *C. vulpina*			he$_1$	H-HH	6	6	8	5
25. *C. elata*			he$_1$	HH	6	6	8	4
26. *C. pseudocyperus*			he$_1$	HH	7	6	8	5
27. *C. flacca*			he$_1$	G	9	6	0	6
28. *C. riparia*			he$_1$	HH	8	6	8	5
29. *Equisetum palustre*			he$_2$	G	0	2	9	1
30. *Lycopus exaltatus*	Phragmitetea		he$_2$	HH	7	6	9	6
31. *Lysimachia vulgaris*	Molino-Juncetea		he$_2$	HH	0	4	7	0
32. *Stachys palustris*	Phragmitetea		he$_2$	H	7	4	10	6
33. *Sium latifolium*	Phragmition		he$_2$	HH	7	6	10	6
34. *Rorippa amphibia*	Phragmitetea		he$_2$-	HH	7	6	9	7
35. *Mentha aquatica*	Phragmitetalia		he$_2$	H-HH	7	6	9	5
36. *Euphorbia palustris*	Molinion		he$_2$	H-HH	8	6	9	5
37. *Urtica kioviensis*			he$_2$	H	6	8	8	6
38. *Lytrum salicaria*	Molinion-Juncetea	Helohygrophyta	hhg$_1$	H-HH	0	4	8	5
39. *Juncus compressus*	Agrostion		hhg$_3$	G	8	6	8	6
40. *Symphytum officinale*	Molinetalia	Hygrophyta	hg$_1$	H	0	4	9	7
41. *Galium palustre*			hg$_2$	H	0	4	10	5
42. *Calystegia sepium*	Phragmitetea		hg$_2$	H	6	6	8	8
43. *Galium aparine*		Hygromesophyta	hgm$_1$	Th	0	4	7	9
44. *Polygonum lapatifolium*	Polygonion-Chenopodion		hgm$_3$	Th	0	0	7	7
45. *Cardamine amara*			hgm$_3$	H	6	4	8	5
46. *Leersia oryzoides*			hgm$_3$	HH	0	6	9	7
47. *Solanum dulcamara*			hgm$_3$	Ch	0	6	9	7
48. *Geranium robertianum*			hgm$_3$	H	0	0	6	7
49. *Juncus articulatus*			hgm$_3$	H	0	0	8	3
50. *Leucojum aestivum*			hgm$_3$	G	8	8	7	5
51. *Amorpha fruticosa*	Calystegion-Bidentetea	Mesophyta	m$_1$	M	0	6	7	5
52. *Salix fragilis*			m$_2$	M-MM	6	6	8	6

After this, the appearance and closure of the reed-grass associations characteristic to the end of the Spring and Summer aspects are observable. At the littoral zone high species-individual diversity is a characteristic phenomenon, while towards the middle of the lake there is a decrease in the diversity of the species composition regarding certain zones. Contrary to the decrease in diversity, an increase in individual number can be experienced (SZALMA 1986). Based on the results of the relevés, it can be concluded that the distribution and appearance within biotope of certain character cenoses can be typified according to the relief relations and the water depth of Lake Sulymos (Fig. 1).

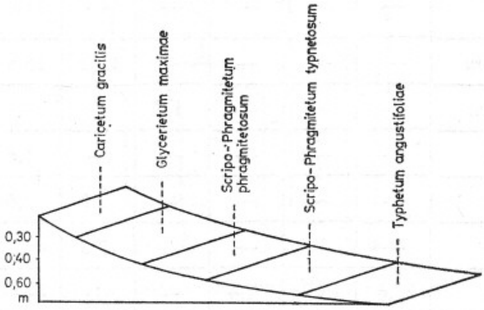

Fig. 1. Zonation of the cenoses belonging to the Phragmitetea association at Lake Sulymos

In the cours of the phytomass decomposition promoting the eutrophication and siltation processes of the lake (MASON and BRYANT 1975), a succession series can be set up which — as assumable from the results — is the following: *Typhetum angustifoliae→Scirpo-Phragmitetum typhetosum→Scirpo-Phragmitetum phragmitetosum→Glycerietum maximae→Caricetum gracilis.*

Classification and ordination of the relevés

Fig. 2. demonstrates the dendogram obtained during the clasisfication based on the covering values of the relevés shown in Table 2. According to the dendogram, the relevés can be divided into 4 well distinguishable groups. In the first group

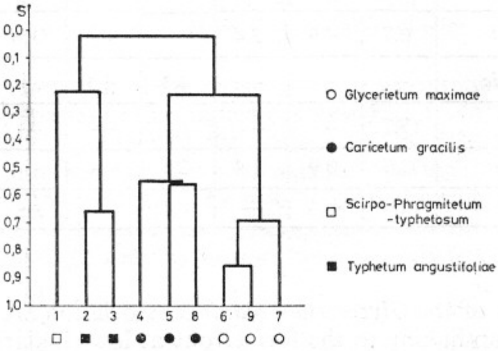

Fig. 2. Dendogram of the classification based on the relevés of July 17, 1985

Table 2. *July, 17. 1985*

Serial number of the stands	1	2	3	4	5	6	7	8	9
Total coverage	60	80	80	85	80	70	60	90	85
1. *Potamogeton lucens*	—	—	—	—	—	—	15	—	—
2. *Polygonum amphibium*	—	—	—	—	3,2	3,5	7	—	3
3. *Hottonia palustris*	+	+	1,4	—	+	+	10	—	—
4. *Schoenoplectus lacustris*	—	—	—	—	—	1,6	3	—	—
5. *Rumex hydrolapathum*	—	—	—	+	12,2	15,6	4	2,5	8,7
6. *Alisma plant.-aquatica*	—	—	—	1,2	+	—	—	0,5	—
7. *Sagitaria sagittifolia*	—	—	—	—	—	1,6	—	—	—
8. *Iris pseudacorus*	—	—	—	9,1	7,2	2,6	+	29,5	1
9. *Glyceria maxima*	—	—	—	+	22,3	65,4	61	7,5	68,6
10. *Phragmites australis*	27,6	13,8	1,4	—	—	—	—	—	—
11. *Typha angustifolia*	2,7	58,8	90,4	—	—	—	—	—	—
12. *Carex gracilis*	—	—	—	54,1	42,3	6,5	—	29,5	13,7
13. *Carex riparia*	17,6	8,9	—	—	—	—	—	—	—
14. *Carex elata*	17,6	3,9	—	—	—	—	—	—	—
15. *Lycopus exaltatus*	—	—	—	2,1	—	—	—	3,5	—
16. *Lysimachia vulgaris*	—	—	—	—	+	1,6	—	2,5	—
17. *Stachys palustris*	—	—	—	+	3,3	—	—	0,5	+
18. *Sium latifolium*	—	—	—	2,1	5,2	—	—	4,5	3
19. *Mentha aquatica*	—	—	—	5,1	+	—	—	0,5	—
20. *Euphorbia palustris*	0,7	—	—	—	—	—	—	—	—
21. *Urtica kioviensis*	0,7	4,9	5,4	—	+	1,6	—	—	1
22. *Symphytum officinale*	+	—	—	6,1	4,3	+	—	14,5	1
23. *Galium palustre*	17,7	—	—	—	—	—	—	—	—
24. *Solanum dulcamara*	2,7	0,9	1,4	2,1	—	+	—	—	—
25. *Amorpha fruticosa*	12,7	8,8	—	18,1	+	—	—	4,5	+

(6., 9., 7) the relevés of the *Glycerietum maxima* association are linked at high similarity level. The group linking to the former one at low similarity level (4., 5., 8) is formed by the relevés belonging to the *Caricetum gracilis* association.

The group consisting of the relevés originating from the *Typhetum angustifoliae* (2., 3) association is segregated from the former. The *Scirpo-Phragmitetum typhetosum* subassociation (1) is linked to these groups at rather low similarity level. The results of the classification regarding the relevés taken in the Autumn aspect of the vegetation period are demonstrated in Fig. 3.

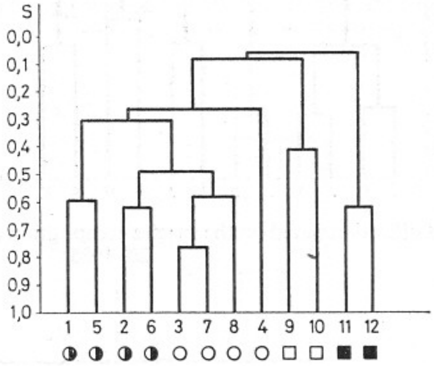

Fig. 3. Dendogram of the classification based on the relevés of October 20, 1985

The stands of the *Typhetum angustifoliae* (11., 12) and separately of the *Scirpo-Phragmitetum typhetosum* subassociations form a well distinguishable cluster core in the dendogram. Segregated from these two groups, another group is formed by the stands of the *Glycerietum maximae* (3., 8., 7., 4) association as well as *Glycerietum maximae caricetosum* (1., 5., 2., 6) subassociation. The differing similarity levels within group are partly caused by the fact that the different relevés originate from different water depths. As a consequence, two cores are separable within the *Glycerietum maximae caricetosum* subassociation (1., 5. and 2., 6). The 1. and 5. relevés derive from the epilittoral grade of the paralimnolittoral zone, where the *Amorpha fruticosa* foreign to the community occurs with a relatively high covering quota. The 2. and 6. relevés originate from the area of the supralittoral grade.

A good comparison is possible between the dendogram obtained during the classification based on the species composition of the different cenoses and the dendogram of the classification based on the covering quota of the relevés. Thus, supporting the previous results, the cenoses can be classified according to species composition and structure, and they form as well distinguishable cluster core in the dendogram (Fig. 4).

Studying the dendograms of the classification based on the covering quota values in the relevés for the species of the studied cenoses (Fig. 5—6), the changes in species composition and covering quota of the cenoses can be followed with attention in the course of the Summer and Autumn aspects. During the appreciation of the different cluster cores the species of the zonally located cenoses were found to form groups and were well distinguishable. The species of transitional character foreign to the community linked to these groups at low similarity level.

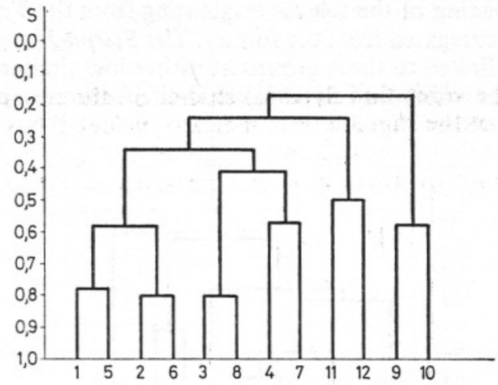

Fig. 4. Dendogram of the classification based on the species composition of the relevés from October 20, 1985

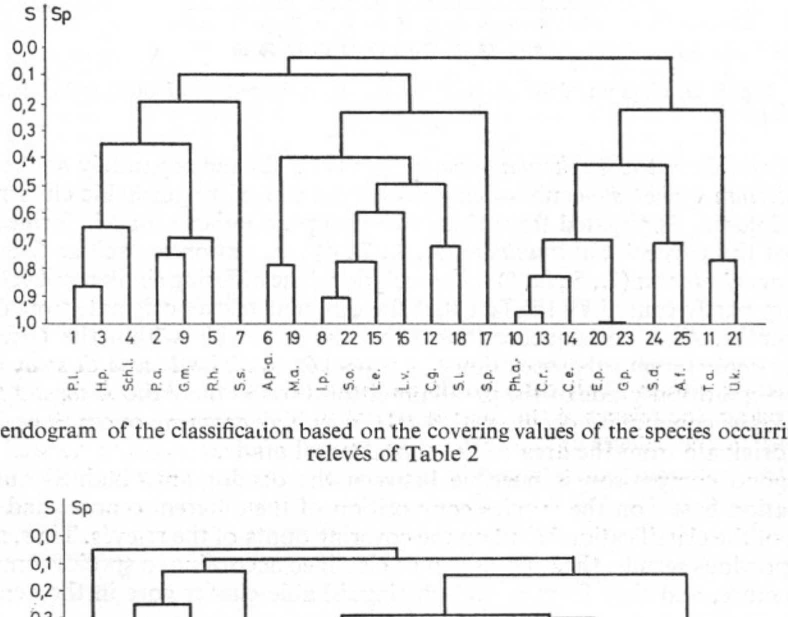

Fig. 5. Dendogram of the classificauon based on the covering values of the species occurring ni teh relevés of Table 2

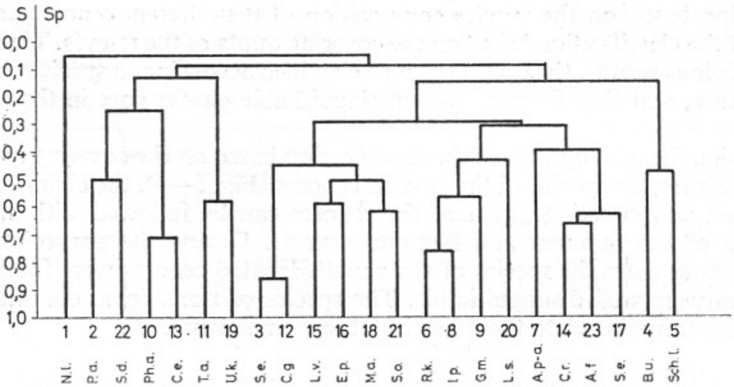

Fig. 6. Dendogram of the classification based on the covering values of the species occurring in the relevés of September 5, 1986

Classification and ordination according to the characteristic indicator values

The results of the vegetation dynamic studies on the cenoses can well be interpreted with the help of the characteristic indicator values (HEJNY 1960, BAGI 1985). The dendogram of the classification based on the T-characteristic indicator values obtained for the relevés of Table 2. is demonstrated in Fig. 7. Great similarity is manifest to the dendogram of the classification based on the relevés, on the basis of which it is assumable that temperature demand belongs to the primary determinative factors in the appearance of the character species of the cenoses at the time of the Spring aspect. In the later relevés, however, the N-demand, acidity relations and the hydroecological demand play emphasized role within the cenoses in the development of he plant populations. It is apparent from the results of the classification based on the N-characteristic indicator values that the character cenoses within the biotope form separate groups easily distinguishable from each other. According to their nitrogen demand, the relevés of the clear stands of the *Glycerietum maximae* association are linked to the relevés of the *Typhetum angustifoliae* association as well as the *Glycerietum maximae caricetosum* subassociation. On the contrary, the fact that the clear stands of the *Glyceria maxima* and the *Typha angustifolia* populations do not, or only partially mix with each other is explained by the competition being present between them (BUTTERY and LAMBERT, 1965) (Fig. 8).

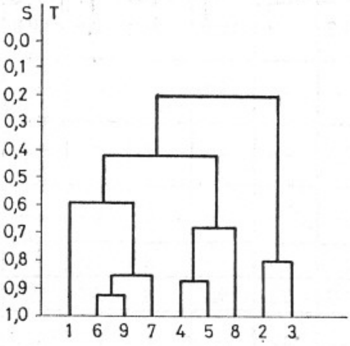

Fig. 7. Dendogram of the classification based on the T-characteristic indicator values of the relevés of July 17, 1985

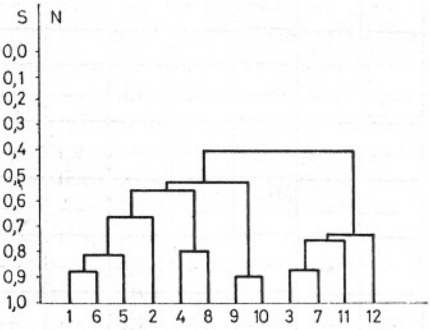

Fig. 8. Dendogram of the classification based on the N-characteristic indicator values of the relevés of October 20, 1985

Table 3. *Oct., 20. 1985*

Serial number of the stands	1	2	3	4	5	6	7	8	9	10	11	12
Total coverage	60	75	70	30	30	80	60	40	15	90	90	50
1. *Stratiotes aloides*	—	—	—	—	—	—	—	—	—	—	—	8
2. *Nuphar lutea*	—	—	—	21,9	—	—	—	18,8	—	—	—	30
3. *Hottonia palustris*	—	4,3	9	16,9	—	1,6	11,8	13,8	—	3,2	4,3	2
4. *Schoenoplectus lacustris*	—	—	—	9,8	—	—	—	13,8	—	—	—	—
5. *Rumex hydrolapathum*	9,8	7,3	—	—	5	2,6	9,8	—	—	—	—	—
6. *Alisma plant.-aquatica*	1,8	—	—	—	4	—	—	—	—	—	—	—
7. *Iris pseudacorus*	—	11	—	—	8	1,6	—	—	—	—	—	—
8. *Glyceria maxima*	29,8	43,3	73	9,8	8	35,6	58,8	34	—	—	—	—
9. *Phragmites australis*	—	—	—	—	—	—	—	—	19,2	27,2	—	—
10. *Typha angustifolia*	—	—	—	—	7,7	—	—	—	—	12	91,4	60
11. *Carex gracilis*	—	8,3	—	9,8	8	35,6	—	—	—	—	—	—
12. *Carex elata*	—	—	—	—	—	—	—	—	16,2	32,2	—	—
13. *Lycopus exaltatus*	1,8	—	—	8,7	4	1,6	—	—	—	—	—	—
14. *Lysimachia vulgaris*	—	4,3	9	—	—	3,6	—	9,8	—	—	—	—
15. *Stachys palustris*	1,8	—	—	—	4	1,6	—	—	—	—	—	—
16. *Sium latifolium*	—	4,3	—	—	—	1,6	—	—	—	—	—	—
17. *Mentha aquatica*	2,7	—	—	—	5	1,6	—	—	—	—	—	—
18. *Euphorbia palustris*	—	—	—	—	—	—	—	—	—	4,2	—	—
19. *Urtica kioviensis*	5,7	—	—	7,7	4	1,6	—	—	—	3,2	4,3	—
20. *Lytrum salicaria*	—	4,3	9	—	4	5,6	9,8	9,8	—	4,2	—	—
21. *Symphytum officinale*	—	—	—	—	—	—	—	—	12,2	3,2	—	—
22. *Galium palustre*	—	4,3	—	—	5	+	—	—	—	—	—	—
23. *Calystegia sepium*	—	4,3	—	—	4	1,6	—	—	—	—	—	—
24. *Polygonum lapatifolium*	—	—	—	7,7	—	—	9,8	—	—	—	—	—
25. *Cardamine amara*	—	—	—	—	—	—	—	—	+	3,2	—	—
26. *Solanum dulcamara*	1,8	—	—	—	4	2,6	—	—	—	4,2	+	—
27. *Amorpha fruticosa*	44,8	4,3	—	—	33	1,6	—	—	26,2	3,2	—	—

Fig. 9. shows the ordination analysis of the relevés of Table 4. Sharply segregated groups are detectable on the diagram along the I. and II. axis. These groups are formed by the *Typhetum angustifoliae* (11., 12.), *Scirpo-Phragmietum typhetosum* (13), *Glycerietum maximae caricetosum* (7., 8), *Caricetum gracilis* (1) and the *Glycerietum maximae* (10., 2., 9., 4., 5., 6) associations. The groups can be placed beside each other at the I. axis, which can be compared with the direction of succession series of the Phragmitetea cenoses.

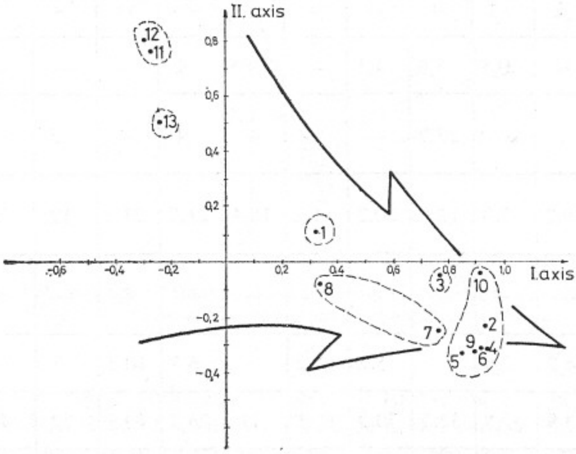

Fig. 9. Diagram of the ordination based on the relevés of September 5, 1986. Arrow indicates the trend (possible shift) of the succession for the different groups

According to the obtained data, the zonation of the cenoses and, as a consequence, the trend of the succession are determined by the R and W characteristic indicator values in case of the cenoses at Lake Sulymos belonging to the Phragmitetea association class. Studying the clusters formed on the dendogram shown in Fig. 5. (the dendogram of the classification based on the covering values of the species occurring in the relevés of July 17, 1985), it could be seen that the cluster cores correspond to the zonally located cenoses. The species belonging to identical or close to identical hydroecological groups were found to aggregate in the cluster cores. In the present case it was not expediential to classify the populations based on the conventional W-characteristic indicator values elaborated by ZÓLYOMI ET *al.* (1967); instead the system developed by BODROGKÖZY was used, distinguishing 3—3 subunits of these indicator values within 10 categories (BODROGKÖZY 1982). The species forming the first group were mainly those growing at the littoral zone, belonging to the hydatophyta 2 and 3, hydato-helophyta 1—3 categories. The second group was firstly composed of helophyta 1—2 species, the third again of helophyta 1—2 species — but here the hygrophyta 2, hygro-mesophyta 3 and mesophyta 1 species also appeared. These species are firstly found at the paralimnolittoral zone. The zonations are well separable from each other, in conformity with the non-constant and constant inundation.

A relationship is manifest between the ordination of the relevés of Table 3 and the W-characteristic indicator values of the different cenoses. On the diagram a W straight line can be drawn for the relevés (Fig. 10), and by letting a perpendicular

Table 4. *Sept., 5. 1986*

Serial number of the stands	1	2	3	4	5	6	7	8	9	10	11	12	13
Total coverge	70	80	75	95	65	85	85	95	65	80	70	70	60
1. *Nuphar lutea*	—	—	—	—	5,2	+	—	—	7	—	—	—	—
2. *Polygonum amphibium*	—	—	—	+	0,1	7,6	11,7	—	—	1	—	—	—
3. *Sparganium erectum*	1,2	1	+	—	—	—	—	+	—	1	+	—	—
4. *Butomus umbellatus*	+	0,5	3,6	1,1	—	0,6	2	—	—	—	—	—	—
5. *Schoenoplectus lacustris*	+	—	22,7	—	+	—	1	+	3	—	—	—	—
6. *Rumex hydrolapathum*	9,2	7,9	12,6	20,2	1,2	15,4	21,7	23,5	12	16	—	—	—
7. *Alisma plantago-aquatica*	—	+	+	+	—	—	—	4,3	—	1	—	—	—
8. *Iris pseudacorus*	4,2	2,9	—	5,2	1,2	+	6,7	10,5	3	6	—	—	—
9. *Glyceria maxima*	3,9	32,8	32,7	70,2	80,1	71	26,7	10,5	72	42	—	—	—
10. *Phragmites australis*	—	—	—	—	—	—	—	—	—	—	—	7,3	18
11. *Typha angustifolia*	—	—	—	—	—	—	—	—	—	—	92,6	32,3	23
12. *Carex gracilis*	29,1	12,8	3,6	1,1	—	2,5	—	—	—	24	—	—	—
13. *Carex elata*	—	—	—	—	—	—	—	—	—	—	—	—	23
14. *Carex riparia*	2,2	2,4	+	—	—	—	16,7	28,6	—	—	—	—	28
15. *Lysimachia vulgaris*	19,1	4,9	17,6	2,2	—	1,7	1,9	10,5	—	5	3,7	—	—
16. *Equisetum palustre*	9	1,4	3,6	+	—	—	5,7	0,8	—	—	—	—	—
17. *Sium latifolium*	—	0,5	—	—	—	—	—	1,3	—	1	—	—	1
18. *Mentha aquatica*	0,2	—	—	—	—	—	—	0,3	—	—	—	—	—
19. *Urtica kioviensis*	—	—	3,5	—	2,2	—	2	+	—	—	3,7	10,4	—
20. *Lytrum salicaria*	0,2	—	+	—	—	—	1	0,8	3	2	—	—	—
21. *Symphytum officinale*	13,5	2,4	+	—	—	—	1,9	5,5	—	—	—	—	1
22. *Solanum dulcamara*	—	—	—	+	—	—	1	—	—	+	—	—	1
23. *Amorpha fruticosa*	3,2	0,5	—	—	—	—	+	3,3	+	1	—	+	5

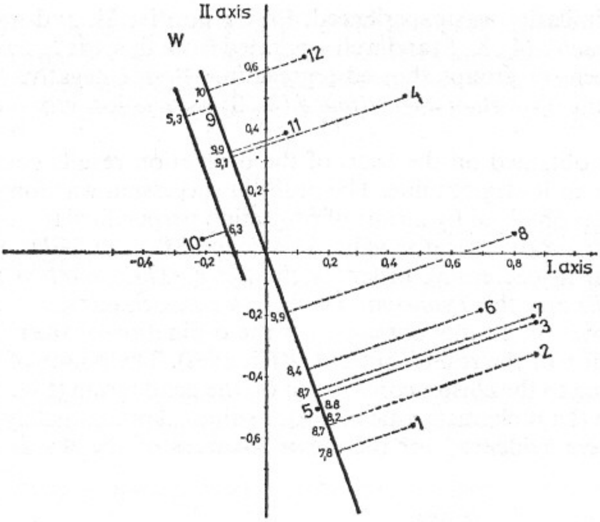

Fig. 10. Relationship between the ordination based on the relevés from October 20, 1985 and the W-characteristic indicator values of the different stands

fall on this from the object (relevés), the arising foot-ends can be ranged in order of magnitude. Based on this the zonation of the character cenoses is easily classifiable, which is related to the raise in water depth and the fluctuation of the inundation. In case of two objects (10., 9) negative deviation was found in the direction of the straight line. These two objects were formed by the stands of the *Scirpo-Phragmitetum* association. This result can be explained by the wide ecological amplitude of the *Phragmites australis* species (BJÖRK 1967). Fig. 11 demonstrates the diagram for the ordination of the stands of the 2. cenological table. Comparing the groups formed along the II.—III. axis of the diagram with the dendogram of the classification of the relevés

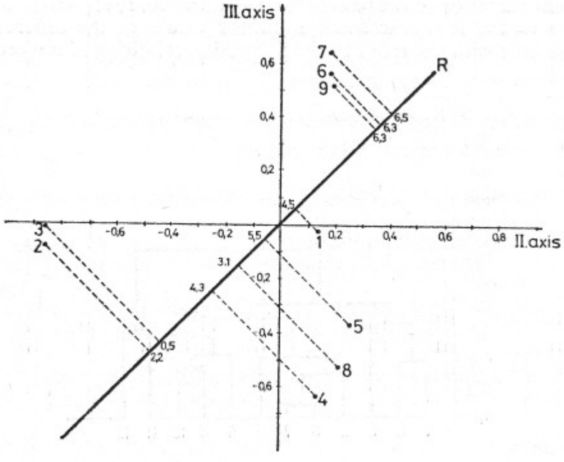

Fig. 11. Relationship between the ordination based on the relevés from July 17, 1985 and the R-characteristic indicator values of the cenoses

(Fig. 2), great similarity was experienced. Beside positive II. and negative III. axis, the *Caricetum gracilis* (4., 8., 5) and well separated from this, the *Scirpo-Phragmitetum typhetosum* (1) cenosis groups showed segregation. Beside negative II. and negative III. axis-values the *Typhetum angustifoliae* (2., 3) association group could be distinguished.

