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Diversity and cluster analysis of the invertebrate macrofauna in the Lake Fertő

By

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Abstract. This paper presents some qualitative and quantitative characteristics of the macrofauna living in different stands of the Lake Fertő. The results of diversity and cluster analysis support the earlier observations and provide statements which cannot be directly extrapolated from the primary zoological data.

Quantitative characteristics of the zoocenoses living in submerz and helophyton vegetations (species composition, relative frequency) and the major ecological factors regulating the occurrences of the macrofauna populations (pH, conductivity, dissolved O_2) have continuously been studied (ANDRIKOVICS, 1973, 1978, 1979 a).

The quantitative relationships of the invertebrate macrofauna occurring in the various aquatic plants have also been examined into consideration (ANDRIKOVICS, 1973, 1980–81).

The most important results of several reports including also the primary data of this paper can be summarized as follows:

A zoological heterogenity of low degree can be developed in the open water and its surroundings due to the frequency of wind-effects (ANDRIKOVICS, 1980–81b). The topography of the weed-zones revealed differences in the fauna groups among the open waters and larger isolates as well as the small ponds surrounded by the reed-belts (ANDRIKOVICS, 1973).

Considering quantitative aspects, the invertebrate macrofauna of the reed-belts bordering the water is poor, whilst that of the weed vegetation is somewhat richer in species (ANDRIKOVICS, 1980–81 a, b). Of the submerz macrovegetations the *Potamogeton pectinatus* fields provide habitats for the zoocenoses of highest number. The community of the *Najas marina* sites examined was conspicously poor from quantitative respects (ANDRIKOVICS, 1979a, b, 1980–81a). Beyond

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these structural-coenological, ecological results two alternatives can be suggested for a further development.

On one hand, initiation of detailed ecofaunistic analyses of the most important aquatic insect groups should be an approach with detailed taxonomical studies of the imagos. On the other hand, the weed repression having taken place since the mid-seventies (ANDRIKOVICS 1979a, 1980–81b; SCHIEMER, 1978) has urged comparing the three major habitats in respects of the helophyton stands of the weed-zones and the macrofauna groups of the sediments, using the more exact diversity and cluster analysis. To utilize more exactly the biological information involved in the primary zoological data, the following objectives were outlined:

– To reveale the differences between the reed-belts (Sc. phragmitetum) and the bulrush stands (Sc. phragmitetum typhetosum angustifolii) in respect of the macrofauna groups.

– To establish the factors of general importance regulating the spatial and timely occurrences of the macrofauna groups living in the submerz and emerz vegetations.

– To determine the spatial heterogenity of the macrofauna groups in identical type vegetations.

– To relate the species and abundance differences of the macrofauna with the determinative ecological factors.

Sites, dates and methods

In weed-zones the samples were taken from May to October during 1971 and 1972 in 11 typical habitats of the Lake Fertő.

Of the submerz stands, quantitative samples were taken during 1975 and 1976 in the surroudings of the Rákos inlet and the Herlakni pond. In reed and bulrush stands as well as in open water sludge, quantitative samples were taken during 1975 and 1976. The samplings were carried out at monthly intervals in all three areas (Fig. 1).

We applied initially the so-called quasi-quantitative sampling method included cutting ca. identical masses of plant over the water-net (No. 25) in the various weed-stand. The principle of the tools suitable for quantitative samplings is a taking fixed water volume and after closing the tools the entire material is taken out.

These methods frequently cannot provide serial samplings in the reed-belts and in the dense bulrush stands due to the low capacity of the cutting tools. As a better alternative, the "frame" sampling can be used.

After submerging the billet, with a basic area of 50×50 cm, covered generally with a 120 cm high nylon net depending upon the water deepness, a diver cuts down the plant stalks with a strong grass-cutting scissors.

The sediment samples were taken with a 50×50×25 cm metal billet, opened at the botton and supplied with a sharp flange. The billet was pressed into the sediment directly over the surface then, closing the bottom of the sampling billet with a metal cover the material was carefully taken out of the water.

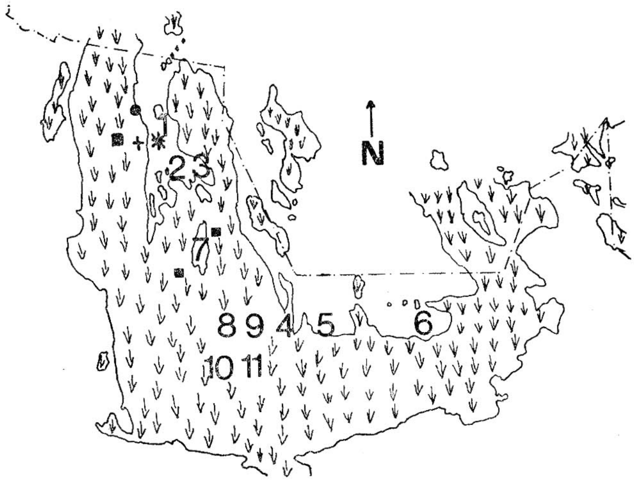

Fig. 1. Sketch of the sampling sites. 1, 4, 6, 7, 8, 10 = *Potamogeton pectinatus;* 2, 3, 5 = *Myriophyllum spicatum;* 9 = *Myriophyllum verticillatum;* 11 = *Utricularia vulgaris* and *Najas marina.* ● open water sediment samples, ■ quantitative zoological samples from the reed stands, + quantitative zoological samples from the bulrush stands, ✱ quantitative zoological samples from the sedge stands

In each month four parallel samples were taken then, the entire sample was analysed. The samples containing also plant fragments were stored in 4% formalin until analysis. In the study areas the frequency distribution of the macrofauna species arranged by size were as follows: 8 Hirudinoidea, 10 Gastropoda, 14 Hydracarina, 1 Isopoda, 5 Ephemeroptera, 9 Odonata (larvae), 13 Trichoptera (larvae), 2 Lepidoptera (larvae), 7 Coleoptera and 7 Heteroptera. The Diptera (Chironomidae + other) were not analysed in details due to the well-known taxonomic problems.