The objects obtained on the basis of the ordination results could be ranged in succession along an R-straight line. The order of succession was formed by the foot-ends of the objects obtained by means of projection perpendicularly on the R straight line. The highest mean indicator value was manifest in the *Glycerietum maximae* cenosis, followed in decreasing order by the *Scirpo-Phragmitetum typhetosum*, the *Caricetum gracilis* and the *Typhetum angustifoliae* associations.

Fig. 12. shows the results obtained for the ordination of the relevés of Table 3 (with consideration of the results of the I.—III. axes). The points of the stands were grouped according to the cluster cores found on the dendogram (Fig. 13) of the classification based on the R characteristic indicator values. Approximately identical orders of magnitude were evidenced for the mean R-values of the stands in the different

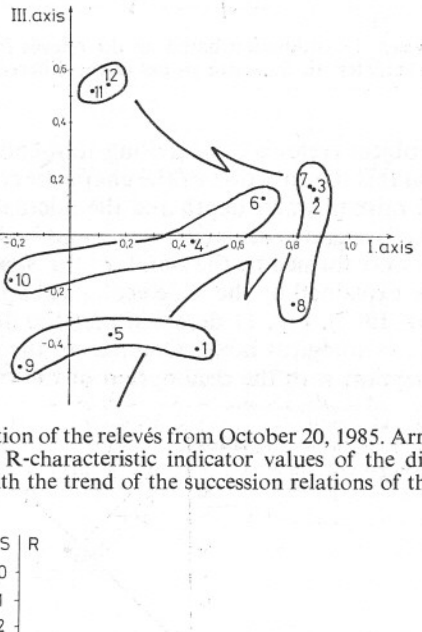

Fig. 12. Diagram of the ordination of the relevés from October 20, 1985. Arrow indicates the direction of the shift according to the R-characteristic indicator values of the different cenoses, which is comparable with the trend of the succession relations of the cenoses

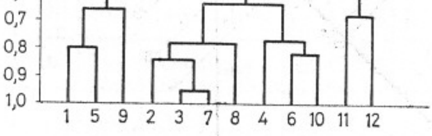

Fig. 13. Dendogram of the classification based on the R-characteristic indicator values of the relevés from October 20, 1985

groups. Examination of the mean R—values of the groups revealed an increase according to order of magnitude along the I. axis, the trend and order of which could be compared with that of the succession of the cenoses. The observed increase is indicated on the Figure by the direction of the arrow.

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Legend

◐ — *Glycerietum maximae caricetosum*
○ — *Glycerietum maximae*
□ — *Scirpo-Phragmitetum typhetosum*
■ — *Typhetum angustifoliae*
● — *Caricetum gracilis*
N. l. — *Nuphar lutea*
P. a. — *Polygonum amphibium var. aquaticum*
Ph. a. — *Phragmites australis*
C. e. — *Carex elata*
T. a. — *Typha angustifolia*
U. k. — *Urtica kioviensis*
S. e. — *Sparganium erectum*
C. g. — *Carex gracilis*
L. v. — *Lysimachia vulgaris*
M. a. — *Mentha aquatica*
E. p. — *Euphorbia palustris*
S. o. — *Symphytum officinale*
R. h. — *Rumex hydrolapathum*
I. p. — *Iris pseudacorus*
G. m. — *Glyceria maxima*
L. s. — *Lytrum salicaria*
A. p-a. — *Alisma plantago-aquatica*
C. r. — *Carex riparia*
A. f. — *Amorpha fruticosa*
S. l. — *Sium latifolium*
D. u. — *Butomus umbellatus*
Sch. l. — *Schoenoplectus lacustris*
S. a. — *Stratiotes aloides*
H. p. — *Hottonia palustris*
S. p. — *Stachys palustris*
S. d. — *Solanum dulcamara*
L. e. — *Lycopus exaltatus*
C. s. — *Calystegia sepium*
G. a. — *Galium aparine*
C. a. — *Cardamine amara*
F. o. — *Fraxinus* sp.
P. l. — *Potamogeton lucens*
G. p. — *Galium palustre*
S. s. — *Sagittaria sagittifolia*

A Sulymos-tó Phragmitetea asszociáció osztályba tartozó cönózisainak szezonális dinamikai és strukturális változásai

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Kivonat

A Kiskunsági Nemzeti Park területén, a lakiteleki Holt-Tisza mellett húzódó Sulymos-tó mocsári (Phragmition) és magassásos (Magnocaricion) karakter cönózisainak cönológiai és szezonális dinamikai vizsgálatát 1985—86. évben végeztük.

A Sulymos-tóban előforduló cönózisokra, a tavaszi aszpektus iniciális fázisában a Phragmition karakter asszociációk túlsúlya a jellemző. A litorális övben a fajok nagy diverzitását figyelhetjük meg, ezzel szemben a tó közepe felé haladva a diverzitás csökkenését, s vele egyidőben a fajok egyedszámának növekedését tapasztalhatjuk.

A cönológiai felvételek klasszifikációja alapján az egyes cönózisok szezonális dinamikai strukturális változásai jól értelmezhetők. A tóban tenyésző asszociációk zonalitását csak a partmenti régióban figyelhetjük meg. A zonáció kialakulását egyrészt a Sulymos-tó domborzati viszonyai a vízszint ingadozása, a vízmélység alakulása okozza. Másrészt a zonálisan megjelenő asszociációkat alkotó fajok ökológiai igénye, s a közöttük kialakuló kompetíció határozza meg.

A eutrofizációs és feltöltődési folyamatok előrehaladtát elősegítő fitomassza dekompozíciója során szukcessziós sor állítható fel. Az eredményekből feltételezett szukcessziós sor: *Typhetum angustifoliae→Scirpo-Phragmitetum typhetosum→Scirpo-Phragmitetum phragmitetosum→Glycerietum maximae→Caricetum gracilis.*

Sezonsko-dinamične i strukturne promene svakog cenozisa koje pripadaju asocijaciji phragmitetea jezera Šuljmoš

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Abstrakt

U 1985—85. godini vršena su cenotička ispitivanja jezera Sulymos kraj mrtvaje Tise Lakitelek na području Nacionalnog parka Kiskunság, u močvarnim (Phragmition i Magnocarition) zajednicama u sezonskom aspektu. U jezeru Sulymos od zajednica prolećnu inicijalnu fazu karakteriše pretežno asocijacija Phragmition. U litoralnoj zoni utvrdjen je veliki diverzitet vrsta, nasuprot sredini jezera, gde se diverzitet smanjuje a broj jedinki pojedinih vrsta povećava.

Klasifikacija cenotičkih snimaka ukazuje na dinamiku strukturalnih promena u datim zajednicama u sezonskom aspektu. Zonalnost asocijacija je uočljiva samo u priobalnoj zoni jezera. Zonalnost je uslovljena delom promenama vodostaja, dubinom vode i konfiguracijom jezera. S druge strane ona je odredjena ekološkim zahtevima i kompeticijom vrsta datih asocijacija.

Dekompozicija fitocenoza ubrzava proces eutrofizacije i nasipavanja, pri čemu je moguće uspostaviti sledeći sukcesivni niz: *Thyphetum angustifoliae→Scirpo-Phragmitetum typhetosum→→Scirpo-Phragmitetum phragmitetosum→Glycerietum maximae→Caricetum gracilis.*

Сезонные динамические и структурные изменения биоценозов класса ассоциаций Phragmitetea озера Шуймош

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Резюме

В 1985—1986 годах проведены ценологические и сезонно-динамические исследования биоценозов болот (Phragmition) и пойменных лугов (Magnocarition) озера Шуймош, находящегося рядом со старицей Тисы вблизи Лакителек на территории Национального парка «Кишкуншаг».

В самый характерный период весны в биоценозах озера Шуймош преобладают ассоциации типа Phragmition. В прибрежном поясе наблюдается большое разнообразие признаков (дивергенция) видов. Приближаясь к центру озера, при увеличении численности особей по видам уменьшается дивергенция видов.

Исходя из классификации ценологических съемок, рассмотрены сезонно-динамические и структурные изменения отдельных биоценозов. Разделение на зоны ассоциаций в озере наблюдается только в прибрежном районе. Возникновение зон обусловлено рельефом дна, колебаниями уровня воды, изменениями глубины озера Шуймош, а также экологическими потребностями видов, образующих сообщества по зонам, и взаимоотношениями между ними.

В результате разложения фитомассы, способствующей ускорению эвтрофии и зарастания, можно определить следующую последовательность сукцесси:

Typhetum angustifoliae → Scirpo-Phragmitetum typhetosum → Scirpo-Phragmietum phragmitetosum → Glycerietum maximae → Caricetum gracilis.

Так как направление сукцессии совпадает с направлением изменения показателя R — характеристик, предполагается, что кислотная среда внутри биотопа имеет замедляющее действие. По показателям индикаторов T, W и N — характеристик определены результаты вегетационно-динамических исследования.

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STUDIES ON THE VEGETATION DYNAMICS OF NANOCYPERION COMMUNITIES III. ZONATION AND SUCCESSION

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Abstract

Using the "degree of succession" (DS) index of Numata, as with the descriptions in Parts I. and II. of this study, the succession types in the upper and lower parts of the Nanocyperion zone can be distinguished. The vegetation of the upper Nanocyperion zone shows a successive relationship with the Bidentetea associations of the higher level, as does the vegetation of the lower zone with the Agropyro-Rumicion associations of the higher flood-plain levels. The transition in the direction of the Agropyro-Rumicion associations is represented by the cyperetosum fusci subassociation of the *Rorippo-Agrostietum stoloniferae* association, first described in the present paper.

Introduction

The rapid changes characteristic of the Nanocyperion (now referred to as Elatini-Eleocharition ovatae Pietsch 65) zone of the river-bed — by the term Nanocyperion zone we mean the bed section where the Nanocyperion species appear with a considerable coverage and which forms a more or less definite zone, even if only for a short period — take place in a manner difficult to interpret cenosystematically and which has not yet been completely clarified. This is referred to by the complicated cenosystematic network of the associations, subassociations and varieties found in this zone. The cenotaxa belonging here (which deserves a mention) can be classed among the Nanocyperion flavescentis W. Koch 26, Chenopodion fluviatile Tx. 60. Bidention tripartitae Nordh. 40, and Agropyro-Rumicion crispi Nordh. 40 association groups, by which means three association classes (Isoëto-Nanojuncetea Br.-Bl. et Tx. 43, Bidentetea tripartitae Tx., Lohm., Prsg. 50, and Plantaginetea majoris Tx. et Prsg. 50) account for the population of a relatively small part of the river-bed.

The studies performed so far (Bagi 1985, Bagi—Körmöczi 1986) with the help of multivariate methods have distinguished two kinds of populations found in the lower zones of the Körös-bed: the "exterior" primary succession taking place in higher reliefs and the "interior" primary succession in the deeper reliefs, closer to the water. The populations of differing types have been verified by the multivariate analysis of both the species and the cenoses.

Historical relations

The botanical analysis of the river-bed was restricted to the classification given by floralists at the beginning. Accordingly, valuable enumerations were provided by Polgár (1912, 1927) from the Szigetköz area of the Danube; by Lányi (1914, 1916) from the Csongrád county regions of the River Tisza; by Boros (1929) and Soó (1938) from the areas touching the reaches of the River Tisza bordering on the Nyírség (a district in north-eastern Hungary), as well as by Prister (1947) from the alluvium-shallows of the Szamos in the surrounding area of Kolozsvár. An overall review of the retraceability of the earlier, rather sporadical botanical information can be obtained from the works of Zólyomi (1937) and Tímár (1950a, b).

The "plant-sociological", cenological studies on riverbeds began to show rapid progress in the 1930s—40s, with the application of the results of the Zürich-Montpellier School (Braun—Blanquet, 1951). The studies of Zólyomi (1937) on the Szigetköz paved the way. The work of Újvárosi (1940) is the first comprehensive cenological study pertaining to the region along the River Tisza. It was Tímár (1943, 1948, 1950a) who studied the banks of the River Tisza most thoroughly, extending his studies to the Maros as well (Tímár 1950b). His works provide an overall view of the cenological, zonational and successive relations of the mentioned rivers. Following Tímár, Bodrogközy (1958, 1971, 1982, 1985) dealt with the vegetation of the lower zones of the River Tisza in detail. He firstly studied the pedological features of the plant communities, and his later publications comprise their hydroecological evaluation. The most complete cenosystematic summary of the Hungarian Nanocyperion associations is linked with the name of Pietsch (1973).

However, specialist literature does not contain such a notion about the succession relations of the lower zones of the river-bed, which would give a joint interpretation of the development and presence of the association-groups mentioned in the Introduction. The most specific study of the process of succession was carried out by Tímár (1950a), the theories of whom were also adopted by Soó (1962). Tímár drew a distinction between the succession types characteristic of the sandy, silty and clayey banks. His succession-scheme for silt soil can be applied to describe, on a large scale, the vegetation along the Körös.

Kárpáti et *al.* (1962) also a refer to the Agropyro-Rumicion group neglected by Tímár (or, more exactly, mentioned by him for higher reliefs as the agrostidetosum stoloniferae flood-plain type) as a characteristic succession stage of the lower reliefs, but no detailed analyses were given, nor were the connections with the Nanocyperion, Bidention and Chenopodion fluviatile demonstrated.

The cenological research of the specific study area, the Körös-bed, is rather meagre, though a large number of studies have been carried out in respect to forest types. The work of Máthé (1936), however, was not followed by any major cenological publications; apart from the forest-communities, studies on other communities are almost completely missing from specialist literature. One descriptive work on the Nanocyperion associations along the Körös is the essay of Tímár—Bodrogközy (1959) relating to Tiszazug.

Materials and Methods

The contour sketch map of the study area is found in Fig. 1. Six, well distinguishable stands are demarcated in the area. The different stands are almost horizontal, thus, their vegetation can be regarded as being of a homogeneous distribution. The relevés were made at two points in time: the

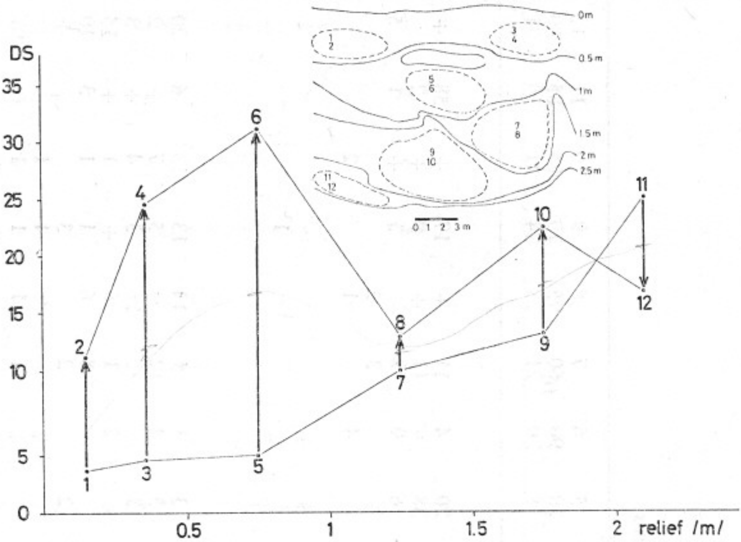

Fig. 1. DS values of the relevés as a function of the relief. The numerals correspond to the serial numbers of the cenological relevés as regards Table 1. The trend of the change of vegetation of the same stand is indicated by an arrow. The regional localization of the different relevés is shown on the complementary contour sketch map, on which a dotted line indicates the border of the stand

earlier ones (on 6th September, 1982) at the beginning of the vegetation period, shortly following inundation; the later ones at the end of the vegetation period (on 30th October, 1982), shortly before the first major autumn frost. Owing to the rapid and marked transformation of the vegetation — which makes mathematical processing possible — the estimation errors of the coverage are negligible as compared with the changes taking place in the composition of the vegetation.

To characterize the successional state of the relevés, the "degree of succession" (DS) index of NUMATA (1962) was used (ref. NUMATA 1969):

$$DS = \frac{\sum^{n} ld}{n} v \tag{1}$$

where l is the number of the Raunkiaer-type life-form of the plant species (FEKETE 1981): Th=1, H and G=10, N=50, M and MM=100; d is the value characteristic of the dominance of the plant species; n is the number of species occuring in the stand; and v characterizes the total coverage of the vegetation: 100% coverage is indicated by the value 1. NUMATA (1979) published a complemented variant of his DS index, according to which:

$$DS = \frac{\sum^{n} ldc}{n} v \tag{2}$$

where c is the so-called "climax adaptation number", being 1 in case of the pioneer species and 5 in case of the climax species. Since, in the given case, the majority of the species can be regarded as pioneer species, the calculations were prepared in the form of index 1. The reliability of the DS index is proved by its applications in Hungary (PAPP—PRÉCSÉNYI 1980, PRÉCSÉNYI 1981).

Results

DS values were calculated on the basis of Table 1, which, apart from the coverage data of the species, also comprises the important data of the relevés, and the life-form categorization of the plant species (Soó 1964—1980), as well as their ordered NUMATA-number.

Table 1. *Cenological data of relevés*

Life forms	Numata's numbers	Number of relevé Total covering (%) Number of species	1 20 17	2 75 30	3 20 14	4 85 28	5 30 18	6 90 20	7 60 21	8 95 28	9 70 24	10 85 31	11 85 16	12 80 21
		Nanocyperion												
Th	1	*Cyperus fuscus*	17	10	20	2	20	4	11	+	17	+	58	+
Th	1	*Dichostylis micheliana*	43	6	36	2	38	+	11	+	9	+	2	
Th	1	*Gnaphalium uliginosum*	5	17	8	5	6	9	8	+	3	+	1	5
H—HH	10	*Veronica anagallis-aquatica*	1	+	2	3	+		3	2				
Th—H	10	*Potentilla supina*		2		5		4		1		2		
H—HH	10	*Veronica beccabunga*	+	+	2	4								
HH	10	*Chlorocyperus glomeratus*		+		+	+	+						
Th	1	*Heleochloa alopecuroides*					+				1			
Th	1	*Juncus bufonius*		1										
Th	1	*Limosella aquatica*		+		+								
		Bidentetea												
Th	1	*Echinochloa crus-galli*	2	2	2	3	3	3	1	14	13	13	6	20
Th	1	*Chenopodium rubrum*	2	17	5	2	3	4	12	4	5	7	+	2
Th	1	*Polygonum lapathifolium*	1	+	2	+	3	+	15	26	3	4	+	3
Th	1	*Bidens tripartita*		1		1	+	2	1	6	+	1	+	15
Th	1	*Xanthium italicum*	3	+		2			8	6	1	1	3	10
Th	1	*Chenopodium polyspermum*	+				2		2		3			+
Th	1	*Chenopodium chenopodioides*	3	+							1	1		
Th	1	*Chenopodium ficifolium*							1	1	1	1		
Th	1	*Chenopodium glaucum*									+	+		
Th	1	*Polygonum hydropiper*								8	+	6		
Th	1	*Atriplex hastata*		+		+				+				
Th	1	*Ranunculus sceleratus*		1										

		Plantaginetea												
H	10	*Plantago major*	9	3	8	9	10	9	4	6	9	10	17	4
H	10	*Rumex stenophyllus*	2	7	4	21	2	17	1	4		4		2
H	10	*Rorippa sylvestris*	4	22	4	9	5	34	8	3	9	10	6	1
H	10	*Agrostis stolonifera*		4		+		1		+	+	6	+	10
H	10	*Tanacetum vulgare*		1		4	1	3	1	5	+	4		+
H—HH	10	*Typhoides arundinacea*											2	5
H	10	*Juncus effusus*		+	1									
		Chenopodio-Scleranthea												
H—HH	10	*Lythrum salicaria*	7	4	7	17	4	3	8	8	7	10	+	8
Th	1	*Amaranthus lividus*	+	1	+	4	2	7	2	+	3	+	2	3
H—HH	10	*Lythrum virgatum*	1	+		+		+	3	2	4	3		
Th	1	*Chenopodium album*		+		1			+	4	4	8		2
Th	1	*Amaranthus retroflexus*		+		+		+				2		2
Th	1	*Portulaca oleracea*					1	+			3	2		
Th	1	*Matricaria inodora*		+		+				+		+		
G	10	*Cirsium arvense*											+	5
Th—H	10	*Malva neglecta*										+		3
Th	1	*Sonchus asper*								+		+		
		Other species												
M	50	*Salix triandra*		1		1			+	+	4	4	3	+
HH	10	*Oenanthe aquatica*			+	4			+	+		+		
HH	10	*Lycopus europaeus*								+		+		
H	10	*Urtica dioica*						+				+		
HH	10	*Alisma lanceolatum*								+				
		Degree of succession (DS)	3.72	13.4	4.90	24.5	4.97	33.3	10.1	12.9	13.0	20.2	25.1	16.8

Table 2. *Rorippo-Agrostietum stoloniferae* (Moor 58) Oberd. et Th. Müll. 61 *cyperetosum fusci* subass. nova

	Number of relevés	1	2	3	4	5	6	7	8		
	Total covering (%)	40	65	30	50	70	20	60	20		
	Number of species	20	23	16	24	36	19	23	18		
	Sampling plot (m²)	18	18	6	25	25	20	6	15		
	Date, 1982:	3.9	3.11	3.9	5.9	1.11	1.11	6.9	1.11	K	
	Ass. Character Species										
H	*Rorippa sylvestris*	2.3	2.3	2.2	2.3	2.3	3.4	3.4	2.2	V	2.2—3.4
	Subass Diff. Species I. Nanocyperion										
Th	*Cyperus fuscus*	2.2	2.1	3.2	2.1	1.1	2.1	2.2	2.1	V	1.1—3.2
Th	*Gnaphalium uliginosum*	2.2	1.1	2.1	1.1	1.1	1.1	1.1	1.1	V	1.1—2.2
Th	*Dichostylis micheliana*	1.1	1.1		2.1	1.1	+	2.1	2.1	IV	1.1—2.1
Th	*Heleochloa alopecuroides*	+	+	1.1				+		IV	+—1.1
Th—H	*Potentilla supina*		+						+	II	+
Th	*Juncus bufonius*		1.1							I	1.1
Th	*Limosella aquatica*								2.1	I	2.1
	Subass. Diff. Species II. Agropyro-Rumicion										
H	*Rumex stenophyllus*				+	2.3	2.2	1.2	2.3	IV	+—2.3
H	*Rumex crispus*	+	2.3	2.3	2.2	2.3				IV	+—2.3
	Agropyro-Rumicion										
H	*Agrostis stolonifera*	+	2.2	1.1	+	1.1	+	1.1	1.1	V	+—2.2
H	*Tanacetum vulgare*		1.1			+		1.1	+	III	+—1.1
Th	*Rorippa palustris*		+			1.1				II	+—1.1
H	*Juncus effusus*				1.1	+				II	+—1.1
G	*Juncus compressus*			1.1						I	1.1
	Plantaginetea										
H	*Plantago major*	2.2	2.2	2.1	1.1	1.1	2.2	2.2	2.3	V	1.1—2.3
HH	*Rorippa amphibia*				1.2	1.1				II	1.1—1.2

	Bidentetea										
Th	*Chenopodium rubrum*	1.2	1.2	+	2.2	1.2	1.1	1.2	1.2	V	+—2.2
Th	*Echinochloa crus-galli*	1.2	1.1	2.2		1.2	1.2	1.2	+	V	+—2.2
Th	*Xanthium italicum*	1.1	1.1	1.1	1.3	1.2	1.1	1.1	1.2	V	1.1—1.3
Th	*Polygonum lapathifolium*	1.2	1.1	2.2	1.1	1.1		1.1		IV	1.1—2.2
Th	*Bidens tripartita*	+	1.1		1.1	1.2		1.1		IV	+—1.2
Th	*Chenopodium ficifolium*	1.1	+	1.1			2.2	+		IV	+—2.2
Th	*Atriplex hastata*	+		+		1.1	1.1		1.2	IV	+—1.2
Th	*Ranunculus sceleratus*		+		1.1	1.2	+		1.2	IV	+—1.2
Th	*Polygonum hydropiper*			1.2	1.2	1.1		+		III	+—1.2
Th	*Chenopodium polyspermum*					1.1				I	1.1
	Chenopodio-Scleranthea										
H—HH	*Lythrum salicaria*		+		2.2	1.1		2.3	1.1	IV	+—2.3
Th	*Portulaca oleracea*	3.2	3.2	1.1		+		+		IV	+—3.2
Th	*Amaranthus lividus*				+	+	+	+		III	+
Th	*Amaranthus retroflexus*	+	+			1.1			+	III	+—1.1
Th	*Chenopodium album*	+	+				1.1			II	+—1.1
Th	*Sonchus asper*		+			1.1	+			II	+—1.1
G	*Cirsium arvense*				1.1	1.1				II	1.1
Th	*Capsella bursa-pastoris*					1.1				I	1.1
	Other species										
M	*Salix triandra* (j)	+	+		1.1	1.1	2.1	+		IV	+—2.1
HH	*Oenanthe aquatica*				+		+		1.2	II	+—1.2

Bolboschoenus maritimus 2+; *Chlorocyperus glomeratus* 7+, 4+; *Chenopodium chenopodioides* 1+, 7+; *Chenopodium glaucum* 6+; *Cyperus difformis* 4+; *Lysimachia vulgaris* 3+, 5+; *Malva neglecta* 5+; *Matricaria inodora* 6+; *Mentha arvensis* 5+; *Plantago lanceolata* 2+; *Solanum dulcamara* 5+; *Taraxacum officinale* 4+, 5+; *Urtica dioica* 5+; *Veronica beccabunga* 7+.

The results illustrated as a function of the relief are shown in Fig 1. The DS values of the relevés taken on the earlier date increase with the raise in relief, the cause of which is that the vegetation had longer periods at disposal for development with an elevation in relief, which mainly led to the increase in total coverage. Characteristic of the species composition is that the Nanocyperion character species are dominant at lower reliefs (1., 3., 5. relevés), while, at higher reliefs (7., 9. relevés), the Chenopodio-Scleranthea and, within this, the Bidentetea and Plantaginetea character species appear with a considerable coverage, besides the Nanocyperion species. In these relevés the species number is somewhat higher. It is also a Nanocyperion species, the *Cyperus fuscus,* that dominates in the 11. relevé. The low coverage ratio of the Chenopodio-Scleranthea character species can be traced back to competitive elimination arising as a consequence of the large coverage of the rapidly spreading *Cyperus fuscus,* which, due to the great moisture content of the soil, may be considerable at the beginning of the vegetation period. The differing species composition of the 7. and 9. relevés is also caused by the circumstance that the two relevés belong to that zone of the river-bed where large amounts of organic matter and debris are deposited by the surf of the river. Therefore, the appearance of the Bidention character species in a higher ratio is a regular feature here. The deposition of organic debris at higher (11. relevé) and reliefs is to a lesser degree.

In case of the relevés recorded at the later point in time, the development of the DS value is sharply divided into two parts. At the lower relief (2., 4., 6. relevés) the DS value shows a marked increase with the elevation of the relief. The increase in DS is in connection with the greater coverage and the appearence of the species having a H, H—HH life-form. These factors can compensate for the decrease in the DS value arising from the increase in species number. At higher reliefs (8., 10., 12. relevés) the increase in DS value is of a slighter degree and is even decreasing in case of the 12. relevé. Such a change in the DS value is caused mainly by the increase in species number, as well as by the fact that, besides the almost unchanged value of the total coverage, Bidentetea instead of Nanocyperion species appear, though both are of Th life-form.

Cenosystematic evaluation

At higher reliefs the first to develop is the Nanocyperion, mainly the *Cypero-Juncetum* association, which can also appear in an almost typical form (11. relevé). In the zone where the organic debris accumulates, the appearance of the Bidentetea species follows shortly after — almost simultaneously with — these Nanocyperion species (7., 9. relevés), which are partly Bidention tripartitae, partly Chenopodion fluviatile character species. With the advanced vegetation period, the soil of the higher reliefs becomes dry, which is unfavourable for the Nanocyperion species sensitive to a lack of water. Hence, their predominance shows a considerable decrease in the cenoses (8., 10., 12. relevés). The degradation of their cenoses is evident, most strikingly, in the decrease in DS value in the 11., 12. relevés. The free areas can be occupied by the Bidentetea species (cf. Soó (1964—80) I. vol., p. 218, Soó (1957), p. 339).

At lower reliefs, the earlier relevés comprise the character species of both the *Cypero-Juncetum* and the *Dichostylidi-Gnaphalietum* associations, in correlation with the fraction-composition of the soil on the Körös-bed (cf. Kárpáti 1985), since, in the lighter soil of the river-bed, the *Cypero-Juncetum,* while, in the bound soils, the *Dichostylidi-Gnaphalietum* are the more characteristic associations. From this point of view, the soil in the studied reach of the Körös is of an intermediate type. Thus, the development of the two communities here either forms mosaic-complexes, or transitions of each other (Fig. 2). According to BODROGKÖZY (1982), the decisive factor is the distribution of the seeds in the soil.

With the advancement of the vegetation period, there is a considerable increase in the vegetation coverage. At the same time, the moisture of the soil does not decrease essentially due to proximity of the water level of the river. Such species appear

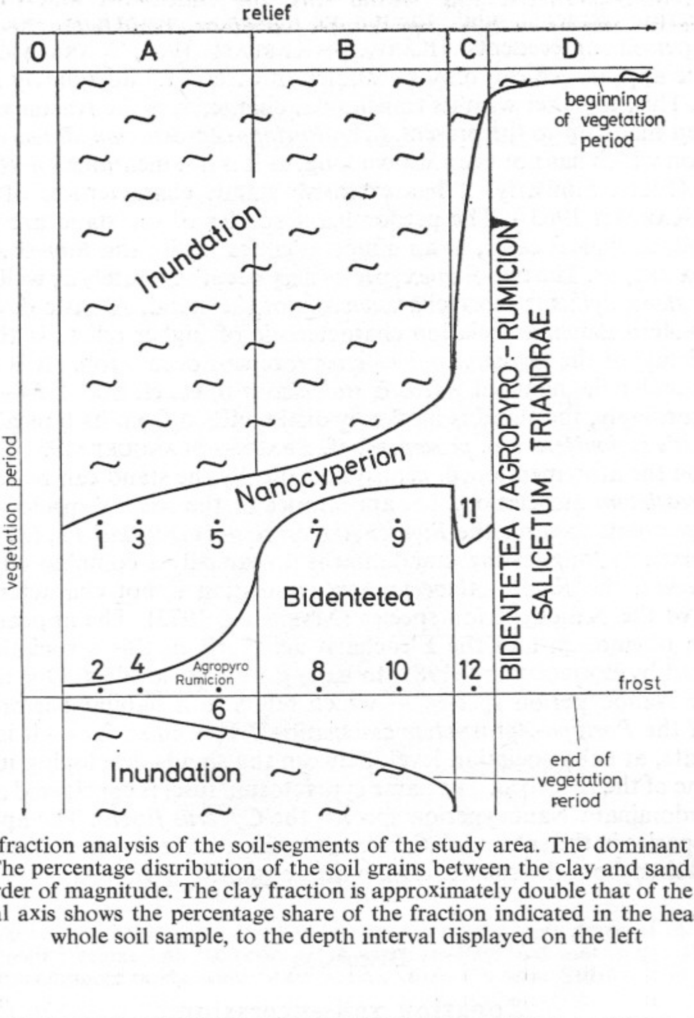

Fig. 2. A soil-fraction analysis of the soil-segments of the study area. The dominant fraction is the silt fraction. The percentage distribution of the soil grains between the clay and sand fractions is of an identical order of magnitude. The clay fraction is approximately double that of the sand fraction. The horizontal axis shows the percentage share of the fraction indicated in the heading from the whole soil sample, to the depth interval displayed on the left

which develop more slowly beside the Nanocyperion species, but have greater competitive ability and hinder the further increase in coverage of the Nanocyperion species. These species are partly of a Chenopodion fluviatile (2. relevé), partly of an Agropyro-Rumicion character (4., 6. relevés). Therefore, in the deepest zone of the river-bed — in case of the vegetation period being enough — there is the possibility for their appearance, which is otherwise characteristic of the relief above the Bidentetea associations (found in the Nanocyperion zone of the river-bed) (KÁRPÁTI et *al.*, 1965). The higher succession grade is indicated by the high DS value of the 6. relevé.

The Agropyro-Rumicion stand developing here differs from the Agropyro-Rumicion associations found on the higher areas in many essential aspects.

The stand is mainly similar to the *Rorippo (sylvestri)-Agrostietum stoloniferae* (MOOR 58) OBERD. et TH. MÜLL. 61. association (cf. MARKOVIĆ 1973, BODROGKÖZY 1985). An essential difference is that, as regards relief, it develops parallel with the dissociation of the Nanocyperion associations characteristic of the zone below the Bidentetea (Chenopodion fluviatile) associations. It contains a considerable amount of Nanocyperion elements, while the typical *Rorippo-Agrostietum* associations have no Nanocyperion antecedents (KÁRPÁTI—KÁRPÁTI 1963, MARKOVIĆ 1978). Its characteristic appearance can only be studied in case of an adequately long vegetation period. This, together with its transitional character, is the reason why no mention has been made up to the present. (The *Rorippo-Agrostietum stoloniferae* itself is an association which has not been known long, as it is not mentioned in the Übersicht III of Soó (1961). Similarly, it has extensive stands characteristic of large areas (KÁRPÁTI—KÁRPÁTI 1963)). The predominant species of the stand are the *Rorippa sylvestris* and, in typical cases, in an almost identical ratio, the *Rumex stenophyllus*, or the *Rumex crispus*. The two *Rumex* species may occur separately as well as together. The *Rumex stenophyllus* is more characteristic of the stand. A basic deviation from the *Rorippo-Agrostietum* association characteristic of higher reliefs is that the subspecies (varietas) of the *Agrostis stolonifera* prorepens occurs too. (It is also held to be a species under the name of *Agrostis stolonizans* BESS., cf. Soó 1964—80, V. vol., p. 399). Accordingly, the stand is markedly distinguished from its typical association by the *Agrostis stolonifera* ssp. *prorepens*, cf. BRAUN—BLANQUET (1951), p. 21.

Based on the aforementioned, cenosystematically the stand can be regarded as a *Rorippo-Agrostietum* association. The appearance of the *Rumex* species in considerable coverage points towards the *Rumici-Alopecuretum geniculati* TX. (37) 50 association. The relatively long-lasting inundation is presumedly a common environmental factor. However, the *Rumici-Alopecuretum* association is not characterized by the appearance of the Nanocyperion species (MARKOVIĆ 1973). The appearance of the Gnaphalium uliginosum and the Eleocharis acicularis in this association has also been identified by BODROGKÖZY (1985) to having a zoogenic effect. Due to the occurrence of the Nanocyperion species — which refers to a habitat basically differing from that of the *Rorippo-Agrostietum* association described so far — it is reasonable to differentiate, at subassociation level, between the stands developing in the Nanocyperion zone of the river-bed. The name cyperetosum fusci is considered appropriate, after the predominant Nanocyperion species, the *Cyperus fuscus*. The appearance of the *Rumex* species in the subassociation can be evaluated cenosystematically as facies. The relevés taken from the subassociation are contained in Table 2.

Discussion

Zonation and succession

The succession relations of the lower zones of the Körös river-bed are illustrated by the following vegetation period — relief scheme (Fig. 3).

On the basis of the idealized scheme (neglecting transitions and mixings), along an optimal horizontally drawn relief axis, it can be readed off what zones are formed by the vegetation at a given time-point on the lower parts of the river-bed. For example, at the time of the earlier plotting the relevés preapred at the deepest reliefs fall into the Nanocyperion zone, the next two into the border of the Bidentetea-Nanocyperion

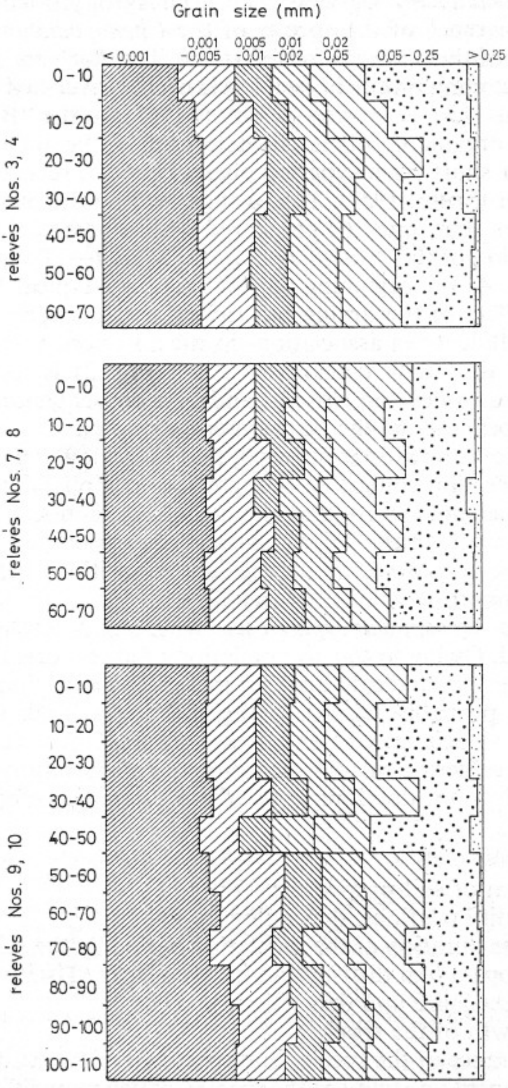

Fig. 3. The connection between zonation and succession on the lower zones of the river-bed. The vegetational period begins with the cessation of water coverage and ends frequently with the first strong frost, more rarely, with the elevation of the water level. See details in the text

zone, and the stand recorded at the hightes relief (11.) into a narrow Nanocyperion zone. The development of the vegetation in the studied section of the river-bed can be regarded as a process of succession which begins with the end of the inundation and the extension of which is hindered by the newer inundation, bringing the succession back to the starting point. The first, examinable steps of the succession are separated from each other in the lower zones of the river-bed. In the "A" zone — if sufficient time is at our disposal — the Nanocyperion associations *(Cypero-Juncetum* and *Dichostylidi-Gnaphalietum*) may develop into an Agropyro-Rumicion association, and there is the appearence of the species of the *Chenopodietum rubri* association. The succession index of these ranges from 20 to 40. The *Rorippo-Agrostietum stoloniferae* association developing on the higher levels of the river-bed is characterized by a DS value around 60—130 (KÁRPÁTI—KÁRPÁTI 1963). In the "B" zone — of which the accumulation of organic debris is characteristic — the Bidentetea associations develop after a rather short Nanocyperion phase. Here the succession has somewhat organogenic character (SIMON 1957). This is suggested by the presence of the Bidention tripartitae species (but, must be compared with cenosystematic uncertainty, as regardings the condition of the "*Xanthietum italici*" (POLI—TÜXEN 1960, SOÓ 1964—80, MARKOVIĆ 1981)). At the beginning the "C" zone is a typical Nanocyperion one. However, with the effect of the drying out caused by the decreased water level, its place is occupied by Bidentetea associations in the advanced vegetation period. The vegetation period of the grade demarcated "D" (Fig. 3) is long enough for the perennial plant species to develop closed stands. As consequence, there is no possibility here for the appearance of the Nanocyperion species.

It is apparent, from the aforementioned, that in the lower parts of the river-bed the zonation and succession cannot be brought into compliance: i.e. the vegetation of the higher zone does not signify that the next succession stage of the vegetation found in the zone below it. In this initial phase of the succession, the Bidentetea associations may not be considered as a successive transitions between the Nanocyperion and the Agropyro-Rumicion associations. This is all the more probable regarding the *Rorippo-Agrostietum cyperetosum fusci* stand developing on the lower reliefs of the river-bed. Owing to the accumulation of excess organic matter, it seems the Bidentetea associations indicate another means of succession (of a degradative character). They are probably related to the Bidentetea, and, within this, to the Bidention tripartitae associations of the higher reliefs. These conclusions are also supported by the DS values calculated according to community types. The following factors may play a role in the development of these alternative succession types of the river-bed:

1. The zonation form of soil properties;
2. Changes in humidity relations, depending on relief;
3. The specifity of the duration of the vegetation period by the relief;
4. Differences in propagulum distribution in the soil (cf. TÍMÁR 1950a for the connection between seed size and deposition, p. 89);
5. The differing growth of the species;
6. The differing tolerance of the species in respect to environmental changes;
7. The differing competitive ability of the species, which may differ from each other, to various degrees, with changes in environmental parameters;
8. The ratio of the life-time of the species and the length of the vegetation period at its disposal (WHITTAKER 1974);
9. The life-form (cf. BAGI—BODROGKÖZY (1984), under identical hydroecological conditions, in a drying out flood-plain lake, besides a sinking water level, the hemikryptophyton *Agrostis stolonifera* is displaced by the therophyton *Heleochloa alopecuroides* at deeper reliefs);
10. The possibility of migration.

The gravity of the listed factors, differing according to zones, is the cause of the differing route per zone of the processes of succession.

In the present report it was aimed to analyse the cenosystematic relations of the succession on the river-bed. The possibilities of the operativity of the mechanism and dynamism were only touched upon to the extent of a few hints. This can be realized by means of performing further studies in respect to the previously listed factors.

Acknowledgement

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Vegetációdinamikai vizsgálatok Nanocyperion jellegű növénytársulásokban III. Zonáció és szukcesszió

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Kivonat

Numata „degree of succession" (DS) indexének felhasználásával a dolgozat I. és II. részében leírtakhoz hasonlóan elkülöníthetők egymástól a Nanocyperion zóna felső és alsó részének szukcessziótípusai. A felső Nanocyperion zóna növényzete a magasabb ártéri szintek Bidentetea, míg az alsó zóna növényzete a magasabb ártéri szintek Agropyro-Rumicion társulásai felé mutat szukcessziós kapcsolatot. Az átmenetet az Agropyro-Rumicion társulások felé a *Rorippo-Agrostietum* stoloniferae asszociáció itt először leírt *cyperetosum fusci* szubasszociációja képviseli.

Ispitivanje dinamike vegetacije sa karakteristikama Nanocyperion zajadnice III. Zonacija i sukcesija

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Abstrakt

Korišćenjem indexa Numata „degree of succession" (DS) mogu se razdvojiti-slično kao što je već napisano u I i II delu-tipovi sukcesije, koje se nalaze u gornjoj i donjoj zoni Nanocyperion.

Vegetacija u gornjoj zoni Nanocyperion pokazuje sukcesijski odnos prema zajednicama na višim nivoima vodoplavnog zemljišta kao što je Bidentetea, dok vegetacija u donjoj zoni Nanocyperion pokazuje sukcesijski odnos prema zajednicama na višim nivoima vodoplavnog zemljišta, kao što je Agropyro-Rumicion. Prelaz prema zajednicama Agropyro-Rumicion pokazuje, prvi put u ovom delu opisana subasocijacija *cyperetosum* fusci, deo asocijacije *Rorippo-Agrostietum stoloniferae.*

Вегетационно-динамические исследования над сообществами растений типа Nanocyperion
III. Зонация и сукцессия

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Резюме

Методом применения индекса Numata „degree of succession" (DS), как описано в I и II главах настоящей работы, разделены друг от друга типы сукцессии нижней и верхней частей зоны Nanocyperion. Растительность верхней части зоны Nanocyperion указывает на преемственную связь с сообществами более высоких уровней затопления типа Bidentetea, а растительность нижней зоны — с сообществами более высоких уровней затопления типа Agropyro-Rumicion. Впервые здесь описанная субассоциация *cyperetosum fusci* сообщества *Rorippo-Agrostietum* представляет собой переход к сообществам Agropyro-Rumicion.

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STUDIES ON THE VEGETATION DYNAMICS OF NANOCYPERION COMMUNITIES IV. DIVERSITY AND SUCCESSION

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Abstract

The paper deals with studies on the temporal and spatial changes in the diversity and evenness of the vegetation of the Nanocyperion zone found on the river-bed. A relatively lower diversity is characteristic of the more or less typical associations developing during the course of the succession, while the stands representing transitional cenoses between the associations are characterized by a higher diversity. The increase in diversity of the vegetation on the lower reliefs developing in the direction of the Agropyro-Rumicion is accompanied by an increase in the value of evenness.

Introduction

Depending on relief, two kinds of courses are distinguishable for the succession of the lower, Nanocyperion zones of the river-bed. This is supported by a comparison between the ordination and classification of the stands and the characteristic indicator values (BAGI 1985), as well as by a cenosystematic evaluation of the ordination and classification of the species (BAGI—KÖRMÖCZI 1986). This notion is verified by the results obtained with the "degree of succession" index of Numata, which have also provided the possibility for the more precise cenosystematic categorization of this part of the river-bed (BAGI 1987).

The spatial segregation of the succession types is determined by the localization of the relief and the differences developing on account of this: in the development of the vegetation at a higher relief compared to the lower relief, decisive factors are the longer vegetation period, the drying out of the soil to a greater extent, the accumulation of organic debris, the direct connection with the higher reliefs of the flood-plain. The lower reliefs adjacent to the river-water are characterized by an extremely short vegetation period and constant favourable soil humidity. Owing to these differing abiotic circumstances, the processes of succession take up divergent courses. The vegetation in the lower zone develops in the direction of the Agrorpyo-Rumicion, that in the upper zone towards the Bidentetea (Bidention tripartitae). (Further details are contained in Parts I—III of this study.) The divergent development is indicated by differences in the changes of the degree of succession. The relationship between degree of succession and diversity is one of the most studied fields of succession research.

The connection between succession and diversity in the succession series is well-known (MCNAUGHTON 1968, MORRISON—YARRANTON 1973, PRÉCSÉNYI 1981). There are also sufficient published data on the diversity changes accompanying secondary succession. There are significant studies pertaining to plough lands no longer under cultivation (Nicholson—Monk 1974, Bazzaz 1975) or to other strongly perturbed systems (Shafi—Yarranton 1973, Lehtonen—Yli—Recola 1979, Papp 1984). However, only a few publications report on studies regarding the diversity changes of objects where the life-span of the components (individuals) and the duration of environmental fluctuations are of an almost similar length. The paper of Précsényi—Dömötör—Czimber (1984) can rather be regarded as an exceptional example. From this point of view, the analysis of the diversity changes in the case of the succession types initiating from the Nanocyperion associations bridges the gap. It is also worthwhile dealing with the changes in diversity of these associations because the diversity may be connected with several other (structural) properties of the system. A large number of data are available, pro and con, regarding propositions on the different parameters (e.g. stability) and the relationship of diversity (McNaughton 1968, Hairston et *al.* 1968).

The relatively (seemingly) easy practicability of the diversity indices is the reason why these are given preference over traditional statistical methods (Eberhardt 1969), for instance, or the topological models (Poston—Stewart 1978, Shaffer 1985).

Materials and Methods

For estimating diversity, three diversity indices differing from each other in approach and possibility of demonstration, as well as their corresponding evenness values were used:

1. Simpson (1949) index

This expresses the probability by means of which an individual can be chosen from one and the same species of the studied specimen by two independent samplings.

For the specimen of a finite element-number we have:

$$H^*_{SI} = \frac{\sum\limits_{i=1}^{s} n_i(n_i-1)}{N(N-1)}$$

where S is the number of species, n_i is the number of individuals belonging to the i species, N is the total number of individuals (designations are the same in the rest of the indices, too). A more frequently used variant is (Pielou 1969):

$$H_{SI} = 1 - H^*_{SI}.$$

However, this must be compared with the publication of Hill (1973).

2. Shannon—Weaver (1949) index

There is a degree of uncertainty whereby an individual of a pre-determined species may be chosen at random from the studied specimen (Pielou 1966). Its cybernetic interpretation and deduction can be found in the work of Brillouin (1951) p. 341. The Shannon—Weaver index may be written down in the following way:

$$H_S = k \sum_{i=1}^{S} p_i \log p_i$$

where k is an optional constant, in expedience, and hereinafter $k=-1$, $p_i = n_i/N$. Based on the general equation of Fager (1972): $E = \mathrm{H} - \mathrm{H}_{\min}/H_{\max} - H_{\min}$, the evenness of the Shannon—Weaver index is:

$$E_S = \frac{-\sum\limits_{i=1}^{S} p_i \log p_i - \log N - \dfrac{N-(S+1)}{N} \log\left[N-(S+1)\right]}{\log S - \log N - \dfrac{N-(S+1)}{N} \log\left[N-(S+1)\right]}$$

which, in practice, correspond to the $J=H_s/\log S$ formula (Pielou 1969), where $\log S=H_{\max}$. The evenness calculated in such a manner is independent of the species number (Sheldon 1969). The table of Précsényi (1981), usable for calculating the evenness of cenological tables comprising relative abundance-dominance data, was used in the calculations. The result of this ('E' in Table 1) almost agrees with the value of J and E_S. The decimal logarithm was used.

3. McIntosh (1967) index

$$H_M^* = \sqrt{\sum_{i=1}^{S} n_i^2}$$

This formula expresses the interpretation of the diversity as such an Euclidian-distance, which "can be regarded as the distance value of the sample from an area of bare ground with zero individuals" (McIntosh 1967). The generally used form of the index is:

$$H_M = \frac{N-\sqrt{\sum_{i=1}^{S} n_i^2}}{N-\sqrt{N}}$$

In this form its value falls between 0 and 1. Since, in the given case, the Simpson and McIntosh indices led to results identical with the Shannon—Weaver index, from the viewpoin of interpretability, the evenness values of these are not given in the paper.*

* According to DeJong (1975), the evenness of the Simpson index based on the general equation of Fager (1972) is:

$$E_{SI} = \frac{1-\frac{\sum_{i=1}^{S}(n_i(n_i-1))}{N(N-1)}-\frac{(S-1)(2N-S)}{N(N-1)}}{\frac{N(S-1)}{S(N-1)}-\frac{(S-1)(2N-S)}{N(N-1)}}$$

The evenness of the McIntosh index is:

$$E_M = \frac{\frac{N-\sqrt{\sum_{i=1}^{S} n_i^2}}{N-\sqrt{N}}-\frac{N-\sqrt{(S-1)+[N-(S-1)]^2}}{N-\sqrt{N}}}{\frac{N-\sqrt{\left(\frac{N}{S}\right)^2}}{N-\sqrt{N}}-\frac{N-\sqrt{(S-1)+[N-(S-1)]^2}}{N-\sqrt{N}}}$$

Among the diversity-indices, these three belong to the ones most frequently used. Their properties are analysed in several theoretical essays (Whittaker 1965, Pielou 1969, Hill 1973, Peet 1974, DeJong 1975, Nosek 1976).

The dominance-diversity curves were applied in accordance with Whittaker (1965): the ordinates illustrate the logarithm of the relative dominance of species.

The description of the study area and the cenological table are found in the previous parts of the paper.

Results

Table 1 comprises the dominance-diversity values characteristic of the different relevés. From the viewpoint of interpretability, the three diversity-indices used led to similar results. This is also true with respect to their evenness. Therefore, only the results of the most frequently used Shannon—Weaver index are reported (Fig. 1).

The lower zones of the river-bed are generally characterized by high diversity (cf. the data of Précsényi (1981) concerning the sandy succession series). A particu-

Table 1. *Diversity-data of the relevés*

Serial no.	I*	I	H_S	J	E	H_{SI}	H_M
1.	17	14	0.8377	0.7309	0.7223	0.7735	0.5734
2.	30	17	1.0059	0.8175	0.8112	0.8786	0.7102
3.	14	13	0.8887	0.7978	0.7912	0.8135	0.6210
4.	27	19	1.0912	0.8533	0.8489	0.9046	0.7521
5.	18	14	0.8728	0.7615	0.7539	0.8018	0.6066
6.	20	13	0.9180	0.8241	0.8184	0.8347	0.6482
7.	21	18	1.1112	0.8853	0.8818	0.9189	0.7752
8.	28	16	1.0535	0.8749	0.8711	0.8889	0.7262
9.	24	19	1.1504	0.8996	0.8966	0.9220	0.7830
10.	31	20	1.1817	0.9083	0.9056	0.9349	0.8082
11.	16	10	0.6280	0.6280	0.6149	0.6305	0.4302
12.	21	17	1.0751	0.8738	0.8699	0.9067	0.7556

I* — The number of species in the relevé
I — The number of species in the relevé with an estimate coverage of 1 % or more.

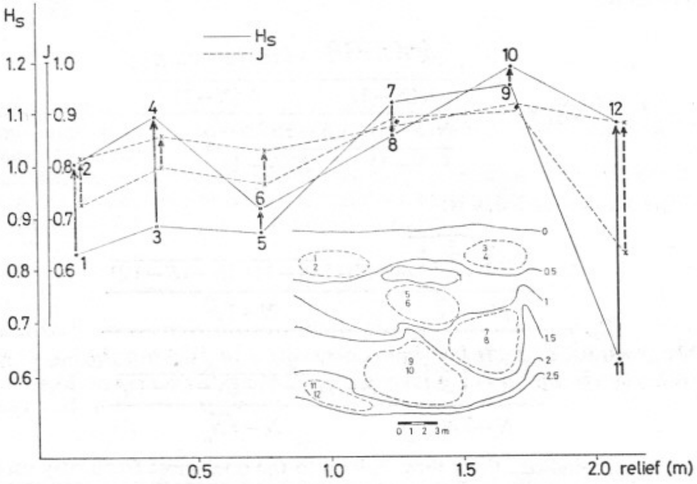

Fig. 1. Temporal and spatial changes of diversity (H_S) and evenness (J) in the studied area. The numbers indicate the serial number of the relevé, in accordance with the cenological table found in Part III of this study series. The earlier and later relevés are interlinked by arrows. The boundary of the stands is indicated by a dotted line on the complementary contour map.

larly high diversity is manifest in the case of the relevés cenologically belonging to a transitional group, while the lowest is detectable in the case of the typical *Cypero-Juncetum* association (11). (The serial number of the relevé, according to Part III of this study, is found in parentheses.) Higher diversity is manifest in the relevés containing a transition between the *Cypero-Juncetum* and the *Dichostylidi-Gnaphalietum* Nanocyperion associations (1, 3, 5). A relatively low diversity can be found in the relevé mentioned as *Rorippo-Agrostietum stoloniferae cyperetosum fusci*, characterized by a high degree of succession value (6). A rather high diversity value is characteristic of the relevés representing transitions between association-groups, Thus, from the earlier relevés, we have the Nanocyperion — Chenopodion fluviatile (7, 9) and, from the later relevés, the Nanocyperion — Agropyro-Rumicion (2, 4), the Chenopodion fluviatile — Bidention (8), Chenopodion fluviatile — Agropyro-Rumicion (10), and Bidention — Agropyro-Rumicion (12).

The diversity values generally show an increase with the advance of the vegetation period. The circumstances of this are connected with the increase in sepcies number only to a slight degree. The main cause of the increase in the relevés is that the species coverage becomes more even. This is shown by the rise in evenness values. The increase in evenness is an evident consequence of the fact that the species of slower growth catch up with the species which have reached an outstanding dominance at the beginning of the vegetation period, owing to their faster growth-rate and stronger colonization capability. In relevés 7 and 8 the decrease of the high diversity value indicates the degradation of the community. The Nanocyperion species die out from beside the *Polygonum lapathifolium*. At the same time, the rest of the Chenopodion fluviatile and Agropyro-Rumicion species do not appear. The process can be traced back to pedological reasons, as well as to the economy of water supply.

As regards relief, the diversity values of the higher and lower areas are well distinguishable from the diversity values of the higher reliefs at the time of the earlier recording. The average diversity of the lower relief (1, 3, 5) is 0.8664, while that of the relevés at higher reliefs (with the exception of relevé 11) is 1.1308. (The low diversity found in the relevé 11 is caused by the high covering quota of the *Cyperus fuscus*, the reasons for which are discussed in Part III of this study.) The lower diversity of the lower reliefs can be explained by the remarkable covering quota of the Nanocyperion species. At the higher reliefs the vegetation had enough time for the dispersal of the appearing Bidentetea species to ensure a "more even" vegetation. By the later point in time this difference between the two reliefs decreases, the primary cause of which is the greater increase in the evenness of the vegetation in the lower zones. An 8.2% increase is manifest in the evenness in the lower zones, while practically no changes are visible in the upper zones (except in relevé 11). The comparatively great evenness increase in case of relevés 5 and 6 was not followed by an essential increase in diversity. Meanwhile, a decrease was observable in the number of the reckoned species (the coverage of which reached 1%).

Succession end diversity

Despite the facts that diversity depends on the size (Fekete—Kovács 1978), and shape of stand (Nosek 1976), the diversity calculations were carried out on the basis of single samples — also characteristic of zone and cenosis, according to the experiences of the author —, certain general conclusions serving as a starting-point for further studies could be drawn. (The area and shape of the stands can be defined by Fig. 1.)

Making use of the parallelism within identical zones of the temporal and spatial processes, the relationship between the diversity values and the succession stages of the relevés can be demonstrated in the following manner. The Nanocyperion associations of the lower zone (1, 3, 5) ($\overline{H}_S=0.8664$) form transitional cenoses (2, 4) ($\overline{H}_S=1.0486$) with the character species of the Chenopodion fluviatile *(Chenopodietum rubri)*, and then the Agropyro-Rumicion association groups. At the end of the process, the developing association is the Agropyro-Rumicion (6) ($H_S=0.9180$). During the course of the outlined process there is first an increase and then a decrease in the diversity.

In the upper zone the convergence of the processes is more perceivable. Here the appearence of the species belonging to the Nanocyperion associations is followed by the Chenopodium fluviatile — in the beginning, the *Chenopodietum rubri* (7) (H_S=1.1112), and later the *Echinochloo-Polygonetum* species (9) (H_S=1.1504). In certain areas a typical Chenopodion fluviatile association, the *Echinochloo-Polygonetum* is formed (8) (H_S=1.0535), and a slight decrease in diversity is observable. In other areas Bidention tripartitae and Plantaginetea species appear, and a further increase in diversity is manifest (10,12) ($\bar{H}_S$=1.1284).

In the course of a vegetation period, the rapid vegetation-transformation characteristic of the vegetation of lower zones of the river-bed results in the development of several members of the succession series. Meanwhile, the diversity, in the case of the relevés standing closer to the typical associations, is lower, being higher in the case of the transitions.

The changes in diversity of the river-bed vegetation necessitate further studies. This demand is supported by the illustrated dominance-diversity curves (WHITTAKER 1965) (Fig. 2). The curves assume various courses, and the most important types are

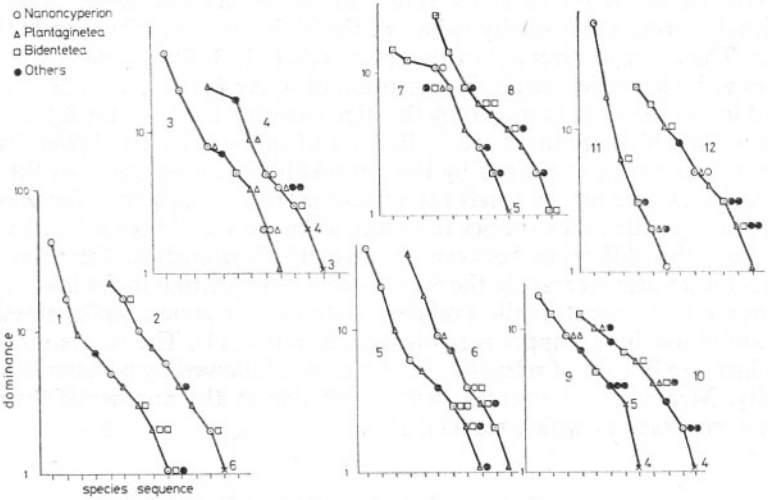

Fig. 2. The dominance-diversity curves of the relevés. The rank-order of the species according to dominance is illustrated on the abscissa, the logarithm of relative dominance on the ordinate. An asterisk indicates the dominance value to which 4 or more species belong in the relevés (the number of species is shown besides the asterisk). The numbers found near the curves, referring to the relevé, can be identified in the same manner as in Fig. 1.

also represented, as mentioned by WHITTAKER. The curves of the earlier and later relevés show a complete rearrangement, as regards species. The changes taking place during the rearrangement require further investigations, as does the demonstration of the differences between the species of the curve with higher serial numbers.

Closing remarks

The main purpose of this study series — apart from a description of the concrete recent results — was to call attention to the possibilities revealed in studying the lower zones of the river-bed. Undoubtedly, these studies may have prime significance in succession research. Though the principle object of succession research is the forest (mainly owing to the reliable estimation of the age of the individuals), through the rapid changes taking place in its vegetation, studies in the lower zone of the river-bed may provide an addition of useful information to our knowledge of the initial stages of succession and of the studies of the transitions from one association to another. The age of the individuals can be determined with exactness following a localization with fixed quadrates. The studies may lead to appreciable results within a few months, while investigations of a forest, with similar aims (if we disregard the possibilities deriving from the principle of timeliness) may require decades.

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Vegetációdinamikai vizsgálatok Nanocyperion jellegű növénytársulásokban IV. Diverzitás és szukcesszió

BAGI I.

J. A. Tudományegyetem, Növénytani Tanszék, Szeged

Kivonat

A dolgozat a diverzitás és az evenness térbeli és időbeli változását vizsgálja a folyómeder Nanocyperion zónájának növényzetén. A szukcesszió során kialakuló többé-kevésbé tipikus társulásokat relatíve alacsonyabb, a társulások közötti átmeneti cönózisokat reprezentáló felvételeket magasabb diverzitás jellemzi. Az alacsonyabb, Agropyro-Rumicion irányba fejlődő térszínek növényzetének diverzitásnövekedését az evenness érték növekedése kíséri.

Ispitivanje dinamike vegetacije sa karakteristikama Nanocyperion zajednice IV. Diverzitet i sukcesija

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Abstrakt

Ovo delo istražuje prostorne i vremenske promene diverziteta i evenness kod vegetacione zone Nanocyperion u rečnom koritu. Prilikom sukcesije, visě ili manje, razvijaju se tipične zajednice sa relativno nižim diverzitetom, prelazni cenosis između zajednice je karakterisano sa višim diverzitetom. Razvitak prema nižem nivou prostora kao što je Agropyro-Rumicion, povećava se vrednost diverziteta sa evennessom.

Вегетационно-динамические исследования над сообществами растений типа Nanocyperion. Дивергенция и сукцессия

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Резюме

В работе исследованы изменения дивергенции и равномерности (evenness) в пространстве и во времени у растений зоны Nanocyperion русла реки. Типичные сообщества, возникшие в результате сукцессии, характеризуются относительно низкой, а переходные биоценозы — более высокой дивергенцией. Увеличение дивергенции растительности более низких уровней, приближающихся к Agropyro-Rumicion сопровождается ростом показателя равномерности (evenness).

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ОПЫТ ВОССТАНОВЛЕНИЯ ВЕРХНЕЙ ГРАНИЦЫ ЛЕСА В КАРПАТАХ

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Аннотация

Изложены результаты тридцатилетних исследований способов восстановления верхней границы леса в Карпатах. Опыты заложены в 1959 году на южном склоне полонины Ровной (1200—1400 м над ур. м.), где естественная граница снижена на 150—200 м. В статье приводятся данные о подборе видового состава древесных пород, способах выращивания и лунковом методе посадок саженцев, приживаемости в экстремальных условиях, ходе роста и прироста культур. Обобщен опыт и разработаны рекомендации по восстановлению верхней границы леса в горах.

Введение

В Карпатах граница леса из субальпийскими лугами-полонинами имеет вид волнистой непрерывной линии (иногда она переходит в редколесье) и достигает, в среднем, высоты 1372 м над ур. м. В восточной части Украинских Карпат темнохвойные леса из *Picea abies* (L) Karst. доходят до субальпийского пояса (г. Кукул, 1540 м над ур. м.). В западной части граница леса, на некоторых вершинах, образована *Fagus sylvatica L.* (1300—1350 м над ур. м.). Климатическая граница, в частности на г. Поп Иван Мармарошский, достигает 1700 м над ур. м.

Главным фактором, влияющим на динамику субальпийского леса, в настоящее время является антропогенный (Комендар 1966). Так, многовековая пастбищная нагрузка имела большое влияние на формирование приполонинского леса. Сегодня в отдельных местах граница леса снизилась от уровня климатической на 150—200 м (полонина Ровная, горы Стой, Плай, Великий Верх и на некоторых других вершинах Боржавских Полонин).

Снижение естественной верхней границы леса, уничтожение во многих местах криволесья, привело к послаблению защитных функций горных лесов и криволесья — основных приемников и распределителей влаги в горах. Это одна из главных причин нарушения равновесия между живой и неживой природой в высокогорье. В связи с этим одной из наиболее актуальных проблем высокогорья является проблема восстановления приполонинских лесов к пределам их естественной границы, особенно в тех местах, где нарушено равновесие в лесных экосистемах и где появляются селевые потоки, снежные лавины и т. п.

Материал и методика

В 1959 г. работники кафедры ботаники Ужгородского госуниверситета и Перечинского лесокомбината начали исследования по искусственному восстановлению верхней границы леса. С этой целью на южном склоне полонины Ровной (1200—1400 м над ур. м.), где естественная верхняя граница леса снизилась на 200 м, был заложен питомник для выращивания сеянев на площади 177 м². О первых результатах исследований уже сообщалось в литературе (Фодор 1962, 1963 1965, Комендар 1966, Комендар та ін. 1972, 1973). Сегодня насаждения леса имеют вид сплошной полосы шириной около 200 м (рис. 1).

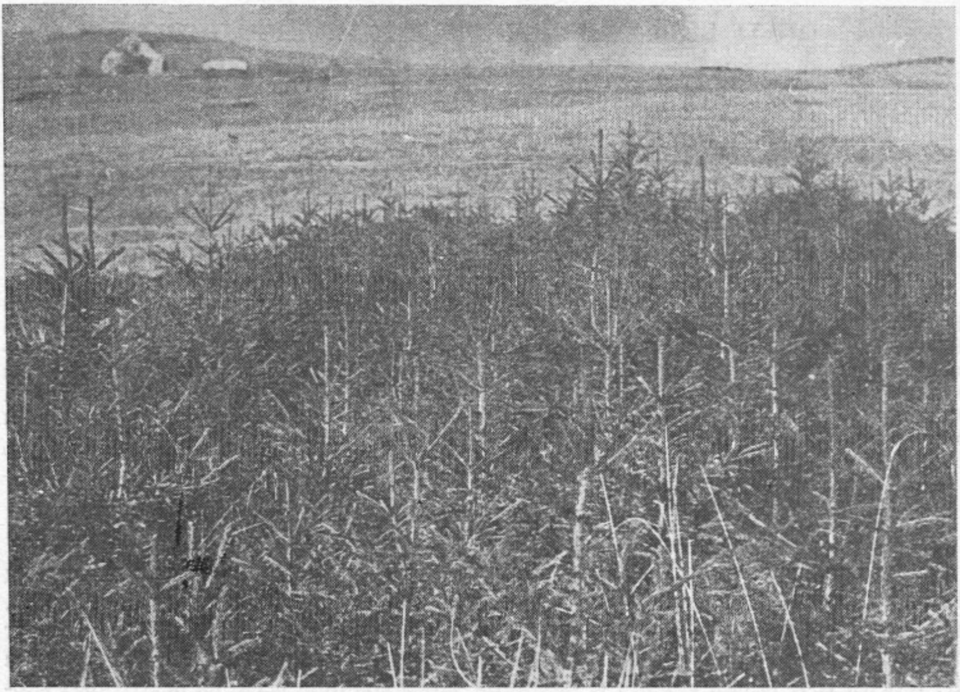

Рис. 1. Маладой лес вегращанний в лунках на паланинах в 1972 году (1290 м. н. у. м.)

Во время исследований был собран значительный материал, дающий возможность сделать предварительные выводы, дать определенные рекомендации производству.

Для восстановления верхней границы леса исключительное значение имеют жизнеспособные саженцы. Их необходимо выращивать в питомниках, заложенных в зоне приполонинских лесов (1000—1300 м над ур. м.). Собирать семена необходимо в высокогорных популяциях деревьев. Для посева следует отбирать первосортные элитные семена, проверенные на всхожесть, энергию прорастания и жизнеспособность ростков при низких температурах. С целью предупреждения поражения семиян грибком, перед посевом их необходимо обработать 0,5% раствором марганцевокислого калия.

Площадь, отведенная для питомника, перепахивалась и разделялась на участки площадью 2×5 м. Посев семян проводился осенью и весной. Присмотра за посевами не было.

При реконструкции и восстановлении верхней границы леса важным является способ его посадки. Дело в том, что в условиях открытой высокогорной местности субальпийского пояса культуры постоянно находятся под влиянием экстремальных, непривычных для них условий существования: низкие температуры зимой (от —30 до —40 °C), сильные ветры (50 км/час), высокая солнечная инсоляция летом при температуре до +25 °C, значительное количество осадков (1400—2000 мм в год), интенсивные эрозионные явления. Наши исследования дали возможность определить наиболее оптимальный способ посадки — лунковый, а также размеры лунки: от 0,5×0,5 до 2×2 м, глубину — до 20 см, плотность посадки 5—13 экз. (1250—10 000 экз/га. Благодаря этому способу посадки леса в высокогорье образуется микроклимат, который способствует выживанию и росту деревьев в экстремальных условиях. Большое значение при посадке леса в субальпийском поясе имеет и то, что посадочный материал выращивается в условиях, близки к естественным. Все это способствует не только хорошему приживанию саженцев, но и выживанию культур в процессе роста. Следует отметить, что в первый год (1959) на опытных участках посадки проводились 3-летними саженцами, которые были взяты из питомников лесокомбинатов, размещенных в горных районах Закарпатья. Это были саженцы таких древесных пород: *Picea abies* (L.) Karst., *Abies alba* Mill., *Pinus cembra* L., *Juniperus communis* L., *Sorbus aucuparia* L., *Acer pseudo-platanus* L., *Fagus sylvatica* L.

В последующие годы после посадок мы наблюдали значительное отмирание саженцев (отдельных пород до 30—40%). Поэтому на этих участках приходилось проводить ремонт путем посадки новых здоровых саженцев.

Размещение лунок на склонах в шахматном порядке способствует уменьшению эрозионных явлений, появлению солнечных ожогов деревьев, ослабляет силу ветров, транспирацию влаги из культур и испарение ее из почвы. На склонах, крутость которых превышает 15^0, перед лункой выравнивалась горизонтальная площадка шириной до 10 см. В каждую лунку высаживали по 10 саженцев 3-летнего возраста однопородных или смешанных культур. Начиная с 1968 г. мы проводили посадки леса саженцами *Picea abies*.

Состояние культур определялось по среднегодовым показателям годичного прироста главного и боковых побегов у 10 деревьев в насаждениях всех возрастных категорий. Прирост измерялся на протяжении вегетационного периода подекадно в 1964—1979 гг.

Результаты и обсуждение

Наблюдения за состоянием сеянцев и саженцев в питомниках, заложенных на полонине Ровной, свидетельствуют о том, что лучше перенесли суровые климатические условия хвойные породы (рис. 2). Однолетние сеянцы прижились хорошо, на 50—80%: *Abies alba* — 80%, *Acer pseudo-platanus* — 71%, *Pseudotsuga taxifolia* — 78%. Семена *Fagus sylvatica* очень повреждались грызунами и поэтому появились только одиночные их всходы. Многолетние исследования дают возможность сделать выводы, что при весеннем посеве в питомниках гибнет 23% сеянцев, а при осеннем — 58%.

В опытах по восстановлению верхней границы леса в Высоких Татрах (ЧССР) Сомора Ю. (Somora 1976, 1977) успешно использовал саженцы *Pinus cembra* L. и *P. mughus* Scop., которые там хорошо прижились. Саженцы *P. cembra* хорошо прижились и на полонине Ровная.

Были заложены также опыты по выявлению влияния плотности на жизнеспособность культур в посадках. Установлено, что наиболее жизнеспособными являются саженцы в загущенных посадках, в частности таких хвойных пород, как *Picea abies*, *Abies alba*, *Pseudotsuga taxifolia*, *Acer pseudo-platanus* и *Fagus sylvatica*. Они хорошо растут в смешанных насаждениях из *Picea abies* и *Abies alba*. Чистые разреженные насаждения лиственных пород деревьев, особенно *F. sylvatica* образуют кустарниковые формы и дают незначительный (3,6—13,4 см) прирост побегов (рис 2).

Площади опытных участков ежегодно расширялись за счет залеснения новых площадей, занятых формацией *Nardeta strictae* выращеными саженцами, в частности *Picea schrenkiana* Fish. и *Pinus sibirica* (Rupr.) Mayr. Их семена высевали в питомнике на полонине Ровной в 1972 г., а в 1975 г. верхняя граница леса здесь была восстановлена до высоты 1396 м над ур. м. Как видно из рисунка 2, наибольший среднегодовой прирост в насаждениях 1964 г. наблюдался у *Picea abies* (36,6 главного и 15,0 см боковых побегов), т.е., быстрее растут ее 16-летние саженцы. В насаждениях этого вида (1966 и 1967 гг.) среднегодовой

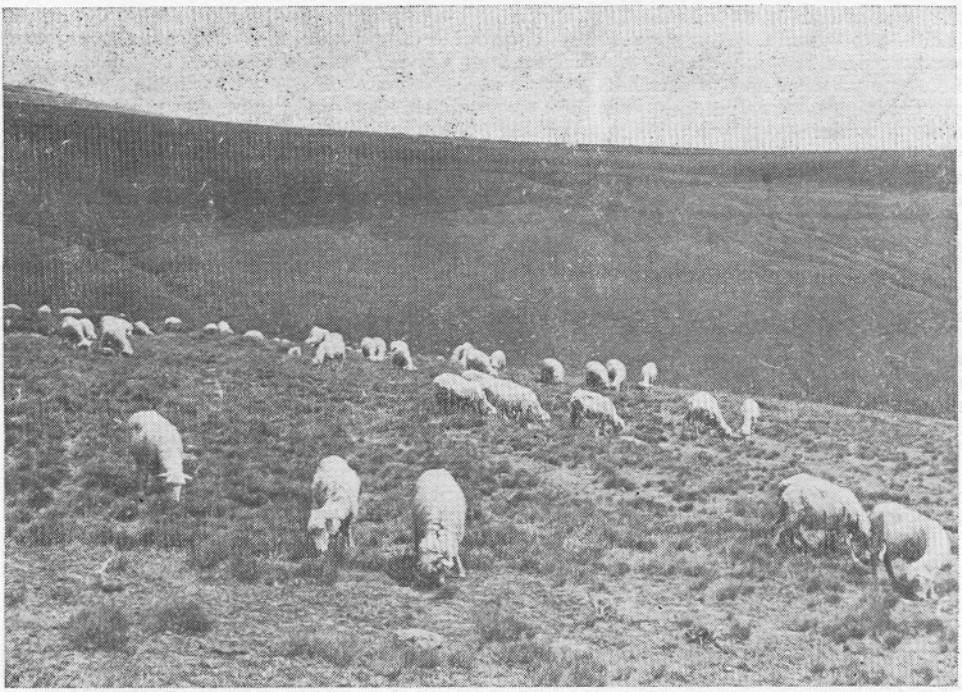

Рис. 2. Вошас борашек в високогодоном поясе гара Паланина Поленая.

прирост несколько меньший (32,2 и 24,3 см). В 1975 г. в насаждениях *P. abies* отмечено смыкание крон деревьев.

Второе место за приростом занимает *Pseudotsuga taxifolia.* Максимальный среднегодовой прирост которой в 16-летнем возрасте составлял 34,5 для главного и 16,3 см для боковых побегов. Среди лиственных пород наилучше растет *Sorbus aucuparia.* Среднегодовой прирост ее в 13-летних насаждениях составляет 19,2 для главного и 8,3 см для боковых побегов.

Не прижились в высокогорье *Pinus sylvestris* и *Pinus sibirica*, а также *Larix polonica* Racib., саженцы которой покрывались лишайниками и через нецоторое время погибали. Интересно отметить, что надземные побеги саженпев у *Pinus sylvestris* через 3—4 года после посадки, под влиянием снежного кокрова, были разостланы по земле, а позже, через 4—5 лет, тоже погибали.

Параллельно с исследованием прироста высаженных древесных культур велось наблюдение за сменой травостоя в насаждениях различного возраста. Сукцессионные изменения луговых ценозов к лесным можно изобразить схемой: Nardeta strictae → Deschampsieta caespitosae → Festuceta rubrae → Luzuleta nemorosae → Varieherbosae (после смыкания крон деревьев в насаждениях).

Изучение возможностей восстановления верхней границы леса дает возможность сделать такие выводы:

I. Восстановление верхней границы леса на открытой местности в экстремальных условиях субальпийского пояса необходимо осуществлять весной путем посадки 3—4-летних саженцев, выращенных из семян популяций автохтонных древесных пород.

2. Саженцы высаживают в лунки размером 0,5×0,5 или 2×2 м, глубиной до 20 см, расположенные в шахматном порядке на расстоянии 1—2 м друг от друга. В подготовленную лунку добавляют почву, взятую из буковых и хвойных лесов (она содержит споры и гифы грибов) и высаживают по 5—10 саженцев.

Наряду с восстановлением верхней границы леса необходимо проводить биологическое оздоровление криволесья и верхней границы леса. С этой целью у *Pinus mughus*, *Alnus viridis*, *Picea abies*, *Fagus sylvatica* и других видов деревьев, растущих в этой зоне, пригибают к земле нижние ветки, закрепляют их специальной рогаткой и засыпают почвой. Через некоторое время в этих местах образуются дополнительные корни. Через 2—3 года укорененные побеги отделяют. Их можно оставить на том самом месте или перенести в другое. Таким образом можно усилить защитные функции лесов и криволесья в субальпийской зоне.

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Vizsgálatok a különböző erdőállományok felső fahatárának megállapítására a Kárpátokban

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Kivonat

A Kárpátokban a különböző erdőállományok felső fahatárának megállapításával kapcsolatban harmincéves kutatási eredmények állnak rendelkezésünkre. Ezen vizsgálatok a Róna havasok déli lejtőin 1200—1400 m tengerszint felett realizálódtak, 1959-ben. Itt a természetes felső erdőhatár 150—200 m-ig szorult le. E közleményben e gondok megoldása érdekében adatok szerepelnek különböző fafajok ültetésének módszeréről, előkészítéséről, gondozásáról stb. Az elvégzett vizsgálatok eredményei jól hasznosíthatók a felső erdőhatár felemelésénél.

Istraživanja za utvrđivanje gornje granice različitih šumskih sastojina u Karpatima

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Abstract

Istrazivanja utvrdjivanja gornje granice šumskih sastojina u Karpatima obuhvataju 30-to godišnje rezultate. Ova ispitivanja su realizovana 1959. godine na južnim padinama snežnjaka Róna iznad 1200—1400 nadmorske visine. Na ovom području prirodna gornja granica šumskog pojasa je potisnuta na 150—200 m. U ovom saopštenju prikazani su podaci o metodama kultivisanja raznih vrsta drveća (priprema, sadjenje, održavanje itd) u cilju rešavanja datog problema. Rezultati ovih istraživanja mogu se uspešno koristiti za podizanje gornje granice šumskog pojasa.

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ИЗУЧЕНИЕ РЕПРОДУКТИВНОЙ БИОЛОГИИ ЭФЕМЕРОИДОВ БАССЕЙНА РЕКИ ТИСЫ (ЗАКАРПАТЬЕ)

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Аннотация

Проведены исследования особенностей репродуктивной биологии (семенного и вегетативного размножения) 7 редких и исчезающих видов эфемероидов Карпат на организменном и популяционно-видовом уровнях. На основании многолетних исследований установлено, что способность к генеративному размножению у изученных растений может быть низкой (высокогорные популяции *Narcissus angustifolius* Curt.), удовлетворительной (*Leucojum aestivum* L., *L. vernum* L., равнинно-предгорные популяции *N. angustifolius*), хорошей (*Erithronium dens-canis* L.) и высокой (*Colchicum autumnale* L., *Crocus heuffelinaus* Herb.). Процент обсеменения у *Ornithogalum umbellatum* L. в разные годы изменяется от удовлетворительного до высокого уровня или вовсе не обеспечивается. Определены факторы, влияющие на величину семенной продуктивности и энергию вегетативного размножения эфемероидов. Установлены особенности их репродуктивной стратегии в разных экологофитоценотических условиях и режимах антропогенного воздействия.

Введение

Однойиз перв оочередных задач при разработке мероприятий по охране и воссозданию редких и исчезающих видов природной флоры в естественных местообитаниях и в условиях интродукции является изучение их репродуктивной биологии. Как известно, она охватывает биологию и экологию возобновления популяций, т.е. стратегию жизни вида в разных условиях физико-географической среды и антропогенного воздействия.

Целью наших исследований являлось изучение репродуктивной биологии эфемероидов Закарпатья на организменном и популяционно-видовом уровнях. Поскольку данная проблема имеет комплексный, многогранный характер в настоящей работе мы остановимся на наиболее важных ее аспектах — генеративном и вегетативном размножении.

Особенности репродуктивной биологии исследовались у таких растений как *Colchicum autumnale* L., *Crocus heuffelianus* Herb., *Erythronium dens-canis* L., *Leucojum aestivum* L., *L. vernum* L., *Narcissus angustifolius* Curt., *Ornithogalum umbellatum* L. Перечисленные виды относятся к биологической группе эфемероидов — растениям с коротким, обычно весенним периодом развития (лишь *C. autumnale* — гистерантный вид). Будучи высокодекоративными растениями, они интенсивно уничтожаются: срываются в больших количествах на букеты и выкапываются для пересадки. В последнее десятилетие отмечается прогрессирующее сокращение ареалов многих видов, фрагментация и исчезновение отдельных популяций, уменьшение их численности до критического уровня и вследствие этого усиливающаяся эррозия раритетного генофонда (Кріичфалушій та ін., 1987). В то же время большинство из них на территории СССР произрастают только в данном регионе, являются медоносными, эфиромасличными, пищевыми и лекарственными растениями, а также обладают прекрасными декоративным свойствами. В связи и ускорением процессов антропогенной трансформации местообитаний, прямого уничтожения вышеупомянутых видов и отдельных популяций они занесены в «Красную книгу СССР» (1984) и «Червону книгу Української РСР» (1980). Насегодня назрела настоятельная необходимость изучения эколого-биологических особенностей эфемероидов, в частности их репродуктивной биологии с целью организации эффективной системы мероприятий, направленных на сохранение их генофонда и восстановление естественного ареала.

Материал и методика

Изучение особенностей семенного и вегетативного размножения исследуемых видов проводилось в следующих географических пунктах Закарпатья:

1. Притисянская низменность — 1. урочище Переш, окрестности с. Червоное Ужгородского р-на, заплавная дубрава, 110 м над ур. м.; 2. окрестности г. Чоп того же р-на, мезогигрофильный луг, 109 м над ур. м.; 3. окрестности с. Сторожница того же р-на, мезофильный луг, 116 м над ур. м.; 4. окрестности с. Оноковцы того же р-на, дубрава на холмистых низкогорьях, 180 м над ур м.

II. Предгорный пояс Карпат — 5. окрестности с. Холмец Ужгородского р-на, дубняк грабовый, 250 м над ур. м.; 6. окрестности с. Ставное, В. Березнянского р-на, мезофильный луг, 399 м над ур. м.; 7. окрестности с. Березинка Мукачевского р-на, дубняк грабовый, 230 м над ур. м.; 8. урочище Била Млака, окрестности с. Иза Хустского р-на, мезофильный луг, 200 м над ур. м.; 9. урочище Киреши, окрестности г. Хуста, мезогигрофильные луга, 180—200 м над ур. м.; 10. урочище Шаян, окрестности пос. Вышково того же р-на, дубняк грабово-буковый, 240 м над ур. м.; 11. урочище Дубровы, окрестности пос. Буштино Тячевского р-на, пойменная дубрава, 250 м няд ур. м.; 12. урочище Дубки, окрестности с. Нересница того же р-на, дубняк буковый, 386 м над ур. м.

III. Нижний горный пояс Карпат — 13. окрестности пос. Н. Ворота Воловецкого р-на, мезофильный луг, 515 м над ур. м.

IV. Высокогорный пояс Карпат (Свидовецкий хребет) — 14 г. Апецка, мелкозлаковый луг, зеленоольховое криволесье, верхняя граница букового леса, 1300—1400 м над ур. м.; 15. г. Подпула, можжевеловое криволесье, 1450 м над ур. м.; 16. г. Стог, крупнозлаковый луг, 1500 м над ур. м.

При изучении генеративного размножения определялись: потенциальная семенная продуктивность (ПСП) — количество семяпочек на плод; фактическая семенная продуктивность (ФСП) — количество семян на плод; процент обсеменения (ПО) — рпоцент семяпочек, развившихся в семена. У многоцветковых растений вычислялся процент плодоцветения — количество цветков образовавших плод (Работнов 1950, Вайнагий 1974). Для определения этих показателей в каждой из популяций рендомным методом исследовалось по 50 учетных особей. Полученный цифровой материал обрабатывался статистическими методами (Зайцев 1973 и др.). Для каждого среднего арифметического ($\overline{X}$) рассчитывались: стандартная ошибка ($S_{\bar{x}}$), коэффициент вариации (V), критерий достоверности Стьюдента (t) и показатель точности исследования (P). Разница между средними значениями показателей семенной продуктивности оценивалась с помощью критерия Стьюдента. Особенности вегетативного размножения исследовались согласно методике М. С. Шалыта (1960).

Результаты и обсуждение

Colchicum autumnale — исчезающий, осенне-цветущий вид; произрастает в логовых сообществах Карпат на высотах от 100 до 800 м над ур. м. Количественные показатели его семенной продуктивности показывают достаточную обеспеченность семенного возобновления. Во всех исследованных популяциях наблюдается высокий процент развития семязачатков в полноценные семена (табл-1). Несколько меньшие значения ПО популяции Ставное, по сравнению с другими местообитаниями, можно объяснить, наверное, более интенсивным антропогенным воздействием (пастбищный сбой).

Crocus heuffelianus — сокращающееся в численности ранневесеннее растение Закарпатья. Встречается во всех поясах растительности: от низменности до альпийских лугов. Как видно из табл. 2, потенциальная и фактическая семенная продуктивность вида в разных эколого-фитоценотических и погодно-климатических условиях практически не отличаются. Это свидетельствует, наряду с высокими значениями процента обсеменения (ПО = 77,54—80,45%), о хорошей приспособленности *C. heuffelianus* к изменяющимся условиям внешней среды (разные типы фитоценозов, вертикальная амплитуда местообитаний от 100 до 2000 м над ур. м. и др.).

Erythronium dens-canis — исчезающий ранневесенний вид широколиственных лесов предгорного пояса Карпат. Очень редко встречаются изолированные местообитания растения на высокогорных лугах Свидовца и его отрогов. Проведенные исследования показали, что предгорные популяции вида по основным параметрам семенной продуктивности существенно между собой не отличаются. Процент обсеменения в разные годы наблюдений изменялася от 52,34% до 54,15% (табл. 3), что указывает на хорошее семенное пополнение популяций.

Leucojum aestivum — исчезающее средневесеннее растение пойменных дубрав Притисянской низменности. Отдельные сведения о генеративном размножении вида публиковались нами ранее (Сабадош, Комендар 1986). Установлено, что значительное влияние на уровень его семенной продуктивности оказывает режим разлива рек, затопляющих местообитания вида. В табл. 4 приведены данные о семенной продуктивности *L. aestivum* за последние три года. Из них следует, что в 1985 г. процент плодоцветения был минимальным — 48,83% и существенно отличался (P = 0,001) от аналогичных показателей в предыдущий и последующий годы. Это можно объяснить вымоканием нижних цветков соцветия вследствие чего плоды образовались лишь на верхних, более высокопродуктивных побегах. За счет этого заметно увеличился процент обсеменения, однако общий урожай семян популяции, естественно, уменьшился.

Leucojum vernum — сокращающийся в численности ранневесенний вид с широкой амплитудой распространения — от равнины до высокогорных лугов. Изучение особенностей генеративного размножения показало, что популяции *L. vernum* произрастающие на низменности и в предгорном поясе по значениям ПСП существенно превышают (P = 0,001) популяции верхнегорного пояса (табл. 5). В отношении ФСП равнинные и предгорные популяции, несмотря на сходные значения ПСП отличаются между собой. Максимальное число семян на плод (ФСП = 13,18—13,87) образуется в популяции Дубки, обитающей в поясе дубовых лесов. Низкое значение ПСП в популяции Киреши, приуроченной к луговым ценозам, может быть связано с их ежегодным затоплением, совпадающим по времени с цветением и завязыванием плодов у *L.*

Таблица 1. Потенциальная и фактическая семенная продиктивность Colchicum autumnale

Популяция	Год наблюдения	ПСП						ФСП						ПО (%)
		$\bar{X}$	$S_{\bar{x}}$	V	t	P	лимиты	$\bar{X}$	$S_{\bar{x}}$	V	t	P	лимиты	
Низменность														
Чоп	1984	136,48	6,80	35,23	20,07	4,98		119,02	3,80	26,88	31,32	3,19		87,20
	1985	134,79	5,66	29,68	23,81	4,20		100,84	4,24	29,73	23,78	4,20		74,81
	1986	138,40	3,93	20,07	35,21	2,84		94,98	2,68	19,98	35,44	2,82		68,63
Предгорный пояс														
Ставное	1984	155,04	2,94	13,42	52,73	1,84		99,00	1,15	8,22	86,08	1,16		63,85
	1985	147,80	2,44	17,27	60,57	1,65		100,20	3,13	22,09	32,01	3,12		67,79
	1986	164,62	4,22	18,13	39,01	2,56		112,32	3,40	21,44	33,03	3,03		68,23
Нижний горный пояс														
Нижние Ворота	1984	129,58	3,91	21,32	33,17	3,02		111,20	3,07	19,50	36,22	2,75		85,75
	1985	140,96	3,07	15,38	45,91	2,17		119,52	2,21	13,08	54,08	1,85		84,79
	1986	164,08	3,99	28,21	41,12	2,43		121,64	2,98	17,37	40,82	2,45		74,13

Тадлица 2. Потенциальная и фактическая сетенная продуктивность Crocus heuffelianus

Популяция	Год наблю-дений	ПСП						ФСП						ПО (%)
		$\bar{X}$	$S_{\bar{x}}$	V	t	P	лимиты	$\bar{X}$	$S_{\bar{x}}$	V	t	P	лимиты	
Предгорный пояс														
Березинка	1985	30,11	0,90	21,13	33,46	3,00	5—48	24,11	1,32	38,71	18,27	5,49	4—50	80,07
	1986	30,84	1,01	23,15	30,53	3,27	4—49	24,81	1,49	42,46	16,65	6,03	3—53	80,45
Дубки	1985	30,62	1,03	23,78	29,73	3,35	4—50	24,31	1,24	36,06	19,60	5,09	5—45	79,40
	1986	31,18	1,09	22,90	28,61	3,49	3—47	24,98	1,46	41,32	17,11	5,84	4—48	80,12
Высокогорный пояс														
Апецка	1985	31,30	1,00	22,59	31,18	3,20	3—49	24,27	1,37	39,91	17,72	5,64	3—44	77,54
	1986	30,87	1,15	26,34	26,84	3,71	3—51	24,19	1,49	43,55	16,23	6,17	4—51	78,35

Таблица 3. Потенциальная и фактическая семенная продуктивность Erythronium dens-canis

Популяция	Год наблю-дения	ПСП						ФСП						ПО (%)
		$\bar{X}$	$S_{\bar{x}}$	V	t	P	лимиты	$\bar{X}$	$S_{\bar{x}}$	V	t	P	лимиты	
Предгорный пояс														
Шаян	1985	41,09	1,75	30,11	23,48	4.27	9—81	22,03	1,28	41,08	17,21	5,82	3—42	53,61
	1986	40,26	1,88	32,94	21,41	4,66	10—86	21,80	1,13	36,74	19,29	5,18	2—39	54,15
Дубки	1985	40,72	1,76	30,56	23,14	4,33	10—71	21,31	1,24	41,14	17,19	5,84	1—40	52,34
	1986	41,90	1,89	31,89	22,17	4,51	9—74	22,32	1,19	37,69	18,76	5,33	2—37	53,27

Таблица 4. *Семенная продуктивность Leucojum aestivum*

Популяция	Год наблюдения	Учетная единица	Побег			Плод		
		Показатель	Цветоножки	Плоды	Плодоцветение (%)	ПСП	ФСП	ПО %
Низменность Перещ	1984	$\bar{X}$	3,82	2,90	76,97	23,88	3,88	15,99
		$S_{\bar{x}}$	0,14	0,15	3,11	0,49	0,23	0,84
		t	27,29	19,33	27,75	48,73	16,87	19,04
		V	26,18	35,86	28,54	14,45	42,27	37,02
		P	3,72	5,05	4,04	2,05	5,93	5,24
		лимиты	2—6	1—5	25—100	17—33	1—9	5—31,03
	1985	$\bar{X}$	3,56	1,62	47,07	26,60	4,92	18,50
		$S_{\bar{x}}$	0,13	0,12	3,55	0,46	0,28	1,01
		t	26,47	13,41	13,82	57,83	17,57	18,32
		V	26,71	52,75	53,47	12,33	40,45	38,59
		P	3,77	7,46	7,56	1,74	5,72	5,46
		лимиты	2—6	0—4	0—100	20—33	1—10	4,76—35,71
	1986	$\bar{X}$	4,12	2,52	60,73	27,80	4,18	14,93
		$S_{\bar{x}}$	0,16	0,14	2,39	0,57	0,30	1,03
		t	25,75	18,00	25,41	48,77	13,93	14,50
		V	27,91	39,29	27,76	14,53	50,72	48,83
		P	3,96	5,58	3,93	2,06	7,19	6,90
		лимиты	2—7	1—5	25—100	19—39	1—11	3,23—36,67

vernum. В связи с этим ПО этой популяции минимальный, несмотря на максимальные значения ПСП. В более суровых погодно-климатических условиях верхнегорного пояса у *L. vernum* образуется примерно такое же число семян на плод, как и в затапливаемых местообитаниях низменности (табл. 5). Однако ПО горных популяций заметно выше и практически соответствует таковому предгорных популяций.

Narcissus angustifolius — редкий, сокращающийся в численности ранневесенний вид лугов и криволесий субальпийского пояса Карпат, а также пойменных дубрав предгорий и влажных лугов низменности. По всем параметрам семенной продуктивности исследованные популяции разделяются на две группы. Первую образуют популяции, произрастающие в равнинно-предгорном поясе, вторую — высокогорные популяции. Значения величины ПСП популяций субальпийского пояса в среднем за 4 года наблюдений на 19,55% ниже, чем равнинно-предгорных, ФСП соответственно — на 67,61%, а ПО — на 59,42% (табл. 6). Интересно, что ПСП популяции Дубровы несколько выше (при $P=0{,}05$), чем у двух других равнинно-предгорных популяций. Это, по-видимому, связано с тем, что в данном местообитании реализуется экологический оптимум вида. Проведенный нами (Комендар, Кричфалуший 1986) дисперсионный анализ и сравнение показателей количества семяпочек и семян по критерию Дункана показал, что разница между популяциями из разных высотных поясов достоверна по всем порогам вероятности безошибочных прогнозов ($P=0{,}001$). С помощью двухфакторного дисперсионного анализа было установлено, что сила влияния климатических условий на величину ПСП, например в 1983. г., составляла $\eta^2=0{,}36\pm0{,}072$ (достоверность влияния $F=13{,}4$), а на

Таблица 5. *Потенциальная и фактическая семенная продуктивность Leucojum vernum*

Популяция	Год наблюдения	ПСП						ФСП						ПО (%)
		$\bar{X}$	$S_{\bar{x}}$	V	t	P	лимиты	$\bar{X}$	$S_{\bar{x}}$	V	t	P	лимиты	
Низменность														
Киреши	1985	38,47	0,58	10,66	66,33	1,51	6—39	7,79	0,23	20,87	33,87	2,95	0—18	20,25
	1986	39,23	0,69	12,44	56,86	1,76	5—37	8,22	0,24	20,64	34,25	2,92	0—17	20,95
Предгорный пояс														
Дубки	1985	36,89	1,21	19,07	30,41	3,29	9—42	13,18	0,49	26,28	26,89	3,72	2—23	35,81
	1986	37,49	1,30	24,51	28,83	3,47	8—45	13,87	0,50	25,49	27,74	3,60	1—21	36,69
Верхний горный пояс														
Апецка	1985	24,00	0,57	16,79	42,11	2,38	4—35	8,46	0,30	25,07	28,20	3,55	1—24	35,23
	1986	24,10	0,54	15,84	44,63	2,24	4—36	8,62	0,28	22,97	30,79	3,25	2—22	35,76

величну ФСП — $\eta^2=0{,}22\pm0{,}072$ (достоверность влияния $F=8{,}5$). Следовательно, суровые условия высокогорья в значительной мере снижают уровень семенной продуктивности N. angustifolius.

Ornithogalum umbellatum — сокращающееся в численности средневесеннее растение. Встречается в дубовых лесах и на мезофильных лугах низменности и предгорного пояса. Исследование особенностей его генеративного размножения показало, что элементы семенной продуктивности вида в разных эколого-фитоценотических условиях отличаются между собой (Мезер-Крічфалушій 1987). Наблюдается увеличение показателей ПСП и ФСП с изменением условий от луговых к лесным ценозам (табл. 7.) Семенная продуктивность вида в разные годы исследований может изменяться от очень высокой (ПО = 88,36—95,59%) и средней (ПО = 42,79—47,97), до низкой (26,90—28,91) или вовсе не обеспечиваться (в 1984 г.) вследствие повреждения генеративной сферы особей сильными заморозками. Таким образом, семенное пополнение популяций *O. umbellatum* осуществляется нерегулярно, а его интенсивность и периодичность определяются комплексом экологофитоценотических и погодно-климатических условий.

Помимо генеративного размножения эфемероидов, нами также исследовались особенности их вегетативного размножения, которое имеет не меньшее биологическое значение, во многих случаях обеспечивая стойкое завоевание пространства.

Вегетативное размножение *C. autumnale* осуществляется посредством клубнелуковиц. К вегетативному размножению растения приступают в средневозрастном генеративном состоянии, образуя 1 дочернюю особь. В процессе вегетативного размножения возникают клоныгнезда с 25—32 клубнелуковицами. Энергия вегетативного размножения популяций *C. autumnale* с увеличением абсолютной высоты их местопроизрастаний почти не изменяется.

C. heuffelianus способен хорошо размножаться вегетативным путем. На клубнелуковице ежегодно образуются 1—2 или изредка 3—4 боковые почки. Темпы вегетативного размножения вида примерно одинаковы как в популяциях предгорного, так и высокогорного поясов. Однако соотношение генеративного и вегетативного размножения не одинаково, вследствие низкой приживаемости ювенильных особей в высокогорьях.

У *E. dens-canis* вегетативное размножение происходит с помощью 1—2 изредка 3 дочерних клубнелуковиц. Удельный вес вегетативно размножающихся особей в исследуемых популяциях равен 40—45% от числа всех взрослых особей. Энергия вегетативного размножения вида в пределах предгорного пояса довольно стабильна.

Вегетативное размножение *L. aestivum* начинается в виргинильном возрастном состоянии, достигая максимума в генеративном периоде развития. Боковые почки (1—2) закладываются параллельно с развитием почек возобновления. В результате многократных делений возникают крупные клоны, в которых может насчитываться до 100 побегов. Следует отметить, что образованию таких гнезд способствуют и особенности диссеминации вида. В исследуемой популяции вегетативно размножающиеся особи составляют 30—40% численности всех взрослых растений.

Способность к вегетативному размножению у *L. vernum* обнаруживается, как и у *L. aestivum*, в виргинильном возрастном состоянии. Энергия вегетативного размножения популяций и степень омоложения их потомства, в разных высотных поясах существенно отличаются. На низменности и в предгорье

Таблица 6. *Потенциальная и фактическая сетенная продуктивность Narcissus angustifolius*

Популяция	Год наблюдения	ПСП						ФСР						ПО (%)
		$\bar{X}$	$S_{\bar{x}}$	V	t	P	лимиты	$\bar{X}$	$S_{\bar{x}}$	V	t	P	лимиты	
Равнинно-предгорный пояс														
Дубровы	1983	94,24	2,15	16,11	43,83	2,28	65—129	27,52	1,86	47,76	14,79	6,76	3—58	29,20
	1984	91,60	2,09	18,18	43,83	2,28	59—127	19,48	1,61	58,42	12,10	8,26	2—46	21,27
	1985	91,74	2,04	15,71	44,97	2,22	66—120	22,52	1,75	54,94	12,87	7,77	1—45	24,54
	1986	91,32	1,90	14,73	48,06	2,08	63—116	23,44	1,29	38,91	18,17	5,50	3—47	25,67
Киреши	1983	94,78	1,93	14,37	49,11	2,04	62—121	21,38	2,05	68,87	10,43	9,59	1—60	22,56
	1984	91,60	2,13	16,44	43,00	2,33	54—120	15,48	1,48	67,60	10,46	9,56	3—48	16,89
	1985	92,50	1,54	11,77	60,06	1,66	75—120	20,18	1,64	57,38	12,30	8,13	0—58	21,82
	1986	90,72	2,12	16,51	42,79	4,95	55—120	20,24	1,48	51,83	13,68	7,31	8—48	22,31
Била Млака	1983	94,28	2,66	19,94	35,44	2,82	53—137	23,46	1,75	52,77	13,41	7,46	4—50	24,88
	1984	91,20	2,81	21,79	32,46	3,08	46—123	16,88	1,36	56,96	12,41	8,06	1—43	18,51
Высокогорный пояс														
Апецка	1983	70,36	1,89	18,98	37,23	2,69	43—105	7,86	0,97	87,28	8,10	12,34	0—28	11,17
	1984	73,92	2,04	19,47	36,24	2,76	49—113	6,68	0,76	80,05	8,79	11,38	0—19	9,04
	1985	75,94	1,79	16,67	42,42	2,36	52—99	7,42	0,85	80,59	8,73	11,46	0—25	9,77
	1986	73,36	1,89	18,21	38,31	2,58	45—107	7,00	0,86	87,29	8,14	12,28	0—27	9,54
Подпула	1983	72,40	1,54	15,03	47,01	2,13	46—103	7,02	0,72	72,72	9,75	10,26	0—19	9,69
	1984	75,82	1,87	17,48	40,55	2,47	54—104	5,84	0,55	66,95	10,62	9,46	0—15	7,70
	1985	74,00	2,39	22,81	30,96	3,23	52—105	7,20	0,84	82,92	8,57	11,67	0—25	9,73
	1986	74,56	1,59	15,09	46,89	2,14	48—105	6,22	0,72	81,35	8,64	11,58	0—19	8,34
Стог	1983	73,26	2,04	19,70	35,91	2,78	45—108	7,12	0,81	80,18	9,79	11,38	0—21	9,72
	1984	76,60	2,37	21,88	32,32	3,09	44—111	5,96	0,54	63,85	11,04	9,06	0—16	7,78
	1985	76,00	1,54	14,29	49,35	2,03	42—111	7,10	0,77	76,76	9,22	10,85	0—21	9,34
	1986	75,78	2,05	19,06	36,97	2,71	45—105	6,84	0,79	82,16	8,66	11,55	0—21	9,03

Примечание: В 1984 г. вследствие распашки земель популяция полностью уннчтожена

Таблица 7. *Потенциальная и фактическая семенная продуктивность Ornithogalum umbellatum*

Популяция	Год наблюдения	ПСП						ФСП						ПО (%)
		$\bar{X}$	$S_{\bar{x}}$	V	t	P	лимиты	$\bar{X}$	$S_{\bar{x}}$	V	t	P	лимиты	
Низменность														
Сторожница	1983	44,02	0,76	12,22	57,91	1,72	11—58	42,08	0,62	28,51	67,87	1,47	8—45	95,59
	1985	36,08	4,17	63,08	8,65	11,55	10—96	15,44	1,95	63,27	7,91	11,17	5—44	42,79
	1986	40,16	1,63	28,69	24,64	4,05	10—45	11,82	0,81	48,45	14,59	6,89	2—15	29,43
Предгорный пояс														
Оноковцы	1983	46,81	0,62	24,32	75,50	1,32	22—73	41,36	0,64	26,51	64,62	1,54	5—43	88,36
	1985	51,36	4,55	44,32	11,29	8,86	19—104	22,68	2,10	46,21	10,80	9,26	4—40	44,16
	1986	41,34	1,39	23,92	29,74	3,36	23—64	11,12	0,78	49,82	14,26	7,02	3—23	26,90
Холмец	1983	47,37	0,74	11,15	63,83	1,56	20—59	44,80	0,54	21,23	92,96	1,20	9—49	94,58
	1985	52,36	3,37	41,80	11,98	8,34	19—100	25,12	2,03	40,32	12,37	7,39	5—42	47,97
	1986	44,00	1,99	31,98	22,11	4,54	19—80	12,72	0,64	35,57	19,88	5,03	8—35	28,91

удельный вес вегетативно размножающихся особей в популяциях (4,26—4,59%) примерно в четыре раза ниже, чем в верхнем горном поясе (17,08%). В первом типе местообитаний на материнской особи образуется не больше одной дочерней луковицы, а во втором — до четырех побегов одновременно. Основную массу вегетативного потомства генеративных растений в равнинно-предгорных условиях составляют виргинильные особи (83,34—100%), а в нижнегорных — имматурные (56,89%). Очевидно, экологические условия у верхней границы буковых лесов неблагоприятные для семенного размножения *L. vernum* и высокая энергия вегетативного размножения, как и более глубокое омоложение вегетативного потомства являются приспособлением для самоподдержания численности популяций в экстремальном окружении.

У *N. angustifolius* вегетативное размножение начинается в виргинильном возрастном состоянии. Органами размножения являются боковые побеги, образующиеся из вегетативных почек (1—2 или редко 3), которые закладываются в пазухах ассимилирующих листьев. В генеративном периоде энергия вегетативного размножения растений наиболее высока. При переходе в следующее возрастное состояние она уменьшается и вегетативное размножение превращается в сенильный распад старческих особей. По степени омоложения вегетативное потомство *N. angustifolius* в зависимости от формы партикуляции варьирует от имматурного до генеративного состояния. В процессе вегетативного размножения возникают группы тесно растущих особей (до 79 экз.), которые проходят три этапа развития: молодого, зрелого и стареющего клона. Энергия вегетативного размножения вида зависит от эколого-фитоценотических условий местообитания и коррелирует с интенсивностью семенного размножения. В равнинно-предгорной зоне его роль в самоподдержании лесных популяций ничтожно мала (к вегетативному размножению способны 3,05—3,48% особей от общего числа растений) и лишь несколько возрастает на разнотравно злаковых (5,31—5,60%) и высокотравных (7,27—7,63%) лугах, однако заметно уступает эффективности семенного размножения. В высокогорном поясе вегетативное размножение полностью преобладает (26,65—36,36%), поскольку семенное возобновление популяций здесь практически не совершается.

O. umbellatum весьма интенсивно вегетативно размножающийся вид. Вегетивное размножение наблюдается у него уже в имматурном возрастном состоянии. В меру перехода к следующему этапу онтогенеза способность к вегетативному размножению усиливается и достигает максимума в генеративном периоде. На одном материнском растении образуется до 60—80 дочерних луковиц-деток. Вегетативное потомство *O. umbellatum* глубокоомолоненное, его составляют ювенильные и имматурные особи. Несмотря на многочисленное вегетативное потомство растение клонов не образует. Это можно объяснить интенсивной деятельностью контрактильных корней, в результате которой луковички перемещаются не только в вертикальном, но и в горизонтальном направлении. В связи с этим распределение особей в популяциях имеет диффузный характер.

Таким, образом, у исследованных видов эфемероидов выявлен ряд общих закономерностей генеративного размножения: 1. у них хорошо выражены все элементы семенной продуктивности; 2. число семяпочек значительно более стабильно, чем семян; 3. разница между числом семяпочек по годам почти у всех видов гораздо меньше, чем для семян, что свидетельствует, наряду с предыдущей характеристикой, о наследственной детерминированности ПСП; 4. уровень ФСП определяется главным образом условиями внешней среды.

По способности к генеративному размножению изученные растения разделяются (на основании величины ПО) на виды с низкой (менее 10%) — высокогорные популяции *Narcissus angustifolius*; удовлетворительной (10—30%) — *Leucojum aestivum*, *L. vernum*, равнинно-предгорные популяции *N. angustifolius* хорошей (30—60%) — *Erythronium dens-canis* и высокой (более 60%) — *Colchicum autumnale*, *Crocus heuffelianus* семенной продуктивностью. ПО у *Ornithogalum umbellatum* сильно варьирует и в разные годы изменяется от удовлетворительного до высокого уровня или вовсе не обеспечивается.

Для вегетативного размножения эфемероидов характерны следующие особенности: 1. совершается посредством боковых побегов, образующихся из вегетативных почек (1—2, редко 3—4 и лишь у *Ornithogalum umbellatum* их число достигает нескольких десятков); 2. начинается в виргинильном возрастном состоянии (у *O. umbellatum* в имматурном), достигает максимума в генеративном, а при переходе в сенильное превращается в партикуляцию старческих особей; 3. степень омоложения вегетативного потомства варьирует от имматурного до генеративного возрастного состояния; в *O. umbellatum* размножение сопровождается глубоким омоложением потомства (преобладают ювенильные и имматурные особи); 4. у высокогорных популяций *Narcissus angustifolius* и *Leucojum vernum* размножение начинается в более ранних возрастных состояниях, чем у равнинно-предгорных популяций и сопровождается образованием более глубокоомоложенного потомства; 5. в ходе размножения растений (за исключением *O. umbellatum*) возникают компактные группы особей, которые проходят три этапа развития: молодого, зрелого и стареющего клона.

В заключение следует отметить, что репродуктивная стратегия большинства исследуемых видов изменяется в зависимости от условий физико-географической среды, обеспечивая тем самым оптимальное сочетание вегетативного и семенного возобновления. В благоприятном эколого-фитоценотическом окружении преобладает генеративное возобновление популяций, способствующее возрастанию их генотипической гетерогенности. Наряду с этим осуществляется и вегетативное возобновление, стабилизирующее генотипическую структуру популяций. В экстремальных условиях соотношение способов возобновления популяций изменяется в сторону преобладания вегетативного размножения особей, образования клонов и уменьшения роли семенного потомства.

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Ritka növényfajok reproduktív biológiájának vizsgálata a kárpátalljai Tisza-völgyben

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Kivonat

Kárpátalja hét ritka illetve veszélyeztetett évelő növényfaja reproduktív biológiájának vizsgálati eredményei kerültek itt közlésre. Több év adatainak feldolgozása során megállapítható volt, hogy e fajoknál a generatív szaporodás lehetősége meglehetősen eltérő. Amíg a *Narcissus angusticolius* Curt. magashegyi populációiban alacsony, a *Leucojum aestivum* L., a *L. vernum* L, s a *Narfissus angustifolius* síksági populációiban kielégítő, az *Erythronium dens-canis* L. esetében jó, a *Colchicum autumnale* L. és a *Crocus heuffelianus* Herb.-nél magas. Ugyanakkor viszont az *Ornithogalum umbellatum* L. magtermése igen változó, a kielégítőtől a magas hozamig. Megállapítást nyertek azok a tényezők, amelyek hatással vannak a mag útján történő szaporodás mennyiségére és a vegetatív szaporodás mértékére. Meghatározást nyertek ezen évelő fajok reproduktív stratégiájának sajátosságai, a különböző ökológiai fitocönologiai és antropogén hatások figyelembevételével.

Ispitivanje reproduktivne biologije retkih vrsta biljaka u dolini reke Tise na podnožju Karpata

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Abstract

U radu su prikazani rezultati ispitivanja reproduktivne biologije 7 retkih odnosno ugroženih višegodišnjih vrsta biljaka sa podnožja Karpata. Višegodisnji rezultati ispitivanja pokazuju da su mogućnosti razmnožavanja generativnim putem kod pojedinih vrsta veoma različita. Tako ono je u populacijama *Narcissus angustifolius* Curt. sa visokoplaninskih predela niska, u slučaju populacija *Leucojum aestivum* L., *L. vernum* L., i *Narcissus angustifolius* sa nizijskih područja zadovoljava, kod *Erythronium dens-canis* L. dobra, dok je u slučaju Colchicum autumnale L. i *Crocus heuffelianus* Herb. visoka. S druge strane fruktifikacija je kod *Ornithogalum umbellatum* L. promenljiva od prosečnog do visokog prinosa. Utvrdjeni su i oni faktori koji utiču na obim razmnožavanja putem plodova i nivo vegetativnog razmnožavanja. Utvrdjeni su specifičnosti reproduktivne strategije navedenih vrsta višegodišnjih biljaka u funkciji ekološkog, fitocenološkog i antropogenog uticaja.

Tiscia (Szeged) Vol. XXII, pp. 75—81 (1987)

БИОМОРФОЛОГИЧЕСКИЕ ОСОБЕННОСТИ ROSA CANINA L. В НЕКОТОРЫХ ПОПУЛЯЦИЯХ БАССЕЙНА РЕКИ ТИСЫ

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Аннотация

Изложены результаты биоморфологического исследования *Rosa canina* L. в трех популяциях Закарпатья. Приведены данные анализа внутри- и межпопуляционной изменчивости 17 вегетативных и генеративных признаков. Изучены полиморфизм и жизнеспособность пыльцевых зерен. Освещены наиболее важные эмбриональные процессы. Определена потенциальная и фактическая семенная продуктивность. Установлена оптимальная доза влияния лазерного облучения на прорастание семян из гипантиев разной спелости. Рассматриваются вопросы восстановления запасов этого ценного витаминоносного сырья путем создания природных культивируемых массивов.

Введение

Одной из важнейших задач современной систематики является изучение вида на уровне популяций, в пределах которых вид существует как таксономическая единица и протекают микроэволюционные процессы.

Исследование структуры природных популяций заключается в выявлении их полиморфизма и цельности на основе анализа особенностей признаков вегетативных и генеративных органов.

В значительной степени это относится к видам со сложными генетическими системами и специфическим способом репродукции, к которым принадлежит R. canina.

Бассейн р. Тисы, в пределах территории Закарпатья, создает своеобразные экологические условия для произрастания локальных популяций многих видов растений, в том числе и комплексного вида *Rosa canina* из состава которого известный флорист А. Маргиттай (Margittai 1923) выделил 20 разновидностей. Позже видовой состав *Rosa* изучали П. Д. Ярошенко (1945), В. Г. Хржановский (1949), С. С. Фодор (1956, 1974). На уровне популяций *R. canina* не исследовалась.

Материал и методика

Наблюдения и сбор материала проводились в трех популяциях *R. canina*, расположенных в равнинно-предгорной зоне (197—620 м над ур. м., популяции 1 и 2) и нижнегорном поясе (821 м над ур. м., популяция 3) Украинских Карпат.

Для изучения биоморфологических особенностей, а также внутри- и межпопуляционной изменчивости вида из каждой популяции рендомным методом отбиралось 50 генеративных особей, которые исследовались по 17 морфологическим признакам. Полученные цифровые данные обрабатывались вариационно-статистическими методами (WEBER 1961, Плохинский 1970, Зайцев 1973). Определялись основные статистические показатели, проводились корреляционный и регрессионный анализы. Расчеты проведены на ЭВМ ЕС—1020, программа составлена на алгоритмическом языке FORTRAN — IV.

Морфология пыльцевых зерен изучалась при помощи сканирующего электронного микроскопа (JEM—35 C), жизнеспособность пыльцевых зерен исследовалась антморфологическим методом, предложенным С. С. Хохловым (1971), с помощью люминесцентной микроскопии и проращиванием пылцы на искусственных питательных средах с разной концентрацией сахарозы.

Эмбриологические исследования были проведены по общей цитологической методике (Паушева 1980 и др.). Рисунки выполнялись рисовальным аппаратом РА—4, микросбемка — с помощью микроскопа Ergaval-Zeiss с микрофотографическим устройством mf-matic, а также стереоскопического микроскопа МБС—9.

Изучалось влияние лазерного излучения на всхожесть семян путем облучения их монохроматическим красным светом He—Ne лазера ОКГ—15 с мощьностью излучения 15 мвт, длиной волны 6328 Å. Время экспозиции выбиралось произвольно. Определение семенной продуктивности проводилось по методике Т. А. Работнова (1969) и И. В. Вайнагия (1974).

Результаты

До настоящего времени *R. canina* на уровне популяций не исследовалась, тогда как это необходимо и при флористических, и при цитоэмбриологических исследованиях для полного понимания микроэволюционных и репродуктивных процессов в пределах сложных в таксономическом отношении видов.

Для изучения биоморфологических особенностей *R. canina* применен анализ внутри — и межпопуляционной изменчивости вегетативных и репродуктивных признаков. Географическая изменчивость исследовалось по 17 признакам (таблица 1).

Анализ внутрипопуляционной изменчивости вегетативных и репродуктивных признаков *R. canina* показал, что подавляющее большинство из них имеет среднюю степень варьирования ($V = 11—20\%$). Полиморфизм таких признаков, как 1, 2, 3, 4, 11, 12, 13, 14, 17 довольно высок ($V > 20\%$) и определяется экологическими условиями местообитания. Признаки с низкой и средней степенью варьирования могут использоваться в качестве критериев морфологической дифференциации популяций, поскольку они довольно стабильны и не зависят в значительной степени от экологических факторов.

Характер варьирования признаков популяций в пределах одного высотного пояса в основном совпадает. Изменчивость признаков популяций из разных поясов имеет свои особенности, в результате чего кривые коэффициентов вариации не тождественны (рис. 1). В популяциях обоих поясов наблюдается корреляция между 11 признаками. Взаимосвязь между изучаемыми признаками выражается в виде линейной функции и представлена показателями уравнений регрессии.

Анализ межпопуляционной изменчивости показал, что процент разхождения между популяциями из одного пояса составляет 27,78%, а между популяциями из разных поясов — 33,33 — 38,89%. Биоморфологические исследования дают возможность сделать вывод о том, что такие признаки, как 4, 6, 11, 12, 13, 14, 15 и 16 имеют значение в систематике для определения микровидов в пределах сложного комплексного вида *R. canina*.

Таблица 1. *Географическая изменчивость признаков разных популяций R. canina L.*

№№ П/П	Признак	Популяции		
		1	2	3
1.	Длина однолетних побегов, мм	106,36	91,32	106,06
2.	Длина двухлетних побегов, мм	115,18	106,88	108,56
3.	Количество плодов на побегах	2,34	1,90	1,72
4.	Количество цветов на побегах	3,06	2,46	1,92
5.	Длина гипантия, мм	19,25	16,08	14,04
6.	Диаметр гипантия, мм	9,98	8,17	8,73
7.	Общая длина листьев, мм	95,24	80,60	84,62
8.	Длина верхних листьев, мм	37,04	31,92	33,32
9.	Длина средних листьев, мм	33,14	27,40	29,40
10.	Длина нижних листьев, мм	27,04	21,74	24,00
11.	Длина шипов на однолетних побегах, мм	4,17	3,54	3,72
12.	Диаметр шипов у основания на однолетних побегах, мм	4,08	3,60	3,73
13.	Длина шипов на двухлетних побегах, мм	4,55	4,07	4,55
14.	Диаметр шипов у основания на двухлетних побегах, мм	4,76	4,51	5,28
15.	Длина шипов на старых побегах, мм	8,55	7,49	7,88
16.	Диаметр шипов у основания на старых побегах, мм	8,68	8,00	9,29
17.	Количество семянок в гипантии	25,70	17,08	17,86

ПРИМЕЧАНИЕ: обведены и соединены средние значения признаков, между которыми отсутствует достоверная разница.

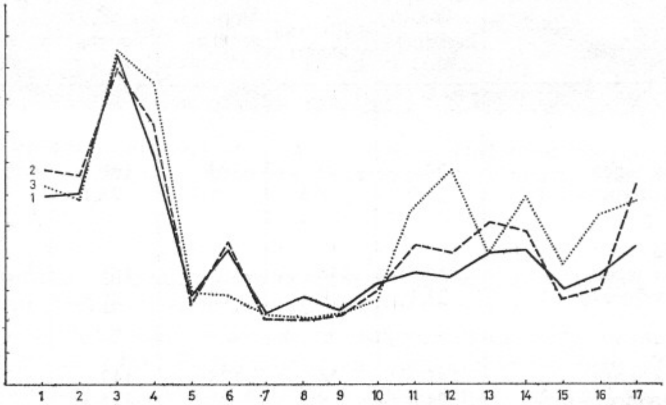

Рис. 1. Характер варьирования признаков популяций *Rosa canina* L. 1, 2 — предгорный пояс; 3 — нижнегорный пояс

По большинству изученных взаимосвязей между признаками все популяции *R. canina* относятся к одной генеральной совокупности. Математические данные свидетельствуют, что *R. canina* является комплексным видом и в пределах локальных популяций может иногда выщеплять микровиды.

Полиморфность *R. canina* проявляется как в макроморфологических чертах, так и в микроморфологических, в частности в размерах пыльцевых зерен. Высокий процент дефектных пыльцевых зеренкарликовых и гигантских — указывает на склонность таких видов к апомиктическому способу размножения (Хохлов, Зайцева, Куприянов, 1978) и одновременно снижает качество пыльцы, необходимой для опыления.

В исследованных популяциях микроспорогенез протекает со значительными отклонениями от нормы, но морфологически аномалии в процессе мейоза до стадии синапсиса не выявляются. В телофазе 11 вследствие, неравномерного распределения унивалентов в анафазах 1, 11 образуется несколько морфологически неравноценных ядер: гигантские, карликовые и ядра нормальных размеров. Нормальные ядра содержат по семь хромосом, образующихся при расхождении коньюгирующих хромосом (бивалентов). Гигантские ядра могут иметь в своем составе кроме основного набора ($n=7$) и унивалентные хромосомы; карликовые содержат униваленты. Из одного микроспороцита может возникать от пяти до десяти ядер различных по размерам и содержащих несбалансированное количество хромосом.

Пыльцевые зерна различны и по величине, и по форме. Размеры их варьируют от 5 до 70 мкм в диаметре (таблица 2). Сравнивая степень фертильности и стерильности пыльцевых зерен *R. canina* во всех исследованных популяциях,

Таблица 2. *Полиморфизм и жизнеспособность пыльцевых зерен Rosa canina L.*

Популяция	Типы пыльцевых зерен					
	нормальные, $d=40$—50 мкм		мелкие, $d=10$—20 мкм		гигантские, $d=70$ мкм	
	Степень окрашивания ацетокармином					
	хорошо окрашенные	слабо окрашенные	хорошо окрашенные	слабо или неокрашенные	хорошо окрашенные	слабо или неокрашенные
1						
а) количество пыльцевых зерен	126	49	147	160	19	72
б) жизнеспособность в %	21,9	8,6	25,7	28,1	3,3	12,5
2						
а) количество пыльцевых зерен	132	154	153	165	22	77
б) жизнеспособность в %	23,1	9,4	23,4	26,8	3,8	13,5
3						
а) количество пыльцевых зерен	141	56	128	147	25	83
б) жизнеспособность в %	24,3	9,7	22,1	25,3	4,3	14,3

Всего фертильных пыльцевых зерен в % по популяциях 1—30,5; 2—32,5; 3—34.

следует отметить, что наивысший процент фертильности (34,0%) обнаружен в третьей популяции, а наименьший в первой. Анализ степени фертильности пыльцевых зерен указывает на то, что стерильность во всех популяциях превышает 50%. Это свидетельствует о том, что в каждой популяции только незначительное количество пыльцы имеет оплодотворяющую способность. Пыльцевые зерна с набором хромосом $n=7$ и диаметром $d=40$—50 мкм жизнеспособны, хорошо окрашиваются ацетокармином, прорастают на искусственной питательной среде (40% сахарозе), при воздействии акридинового оранжевого ядра их дают ярко зеленую флюоресценцию, а цитоплазма — оранжевую.

Для пыльцевых зерен семейства *Rosaceae* характерно наличие трех борозд. Нормальные пыльцевые зерна *R. canina* медитерально-трехбороздно-поровые, округло сфероидальные. Большой экваториальный диаметр 14,5 мкм, малый — 11 мкм, Экзина двухслойная, в области мезокольпиума неравномерно утолщенная, по краям борозд бородавчастая. Скульптура пыльцевых зерен тонкоструйчатая, волнистая. Текстура мелкопятнистая (рис. 2). Дефектные пыльцевые зерна сильно сжатые, борозды искривленные, мезокольпиумы широкие, неправильной формы, полюса притупленные.

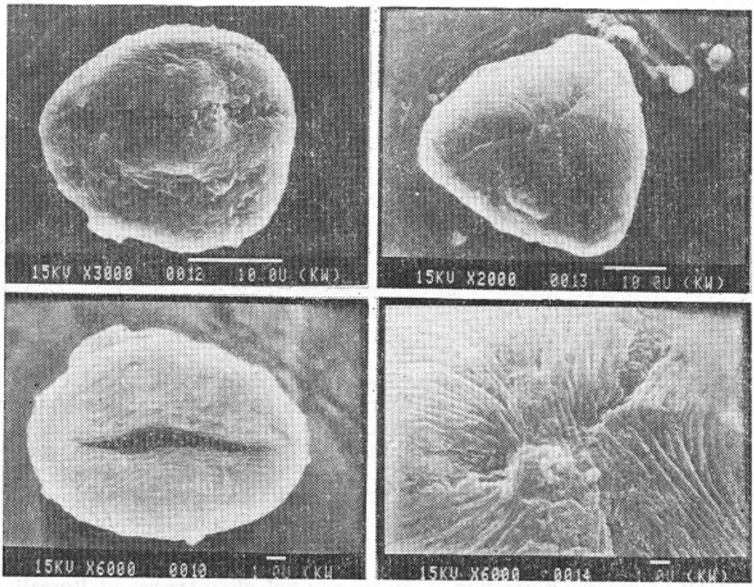

Рис. 2. Микрофотографии пыльцевых зерен *Rosa canina* L. Цифровые обозначения: первое — напряжение, кв; второе — увеличение; третье — номер кадра; четвертое — масштабная черта, мкм.

Литературные сведения, касающиеся эмбриологии рода незначительны (Jackholm 1922, Hurst 1931). Нами изучались следующие эмбриональные процессы: мегаспорогенез и развитие женского гаметофита, оплодотворение, развитие эндосперма и зародыша. Установлено, что зародышевый мешок развивается из микропилярной мегаспоры по *Polygonum* — типу. Иногда развивается несколько зародышевых мешков (два-три), но зрелого состояния достигает один. Для *R. canina* характерный половой процесс размножения и в некоторых биотипов выявлен апомиксис — генеративная апоспория в сочетании с нередуцированным партеногенезом. Оплодотворение осуществляется по промежуточному типу. Эндосперм нуклеарный. Развитие зародыша протекает по *Asterad* — типу. var. *Rosa*.

Интенсивность семенного размножения *R. canina* зависит от условий местообитания. Наибольшее количество семяпочек дегенерирует в третьей популяции. Процент обсеменения нижнегорной популяции (69,3%) ниже, чем процент обсеменения популяций из равнинно-предгорной зоны (74,4%). Лазерное облучение (доза 15 мин.) стимулирует прорастание семян. Прорастание наблюдается через сутки после посева, по сравнению с контрольными, прорастающими спустя 5—7 дней. Наивысший процент всхожести семян (плодиков) получен при изъятии их из полуспелых гипантиев.

В связи с возрастающими масштабами использования *R. canina* как подвоя и ценного вытаминоносного сырья, возникает необходимость ее охраны. Предполагается восстановление запасов *R. canina* путем создания природных культивируемых массивов.

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A Rosa canina L. néhány populációjának biomorfológiai sajátosságai a kárpátaljai Tisza-völgyben

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Kivonat

E közleményben a Rosa canina három kárpátaljai populációjának biomorfológiai leírása szerepel. Feltárásra kerültek 17 populáció közötti vegetatív és generatív összefüggések. Meghatározást nyert virágporuk polimorfizmusa, élettartama és fontosabb embriológiai processzusa. Megállapítást nyertek potenciális és valóságos terméshozamaik s a kezelésük során alkalmazott lézersugár optimális dózisai. A vizsgálatok kiterjedtek a terméskék csírázás mértékének megfigyelésére különböző érettségi stádiumukban. Ismertetésre került ennek a vitamindús nyersanyagokat szolgáltató cserjének a Tisza-völgyben számára alkalmas területeken történő újratelepítésének módszere is.

Biomorfološke osobenosti nekih populacija Rosa canina L. u dolini Tise na podnožju Karpata

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Abstrakt

U radu se prikazuju biomorfološke osobenosti tri populacije Rosa canina sa područja Karpata. Konstatovana je vegetativna i generativna uslovljenost medju 17 populacija. Odredjen je polimorfizam, dužina života i značajni embriološki procesi polenovih zrnaca. Utvrdjena je potencijalna i realizovana fruktifikacija kao i optimalna doza korišćenih laserovih zrakova. Ispitivanjima je bilo obuhvaćeno i utvrdjivanje stepena klijavosti plodova u različitim stadijumima zrelosti. Prikazane su i metode rekultivacije na pogodnim površinama u dolini Tise, ove žbunaste biljke, koja sadrži vitaminima bogate sirovine.

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SAISONMÄSSIGE VARIATIONEN DER ZUSAMMENSETZUNG DES PLANKTONS UND DER BODENBESIEDLUNG IN DER CARSKA BARA (JUGOSLAWIEN)

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Zusammensetzung

Mittels Erforschungen in der Carska bara (Kaisersumpf) im Zeitraum 1982—1985 wurde eine starke Varierung der grundlegenden ökologischen Faktoren: des Wasserstandes, der Temperatur, des pH-Wertes und der Sauerstoffsättigung festgestellt. Diese Varierungen waren von Einfluss auf die Dynamik und der Zusammensetzung des Planktons und der Bodenbesiedlung. Im eingeführten Zeitraum wurden in der Phytoplankton-, Phytoperiphytonzusammensetzung 103 Arten festgestellt, die zu den Gruppen: Cyanobacteria (Cyanophyta)=12, Chrysophyta=2, Diatomophyta (Bacillariophyta)=34, Xantophyta=2, Pyrrhophyta=2, Euglenophyta=13 und Chlorphyta=38 gehörten. In allen untersuchten Jahren wurde die grösste Anzahl von Arten im Frühjahr festgestellt, während der Artenanzahl nach die Jahre 1982 und 1984 eine grössere Ähnlichkeit aufwiesen als die anderen zwei. Mit Ausnahme des Jahres 1982 dominieren in allen Winterperioden Diatomophyta, während in der Sommer und Herbst diesen Platz Chlorophyta und Euglenophyta übernehmen. Das Zooplankton und die Mikrofauna weisen eine grössere Verschiedenheit in der Frühlings- und Sommerperiode, ausnahmsweise in der Herbstperiode (1985) auf. Auch in Bezug auf diese Komponente beobachten wir eine grössere Ahnlichkeit zwischen den Jahren 1982 und 1984. In der Bodenbesiedlung spielen wahrend des gesamten Untersuchungszeitraums die haupt Rolle die Oligochaeten, die mit 14 Arten und einer Dynamik von 44,4 Ind. m^{-2} bis 5.194 Ind. m^{-2} sowie einer Biomasse von 0,2 g bis zu 24,558 g. m^{-2} vertreten waren. Die vorherrschende Art war *Limnodrilus hoffmeisteri* Claparede in allen Untersuchungsjahren, während sich das Vorkommen der übrigen Arten von Jahr zu Jahr ändert.

Einleitung

Die ersten Daten über die Erforschungen der Carska bara sind neueren Datums, und beziehen sich auf den Zeitraum 1982—1985. Sie erfassen die Dynamik und Zusammensetzung des Zooplanktons, der Mikerofauna und der Bodenbesiedlung in diesem unter Naturschutz stehendem Ökosystem (PUJIN et al. 1985). Mit Rücksicht darauf dass die Untersuchungen auch in diesem Jahr fortgesetzt wurden, und das Material aus früheren Jahren auf die Phytoplankton-, Phytoperiphytonzusammensetzung ausgearbeitet wurde, war der Zweck vorliegender Arbeit, ein umfassenderes Bild über dieses Ökosystem zu gewinnen.

Material und Arbeitsmethode

Das Material wurde im Laufe der Jahre 1982—1985 in zweimonatlichen Zeitabständen gesammelt. Mit Rücksicht darauf, dass wir unserer vorhergehenden Arbeit die detaillierte Arbeitsmethodik dargelegt haben (Pujin et *al*. 1985), erwähnen wir lediglich, dass auch in der Fortsetzung der Arbeit im Jahre 1985 die gleiche Methodik angewandt wurde.

Ergebnisse und Diskussion

Gewisse Daten über die Carska bara wurden bereits in unserer vorhergehenden Arbeit mitgeteilt. Hier wollen wir noch welche anführen, die für die grundlegende ökologischen Faktoren von Bedeutung sind, mit Rücksicht darauf dass wir in der vorliegenden Arbeit den Versuch unternehmen, die Planktongemeinschaft und der Bodenbesiedlung, mit besonderem Rückblick auf die ökologischen Faktoren in Verbindung zu bringen. Hinsichtlich der Wasserregimeverhältnisse der Carska bara soll auf zwei kennzeichnende Zeiträume hingewiesen werden: jenen bis zum Jahre 1971 und auf den heutigen Zustand unter den Bedingungen des Funktionierens des neuerbauten Kanalbettes des Begej-Kanals durch des Perlezer Ried. Bis zum Jahre 1971 wurden die Carska bara und ihr weiteres Gebiet durch die Hochwasser der Theiss überflutet, jeweils wenn der Wasserstand der Theiss in Titel höher als 340 cm betrug. Während der Dürreperioden wurde die Carska bara mit Wasser aus dem Begej versorgt, dank des mittels der Stauwehr in Titel künstlich aufrechterhaltenen Wasseniveaus. Beim Entwurf des neuen Bettes des Begejs durch die Perlezer Ried wurde Rücksicht darauf genommen, dem alten Bett des Begejs die Funktion des Erhaltens der nötigen Wasserverhältnisse in der Carska bara zu bewahren. Durch Ausbau der Stauwehr flussaufwärts wurde die Wasserversorgung des alten Bettes des Begejs ermöglicht, währen mit dem Bau der Stauwehr flussabwärts (Perlezer Wehr) die Entleerung des Begejbettes bis zum jeweils gewünschten Wasserstand sichergestellt wurde. Zu gleicher Zeit wurde auch der Damm am rechten Ufer des neuen Bettes des Begejs fertiggestellt, so dass die Carska bara sich in den mit Dämmen abgegrenzten Raum erstreckte, in welchem sich auch das alte Bett des Begej mit seinem Armen befindet. Durch den Ausbau dieser hydrotechnischen Objekte wurde die Überflutung der Carska bara mit dem Hochwasser der Theiss verhindert, dirigierte Wasserversorgung-verhältnisse für einen längeren Zeitraum während des Jahres festgelegt, die Versorsorgung mit Wasser aus dem Begej und den Fischteichen „Ečka“ zum Teil auch aus der Theiss, dies jedoch nur bei einem bestimmten Wasserstand, ermöglicht. Aus diesen Angaben ist ersichtlich, dass die Carska bara-obwohl sie ein geschützes Naturreservat darstellt-unter starcken Einfluss des Menschen steht, insbesondere wenn es sich um den Wasserstand handelt. So kam es im untersuchten Zeitraum während des Sommers 1983 infolge eines ausgeprägt niedrigen Wasserstandes, zum Austrocknen des Sumpfes.

Bei ferfolgung der grundlegenden ökologischen Faktoren ist ihre starke Variierung zu beobachten. Die Temperaturschwankungen sind durch saisonmässige Veränderungen, jedoch auch durch die kleine Tiefe (im Durchschnitt um 1,2 m.) bedingt, wodurch sich das Wasser rasch erwärmt und abkühlt. Im untersuchten Zeitraum varierte die Temperatur zwischen 0 °C und 28 °C. Auch die übrige Faktoren schwakten ziemlich stark, so der pH-Wert zwischen 7,0 und 9,5, die Sauerstoffsättigung zwischen 20,9% und 139% (siehe Abb. 1). Auf dieser Umstände beobachtet man eine grössere Ähnlichkeit zwischen den Jahren 1982 und 1984 im Vergleich zu den Jahren 1983 und 1985. Alle diese Schwankungen spiegelten sich auch in der Dynamik der Planktonzusammensetzung und der Bodenbesiedlung wieder.

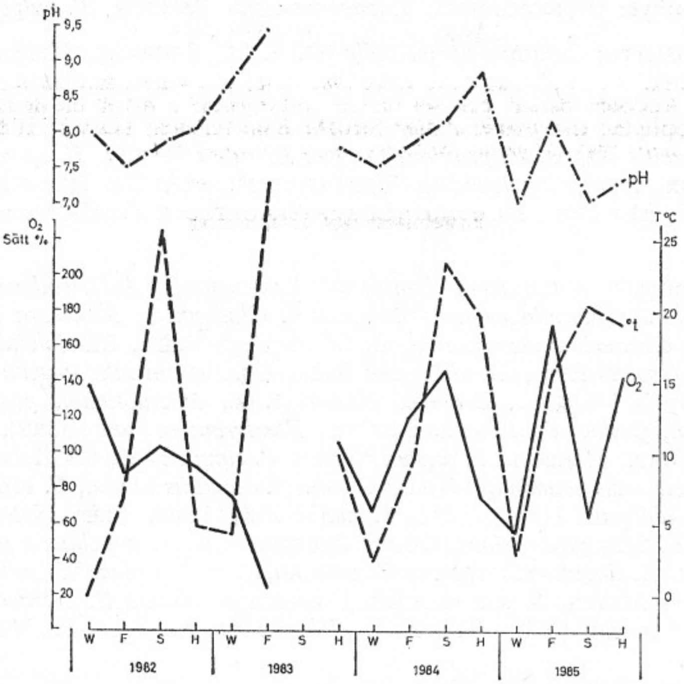

Abb. 1. Saisonmässige Änderungen der Temperatur, pH-Werte und Sauerstoffsättigung in Carska Bara (1982—1985)

Das Phytoplankton und Phytoperiphyton

In der qualitativen Zusammensetzung des Phytoplanktons und Phytoperiphytons wurden folgende Arten festgestellt:

Cyanobacteria (Cyanophyta)- *Anabaena flos-aque* (Lyng.) Brèb, *Aphanizomenon flos-aque* (L.) Ralfs, *Merismopedia glauca* (Ehr.) Nag., *M. punctata* Meyen, *M. tenuissima* Lemm., *Microcystis flos-aque* Wittr., *Nostoc commune* Vaucher, *Oscillatoria chlorina* (Kütz.) Gom., *O. limosa* (Roth) Agardh, *O. princeps* Vaucher, *Spirulina subsalsa* Oersted.

Chrysophyta: *Dinobryon sertularia* Ehr., *Dinobryon* sp.

Diatomophyta (Bacillariophyta): *Asterionella formosa* Hass. *Cocconeis disculus* (Schum.) Cl., *C. prostrata* Ehr., *Diatoma anceps* (Ehr.) Kirch., *D. vulgare* Bory, *Eunotia monodon* Ehr., *Fragilaria capucina* Desm., *F. crotonensis* Kitton, *Gomphonema constrictum* Ehr., *Gyrosigma acuminatum* (Kütz.) Rab., *Meridion circulare* Ag., *Melosira granulata* (Ehr.) Ralfs, *M. varians* Ag., *Navicula cryptocephala* Kütz., *N. cuspidata* Kütz., *N. dicephala* (Ehr.) W. Smith, *N. rhynchocephala* Kütz., *Navicula* sp., *Nitzschia acicularis* W. Smith, *N. filiformis* (W. Smith) Hust., *N. gracilis* Hantz., *N. palea* (Kütz.) Smith, *N. sigmoidea* (Ehr.) Smith, *Pinnularia major* Kütz., *P. viridis* (Nitz.) Ehr., *Stauroneis anceps* Ehr., *Stephanodiscus astraea* (Ehr.) Grun., *Surirella capronii* Brèb, *Synedra acus* Kütz., *S. ulna* (Nitzsch) Ehr., *Tabellaria fenestrata* (Langb.) Kütz.

Xanthophyta (Heterocontae): *Tribonema viride* PASCHER, *T. vulgare* PASCHER.

PYRRHOPHYTA: *Ceratium hirundinella* (O. F. M.) SCHRANK, *Peridinium cinctum* (MÜLLER) EHR.

Euglenophyta: *Chrysoxus maior* SKUJA, *Euglena acus* (DUJ.) HÜBN., *E. deses* EHR., *E. gracilis* KLEBS, *E. proxima* DANG., *E. rubra* HARDY, *E. spiroides* LEMM., *E. viridis* EHR., *Phacus longicaudata* (EHR.) DUJ., *Ph. orbicularis* HÜBNER, *Ph. pleuronectes* (O. F. M.) DUJ., *Ph. tortus* (LEMM.) SKVORTZOW, *Trachelomonas gibberosa* PLAYFAIR.

Chlorophyta: *Actinastrum hantzschii* LAGERHEIM, *Ankistrodesmus falcatus* (CORDA) RALFS, *Chlorella vulgaris* BEYERINCK, *Cladophora glomerata* KÜTZ., *Cladophora* sp., *Closterium acerosum* EHR., *Cl. kützingii* BRÈB., *Cl.leibleini* KÜTZ., *Cl. moniliferum* (BORY) EHR., *Cl. strigosum* BRÈB., *Coelastrum microporum* NÄG., *Cosmarium botrytis* MENEGH., *Eudorina elegans* EHR., *Micractinium pusillum* FRES., *Mugeotia* sp., *Oedogonium capilare* KÜTZ., *Pandorina morum* (BORY), *Pediastrum boryanum* (TURP.) MENEGH., *P. duplex* MEYEN, *P. simplex* (MEYEN) LEMM., *P. tetras* RALFS, *Scenedesmus acuminatus* (LAG.) CHOD., *S. arcuatus* LEMM., *S. ecornis* (RALFS) CHODAT., *S. obliquus* (TURP.) KÜTZ., *S. quadricauda* (TURP.) BRÈB., *Selenastrum gracilis* REINSCH., *Spirogyra varians* (KÜTZ.) CZURDA, *Staurastrum chaetoceros* (SHROD.) G. M. SMITH., *S. cingulum* SCOTT and GRONBLAD, *S. ornitopodum* W. and G. S. WEST, *S. paradoxum* MEYEN, *S. subcruciatum* COOKE and WILLE, *S. tetracerum* RALFS, *Tetraëdron trigonum* (NÄG.) HANSGIRG, *Ulotrix zonata* (WEB. et MOHR) KÜTZ., *Zygnema* sp.

Wie aus obiger Aufzählung ersichtlich ist, verzeichnete man die grösste Anzahl von Arten bei Chlorophyta (38), so dann Diatomophyta (34), Euglenophyta (13), Cyanobacteria (12), während andere Gruppen mit nur je 2 Arten anwesend waren. Die gesamte Artenanzahl als auch die procentuelle Vertretenheit der einzelnen Gruppe wiesen saisonmässige Schwankungen auf (Abb. 2). Mit Ausnahme des Jahres 1982, herrschen in allen untersuchten Jahren in den winterichen u frühjah Zeitabschnitten Diatomophyta vor, während im Sommer und Herbst diese Rolle Chlorophyta und Euglenophyta übernehmen. Cyanobacteria sind Artenanzahl nach weniger als die vorhergehenden zwei Gruppen vertreten und sind mehr an den Frühjahr- und Sommerzeitabschnitten gebunden (Abb. 3). Sie kommen indessen in den Regel mit einer höheren Zahlenwerte vor und stellen oft die vorherrschende Gruppe dar. So erscheinen als dominante Arten *Anabaena flos aque, Aphanizomenon flos-aque* und *Microcystis flos-aque.* Neben diesen Arten erscheinen auch in höheren Individuenanzahl einzelne Arten der Gattung *Scenedesmus.* Als subdominante Arten wurden verzeichnet: *Diatoma vulgare, Nitzschia sigmoidea,* sowie die Arten der Gattungen *Synedra* und *Pediastrum.*

Das Zooplankton und die Mikrofauna

In de Zooplankton- und Mikrofauna-zusammensetzung nahmen die Gruppen: Protozoa, Rotatoria, Cladocera und Copepoda teil. Ein ausführliches Verzeichnis der vertretenen Arten mit ihrer relativen Abundanz lieferten wir für den Zeitraum 1982—1984 (PUJIN et al. 1985) und nehmen an dass es sich erübrigt dasselbe wiederholt anzuführen. Wir wollen bloss die Daten über die Artenanzahl im Zaitraum des Herbstes 1984 und des gesamten Jahres 1985 anführen, um den gesamten untersuchten Zeitraum abzurunden (Tab. 1).

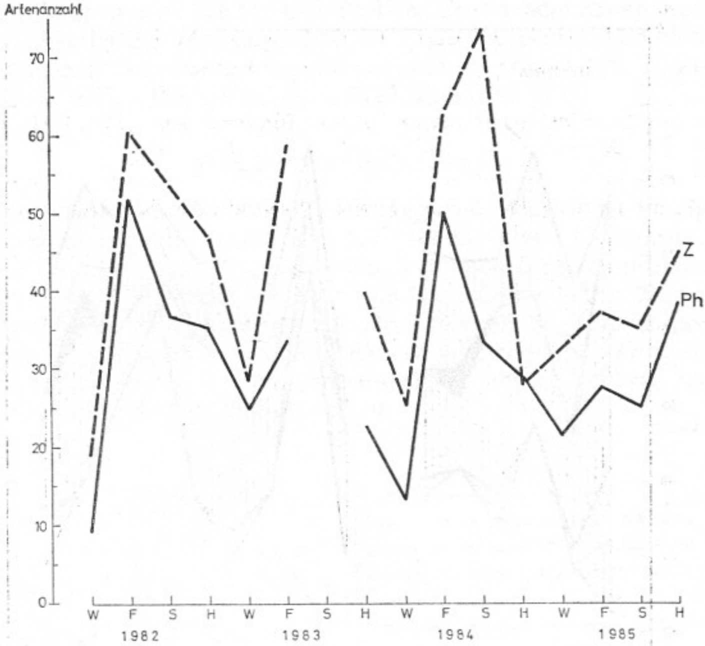

Abb. 2. Saissonmässige Änderungen von Gesamtartenanzahl des Phyto-und Zooplanktons in Carska bara (1982—1985)

Tabelle 1. *Anzahl der Zooplankton- und Mikrofauna-arten, als auch ihre prozentuelle Vertretenheit in der Carska bara (Herbst 1984, und im Jahre 1985)*

Gruppen	1984		1985							
	Herbst		Winter		Frühling		Sommer		Herbst	
	№	%	№	%	№	%	№	%	№	%
Protozoa	6	22,6	6	28,6	7	18,9	5	12,8	7	15,6
Rotatoria	13	48,2	7	33,3	20	54,1	21	53,9	28	62,6
Cladocera	4	14,8	3	14,3	5	13,5	8	20,5	6	13,3
Copepoda	4	14,8	5	23,8	5	13,5	5	12,8	4	8,9
Insgesamt:	27	100	21	100	37	100	39	100	45	100

Wenn wir die Gesamtezahl der Zooplankton- und Mikrofauna-arten nach Saisonen im gesamten untersuchten zeitraum vergleichen, so können wir eine grössere Ähnlichkeit zwischen den Jahren 1982 und 1984 feststellen, was auch in der Gesamtanzahl der Phytoplankton-, Phytoperiphyton-arten beobachtet wurde (Abb. 2). Bei der Analyse der grundlegenden ökologischen Faktoren bemerkt man ebenfalls eine solche Ähnlichkeit.

Hinsichtlich der qualitativen Zusammensetung des Zooplanktons und der Mikrofauna im Jahre 1985 bestand wesentlicherer Unterschied im Vergleich zur vorhergehenden Jahren. Wir heben bloss einige Arten hervor die in diesem Zeitraum verzeichnet wurden, aber in fruheren Proben nicht vorgefunden wurden. Von den

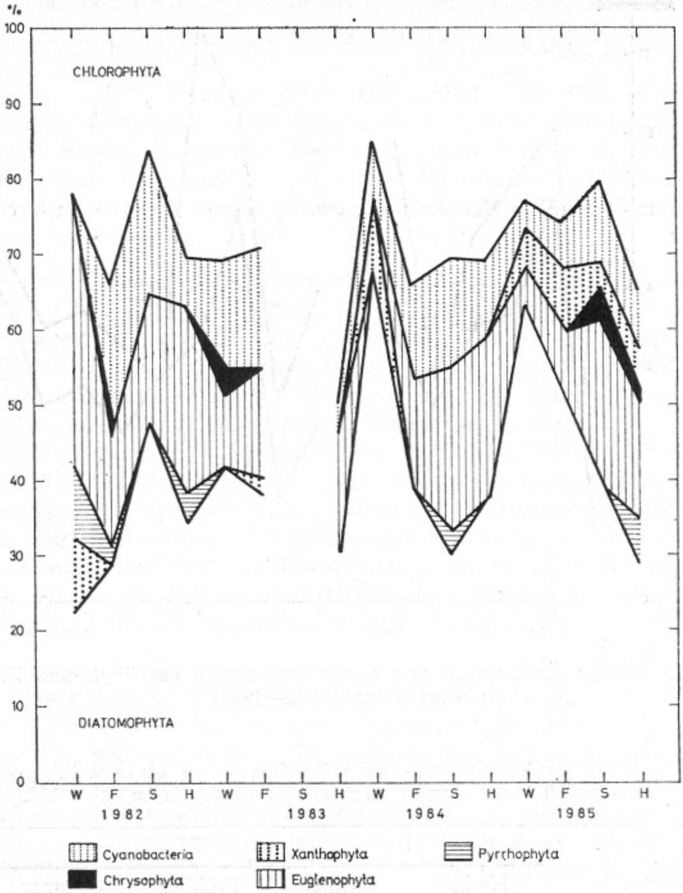

Abb. 3. Die Prozentmässige Beteiligung von verschiedenen Phytoplankton und Phyto-periphyton-gruppen in Carska bara (1982—1985)

Rotatoria sind dies: *Beauschampia crucigera* DUTROCHET, *Mytilina bisulcata* (LUCKS) und *Lepadella rhomboides* (GOSSE), von den Cladocera: *Alona costata* (SARS), *Alonella excisa* (FISCHER), *Macrotrix laticornis* (JURINE) und *Scapholeberis mucronata* (O. F. M.) und von den Copepoden: *Cyclops furcifer* (CLAUS) und *Macrocyclops fuscus* JURINE. Ansonsten war im Jahre 1985 die Gesamtenartenanzahl kleiner als in 1984. Eine gewisse Artenzahl die in früheren Jahren vorkamen, blieben in disem Jahr aus. Obwohl die Artenzahl im Jahre 1985 kleiner war, waren die numerischen Werte ähnlich. Die höchsten numerischen Werte im Jahre 1985 fielen in den Herbst (7.360 Ind. dm^{-3}), die niedrigsten in den Winter (2780 Ind. dm^{-3}). Im Frühling und im Sommer finden sich annährend gleiche numerischen Werte (6.750 Ind. dm^{-3} bzw. 6.030 Ind. dm^{-3}), wobei sich im Frühling ziemlich zahlreiche Protozoen (1.700 Ind. dm^{-3}), als auch Copepodit- und Naupliusstadien (1.310 Ind. dm^{-3}) vorfinden, während im Sommer Rotatorien vorherrschen (4.200 Ind. dm^{-3}). Die in diesem Zeitraum erhaltenen Ergebnisse weisen auf ähnliche Schlussfolgerungen hin wie sie in der vorhergehenden Arbeit angeführt wurden (PUJIN et *al.* 1985), was vor allem in Variierungen sowohl der qualitativen wie auch der quantitativen Zusammensetzung, bedingt durch die Schwankungen der der grundlegenden Faktoren zu Ausdruck kommt, was auch in anderen ähnlichen Gawässern festgestellt wurde (MILOVANOVIĆ, ŽIVKOVIĆ, 1953, PUJIN et *al.* 1978, 1983, 1985, 1985a, GÁL, 1982, ŽIVKOVIĆ 1973).

Die Bodenbesiedlung

Die relative Armut in der Bodenbesiedlung, insbesonders in der qualitativen Zusammensetzung, regte zur detaillierten Erforschung dieser biocönosischen Komponente an; die Probenanzahl wurde erhöht, aus auch Entnahmprobestellen. Das Ergebnis dieser Untersuchungen waren einige Oligochaetenarten, die in vorhergehenden Zeitraum nicht verzeichnet wurden: *Ilyodrilus perrieri, Limnodrilus helveticus,* L. *udekemianus, Psamoryctes deserticola, Peloscolex superiorensis, Potamotrix bavaricus* und *Ryacodrilus coccineus.* Die prozentuelle Artenvertretenheit die im Jahre 1985 festgestellt wurde findet sich auf Abb. 4.

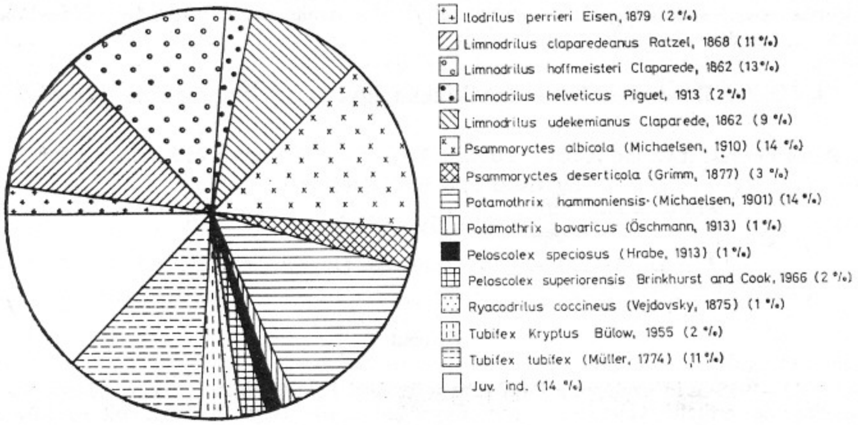

Abb. 4. Die Durchschnittlichen prozentmässigen Beteiligung von einzelnen Oligochaetenarten in Carska bara (1985)

Es ist interessant anzuführen, dass die Art *Peloscolex superiorensis,* nach dem Katalog der Oligochaeten-Fauna Jugoslawien (KEROVAC, MRŠIĆ 1982) bisher in unserem Lande nicht verzeichnet wurde, während die Arten *Psammoryctes deserticola* und *Potamothrix bavaricus* die ersten Funde in Vojvodina sind. Die Art Ryacodrilus coccineus wurde bisher nur in der Fauna der Obedska bara (Obeder Sumpf) festgestellt (DJUKIĆ 1983). Die übrigen Oligochaetenarten sind sehr oft in den Bodenbesiedlung von Wasserökosystemen in Vojvodina vertreten. Den vertretenen Oligochaetenarten nach, als auch ihrer quantitativen Anwesenheit nach ist die Carska bara ein Ökosystem mit hoher Menge von organischen Stoffen, und demnach auch einem sehr ausgeprägten Prozess der Eutrophierung, vor allem autochtonen Ursprung. Die numerische Werte der Oligochaeten in Carska bara im Jahre 1985 bewegten sich zwischen 44,4 Ind. m^{-2} (im Winter) und eine Biomasse von 0,22 g. m^{-2}, und 5.194,8 Ind. m^{-2} und Biomasse von 24,55 g. m^{-2} (im Frühjahr). Die Chrionomiden wurden auch in diesem Jahre nur mit 88,8 Ind. m^{-2} im Oktober festgestellt.

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A Carska Bara plankton és fenékfauna együttesének szezonális változása

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Kivonat

Az 1982—1985-ös időszakban a Carska bara ökológiai tényezőinek (vízszint, hőmérséklet, pH, oxigéntelítettség) erőteljes változása volt megfigyelhető, amely nagy kihatással volt a plankton és a fenékfauna összetételére. A vizsgált időszakban a fitoplankton és a fito-perifiton megállapított 103 fajának megoszlása a következő: *Cyanobacteria (Cyanophyta)*=12, *Chrysophyta*=2, *Diatomophyta (Bacillariophyta)*=34, *Xanthophyta*=2, *Pyrrhophyta*=2, *Euglenophyta*=13, *Chlorophyta*=38. A fajgazdagság a vizsgálati évek tavaszán a legnagyobb. Azonos szintű fajszámhasonlóság az 1982 és 1984-es években jelentkezett. Az 1982-es év kivételével, télen a *Dyatomophyta*, a nyári és őszi idényben pedig a *Chlorophyta* és *Euglenophyta* dominánció volt kimutatható. A zooplankton és a mikrofauna változásai nagyobb arányúak a tavaszi és nyári idényben, kivéve az 1985-ös évet. Mint a fitoplankton esetében, a zooplankton és mikrofauna hasonlósága is szembetűnőbb 1982 és 1984-ben.

A fenékfauna együttesében az *Oligochaeta* dominánció jelentkezett. A megállapított 14 faj 44,4 ind. m^{-2}-től 5.194 ind. m^{-2} egyedszáma és 0,2 g. m^{-2}-től 24,55 g. m^{-2} biomassza ingadozása volt kimutatható. A vizsgált időszakban a *Limnodrilus hoffmeisteri* dominánsfajként jelentkezett, míg a többi faj jelenléte évről-évre változott.

Sezonska variranja sastava planktona i naselja dna u Carskoj Bari (Jugoslavija)

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Abstrakt

Istraživanjima u Carskoj bari u periodu 1982—1985 utvrdjeno je veliko variranje osnovnih ekoloških faktora: vodostaja, temperature, pH i zasićenosti vode kiseonikom. Ova variranja su imala uticaja na dinamiku i sastav planktona i naselja dna. U navedenom periodu u sastavu fitoplanktona i fitoperifitona konstatovano je 103 vrste, koje su pripadale grupama: Cyanobacteria = 12, Chrysophyta = 2, Diatomophyta = 34, Xanthophyta = 2, Pyrrhophyta = 2, Euglenophyta = 13, Chlorophyta = = 38. U svim ispitivanim godinama najveći broj vrsta je konstatovan u prolećnjem periodu, a po broju vrsta veću sličnost su pokazale 1982 i 1984, nego druge dve godine. Sa izuzetkom 1982 god., u svim zimskim periodima dominiraju Diatomophyta dok u letnjim i jesenjim periodina ovo mesto preuzimaju Chlorophyta i Euglenophyta. Zooplankton i mikrofauna veću raznovrsnost imaju u prolećnjem i letnjem periodu, izuzetno u jesenjem (1985). I u ovoj komponenti su zapažene veće sličnosti izmedju 1982 i 1984 godine. U naselju dna, u čitavom periodu istraživanja dominantnu ulogu igraju Oligochaeta, zastupljene sa 14 vrsta i dinamikom brojnosti od 44,4 ind. m^{-2} i biomasom 0,22 g. m^{-2}, do 5.194 ind. m^{-2}, a biomasom od 24,55 g. m^{-2}. Dominantna vrsta u svim godinama ispitivanja je *Limnodrilus hoffmeisteri,* dok se zastupljenost drugih vrsta menja iz godine u godinu.

Сезонные изменения сообщества планктона и донной фауны в Царска баре

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Резюме

В 1982—1985 годах наблюдалось значительное изменение экологических факторов Царска бары (уровень воды, температура, pH, содержание кислорода), влияющих на состав планктона и донной фауны. В исследованный период установлены 103 вида фитолланктона и фитоперифитона: Cyanobacteria (Cyanophyta) — 12 видов, Chrysophyta —2, Diatomophyta (Bacillariophyta)—34, Xanthophyta—2, Euglenophyta—13, Pyrrhophyta—2, Chlorophyta —38 видов. Наибольшее количество видов в исследованный период отмечалось весной. В 1982 и 1984 годах установлен одинаковый уровень количества видов. За исключением 1982 года, зимой преобладала Dyatomophyta, летом и осенью — Chlorophyta и Euglenophyta. Изменения зоопланктона и микрофауны более существенны весной и летом, за исключением 1985 года. Как у фитопланктона, сходсхтво зоопланктона и микрофауны более заметно в 1982 и 1984 годах.

В сообществе донной фауны преобладала Oligochaeta. Y 14 установленных видов были выявлены колебания численности особей в пределах от 44,4 инд. $м^{-2}$ до 5194 инд. $м^{-2}$ и колебания биомассы в пределах от 0,2 $гм^{-2}$ до 24,55 $гм^{-2}$. В исследованный период доминирующим видом являлся *Limnodrilus hoffmeisteri*, присутствие других видов менялось из года в год.

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DIET OF PRUSSIAN CARP (CARASSIUS AURATUS GIBELIO BLOCH) IN THE CARSKA BARA

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Abstract

Diet of Prussian carp, introduced from the waters of the Far East was studied on 209 specimen, collected in spring and summer period of 1984—1985. Analyzed exemplars were 113—248 mm of standard length, 42—415 g of body mass and 2—5 years of age. Their diet consisted of both plant and animal components. The diet contained the following algae: Cyanobacteria, Diatomophyta, Euglenophyta and Chlorophyta. Parts of makrophyta were also present. Animal component consisted of Rotatoria, Cladocera, Copepoda, Oligochaeta, Chironomidae and some other larvae of insects, not precisely defined. The highest frequency was noted for Cladocera and Copepoda (100%), followed by Rotatoria (90% in spring time, 80% in summer time) and Oligochaeta (75%/85% respectively). Diatomorphyta (80/90%) were the most frequent amon algae. As regards relative abundance these groups would also play a significant role in Prussian carp diet. However, if the biomass of aforementioned organisms was taken into consideration, Oligochaeta, Cladocera and Copepoda had the highest incidence. Similar results were obtained when other water Ecosystems in Vojvodina were investigated, eventhough differences related to food availability were noted.

Introduction

Lately, Prussian carp (*Carassius auratus gibelio* BLOCH) has become a subject of many studies in Vojvodina (BUDAKOV et *al.* 1979; MALETIN et *al.* 1979, PUJINET BUDAKOV 1979, MALETIN et *al.* 1981, MALETIN et BUDAKOV 1982, 1983, BUDAKOV et *al.* 1983, 1983a and KOSTIĆ 1985). The main reason for this interest is its presence in many water system, where it reaches high population density, eventhough it was introduced to our waters from the Far East at the middle of this century. It is constantly present in the Carska Bara. The objective of this study was to investigate the food composition of this type of fish within the complex ecological studies, with special reference to available supply.

Materials and Methods

Material used to investigate Prussian carp diet in Carska Bara was collected in spring April and summer June, July period in the course of 1984/85. The analysis encompassed 209 specimens, 113—248 mm of standard length, 42—415 g of body mass and 2—5 years of age. Complete intestine tract was observed and 1 cm^3 of the content from various regions of the intestine tract was analyzed. With this procedure 5 cm^3 of each sample was analyzed. On the basis of examined contents, the frequency of individual components expressed in percentage along with relative abundance in percentage was defined. This was based on numerical availability of components in the analyzed intestine contents.

Results and discussion

Both plant and animal components were found in the analyzed intestine contents. The following algae were present: Cyanobacteria, Diatomophyta, Euglenophyta and Chlorophyta. Parts of makrophyta were also detected. Animal organisms found were: Rotatoria, Cledocera, Copepoda, Oligochaeta, Chironomidae, as well as some other larvae of insects which were not precisely defined.

All analyzed intestine contents were filled with food, thus indicating nutrition intensity in the investigated period. Diet spectrum was very diversified (Table 1).

In spring the incidence of Diatomophyta species was the highest, while in summer period Chlorophyta species were in greater number. Other groups of algae were present only with few species. Analysing this portion of nutrition spectrum with qualitative content of phytoplancton in the same period, reflection of food offered and its use can be noted. This, however, does not appy to all algae species. Some species are found in pond, but not in any intestine content. This applies specificly to algae appearing only in certain periods such as Chrysophyta, Xanthophyta and Pyrrophyta (Pujin et *al.* 1985).

Only 12 species of Rotatoria were found in the qualitative composition of the animal diet component, eventhough their number in pond is considerably greater. Their incidence in summer period is greater than in spring, which again suits their dynymics in the pond. It is worth mentioning that some Rotatoria appears in abundance in the pond, while no trace was noted in the intestine content *(Lecane quadridentata, Mytilina mucronata)*. Cladocera and Copepoda species are found both in the pond and intestine content. This especially to *Chydorus sphaericus,* constantly present in the intestine content and very often in high number. Similar Prussian carp diet spectrum was found in other water ecosystem in Vojvodina, eventhough some differences were noted. In Mrtva Tisa, for example, few Diatomophyta species (2) were found, in Jegrička (13) and in Koviljski rit (22) (Pujin et *al.* 1985a).

Contrary to algae, content of animal component was rather similar in these studies. Aforementioned components in the analyzed intestine content were found in different frequencies. Only Cladocera and Copepoda (frequency 100%) were present constantly in all analyzed contents. Diatomophyta, Rotatoria and Oligochaeta were also present with high frequency. Other groups were found only in few numbers in intestine content (Fig. 1).

The abundance of species present in intestine content varied. In spring time, for example, Rotatoria recorded the highest relative abundance (40%), Oligochaeta and Copepoda (30%) and Diatomophyta (20%). In summer time relative abundance of Cladocera reaches 50%, Copepoda 20% and Oligochaeta 10% (Fig. 2).

Eventhough reconstruction in relation to biomass of stated components was not conducted, it is known that Rotatoria and algae regardless of their presence in large numbers leg behind Cladocera, Copepoda and especially Oligochaeta in the biomass. Therefore a conclusion could be drown on the basis of analyzed contents, that the main components in Prussian carp diet are Oligochaeta, Cladocera and Copepoda. Other components with higher frequency and relative abundance could be considered as complementary and those with low frequency and relative abundance as accidental. Similar results were obtained with studies conducted in other ecosystems in Vojvodina. The frequency of Oligochaeta in Jegrička was 27,5%, in Mrtva Tisa 49% and in Koviljski rit 44%. Differences in relative abundance were also noted (Pujin et *al.* 1985a). These differences, however do not change the picture about the main com-

Table 1. *Spectrum of nutrition of Prussian carp (Carassius auratus gibelio* BLOCH) *in Carska bara*

Species	Spring	Summer
Cyanophyta (Cyanobacteria)		
Microcystis flos-aque		+
Oscillatoria sp.	+	
Bacillariophyta (Diatomophyta)		
Cymatopleura solea		+
Fragilaria crotonensis	+	+
Navycula ctyptocephala	+	+
N. cuspidata	+	
N. rhynchocephala	+	
Nitzschia sigmoidea	+	
N. palea	+	
Melosira granulata	+	
M. varians	+	+
Synedra acus	+	+
S. ulna	+	+
Euglenophyta		
Euglena spiroides		+
E. viridis		+
Phacus pleuronectes	+	
Chlorophyta		
Coelastrom microporum		+
Closterium moniliferum	+	
Eudorina elegans		+
Pandorina morum	+	+
Pediastrum borianum	+	+
P. duplex		+
P. simplex		+
Scenedesmus acuminatus	+	+
S. obliquus		+
S. quadricauda		+
Makrophyta		+
Rotatoria		
Asplanchna brightwelli		+
Brachionus angularis	+	+
B. calyciflorus		+
B. diversicornis		+
B. quadridentatus cluniorbicularis	+	+
Epiphanes senta		+
Keratella cochlearis	+	+
K. cochlearis tecta	+	+
K. quadrata		+
Polyarthra euryptera		+
P. vulgaris		+
Rotatoria rotatoria		+
Cladocera		
Alona costata		+
A. quadrangularis		+
Bosmina longirostris	+	+
Chydorus sphaericus	+	+
Daphnia longispina		+
Diaphanosoma brachyurum		+
Copepoda		
Acanthocyclops vernalis	+	+
Cyclops vicinus		+
Eudiaptomus gracilis		+
Oligochaeta	+	+
Chironomidae	+	+
Other Insects		+

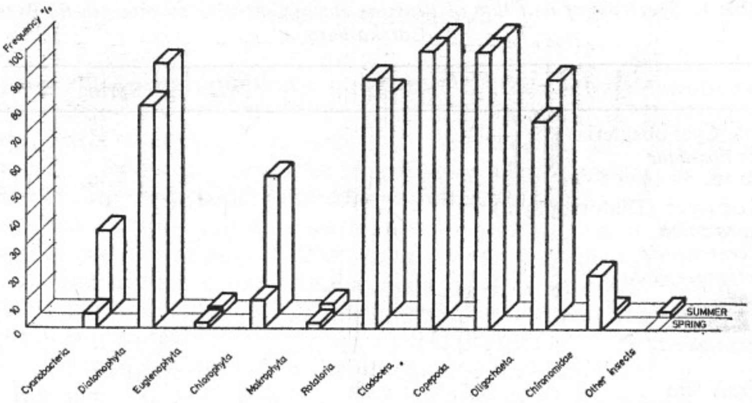

Fig. 1. Frequency of the food components (%) of Prussian carp (*Carassius auratus gibelio* Bloch) in Carska bara

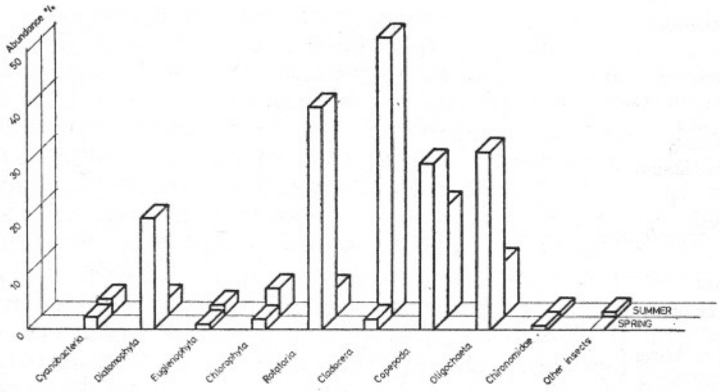

Fig. 2. Relative abundance of the food components (%) of Prussian carp (*Carassius auratus gibelio* Bloch) in Carska bara

ponents in Prussian carp diet, but are related to the immediate food supply in aforementioned ecosystems.

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Az ezüst kárász (Carassius auratus gibelio Bloch) táplálkozása a Carska bara-ban

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Kivonat

A szerzők az 1984—85 év tavaszán és nyarán gyűjtött 209 ezüst kárász egyeden végeztek táplálkozásbiológiai vizsgálatot. A 2—5 éves korosztályú példányok nagysága 113—248 mm, tömege pedig 42—415 g között oszlott meg. Táplálékukat növényi és állati eredetű komponensek képezik. A *Cyanobacteria, Diatomophyta, Euglenophyta* és *Chlorophyta* algákon kívül makrofita elemek is jelen vannak. Az állati eredetű táplálékot a: *Rotatoria, Cledocera, Copeopoda, Oligochaeta, Chironomidae,* valamint egyes rovarok lárvái tették ki.

Az előkerült táplálék gyakorisága különböző volt: a *Cladocera* és *Copepoda* 100%, a Rotatoria 90% tavaszi és 80% nyári, valamint az *Oligochaeta* 75%, illetve 85%. Az algák közül a *Diatomophyta* gyakorisága a legnagyobb (80%, 90%),így a viszonylagos abundancia alapján a legnagyobb jelentőséggel bírnak. Azonban a nevezett szervezetek tömegét véve figyelembe, az *Oligochaeta,* majd a *Cladocera* és *Copepodá*-k kerülnek előtérbe az ezüst kárász táplálkozásában. Vajdaság más vízi ökoszisztémáiban is hasonlóak az eredmények. Az észlelt különbségek a rendelkezésre álló táplálékkal vannak összefüggésbe.

Ishrana srebrnog karaša (Carassius auratus gibelio Bloch) u Carskoj Bari

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Abstrakt

Na 209 primeraka srebrnog karaša, sakupljenih u proleće i leto 1984—1985. godine, analizirana je ishrana ove vrste ribe, unesene iz voda Dalekog Istoka. Analizirani primerci su bili standardne dužine 113—248 mm, mase tela 42—415 g i 2—5 godina starosti. U sastavu hrane bile su zastupljene kako biljne, tako i životinjske komponente. Od algi u sastavu hrane bile su prisutne: Cyanobacteria, Diatomophyta, Euglenophyta i Chlorophyta. Bilo je prisutnih i delova makrofita. Životinjska komponenta se sastojala od Rotatoria, Cladocera, Copepoda, Oligochaeta, Chironomidae i još nekih

larava insekata, koje nisu detaljnije determinisane. Najveću frekventnost su imale Cladocera i Copepoda (100%), a zatim dolaze Rotatoria (90% u proleće, 80% u leto) i Oligochaeta (75, odn 85%). Medju algama najfrekvantnije su bile Diatomophyta (80, odn. 90%). Po relativnoj abundanci ove grupe bi takodje imale najznačajniju ulogu u ishrani srebrnog karaša. Medjutim, ako uzmemo u obzir masu navedenih organizama, onda bi prvo mesto zauzimale Oligochaeta, zatim Cledocera i Copepoda. Slični rezultati su dobijeni ispitivanjima u drugim vodenim ekosistemima u Vojvodini, iako su uočene i razlike koje su u vezi sa raspoloživom hranom.

Питание серебристого карася (Carassius auratus gibelio Bloch) в Царска баре

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Резюме

Авторы проводили исследования биологии питания 209 особей серебристого карася, собранных весной и летом 1984—1985 годов. Длина особей в возрасте 2—5 лет находилась в пределах 113—248 мм, их масса — в пределах 42—415 г. Их пища состояла из компонентов растительного и животного происхождения. Кроме водорослей Cyanobacteria, Diatomophyta, Euglenophyta Chlorophyta имелись в наличии макрофильные элементы. Пищу животного происхождения составляли Rotatoria, Cladocera, Copepoda, Oligochaeta, Chironomidae и личинки некоторых насекомых.

Распространенность определенного вида пищи была различной: у Cladocera и Copepoda 100%, у Rotatoria весной 90%, летом 80%, у Oligochaeta соответственно 75% и 85%. Чаще всего обнаруживалась из водорослей Diatomophyta (80—90%), таким образом, исходя из относительной абунданции, они имеют наибольшее значение. Однако, с учетом массы указанных организмов, в питании серебристого карася преобладают виды Oligochaeta, а также Cladocera и Copepoda. Такие же результаты получены и в других экосистемах водоемов Воеводины. Установленные различия зависят от имеющейся пищи.