Some aspects of data evaluation

The data obtained from the quasi-quantitative samplings are only informative of the stocking differences of the various habitats, using an arbitary scoring system: few-1, intermediate-2, many-3, mass-4. The data of the quantitative samplings enable us to compute some major structural elements of zoocenology, i.e. the mean number of individuals/m^2 and the dominance relationships in the various vegetations. The results are referred to 1 m^2 water surface so as to ensure a direct comparison with the data for the submerge fauna. The diversity of the macrofauna cenoses was assessed with the Shannon-formule (Shannon, 1948). Of the various similarity indices the Sokal-Mitchener index, the Hummon-index (Hummon, 1974) and the WPGMA fusion algorythm (Sheat and Sokal, 1973) were applied. The data were computerized with the aid of a SZTAKI CDC – 3300 type computer.

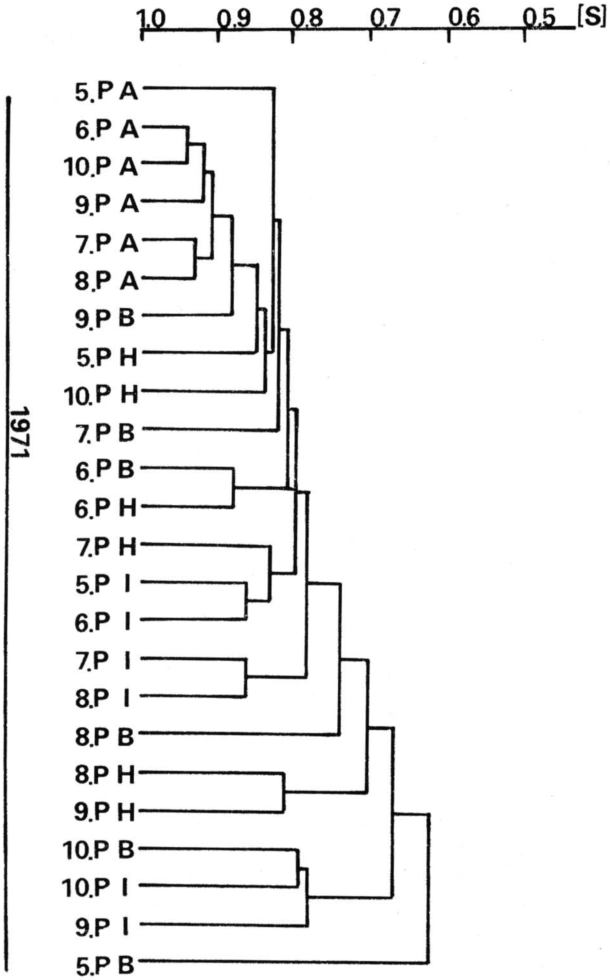

Fig. 2. Dendrogram for the macrofauna cenoses sampled in the open water of the Herlakni pond and in the *Potamogeton pectinatus* stands, on the basis of cluster analysis (Sokal – Mitchener index). PA = *Potamogeton pectinatus* stands in the open water; PB = *Potamogeton pectinatus* stands before the reed walls in the open water; PH = *Potamogeton* stands in the Herlakni pond; PI = *Potamogeton* stands in the isolated ponds; S = similarity

Results and discussion

Taxonomic assessment of the zoological data and a considerable part of the ecological consequences are not discussed here since these have already been reported elsewhere (see Introduction). This paper is focused on the results of the diversity and cluster analysis.

Contrary to the weed-stands of the open waters, the *Potamogeton pectinatus* zones of the isolated small ponds are inhabited by a zoocenoses of greater species

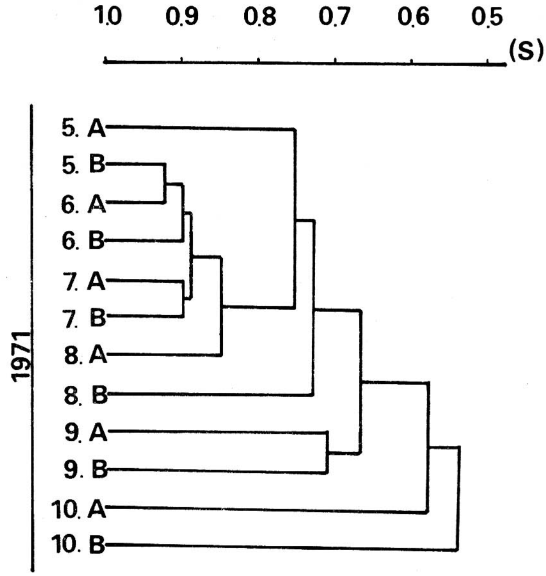

Fig. 3. Dendrogram for the macrofauna groups in the open water and the reed-bordered *Potamogeton pectinatus* stands, on the basis of the cluster analysis (Sokal-Mitchener index). A = *Potamogeton* stands in the open water; B = *Potamogeton* stands before the reed-walls in the open lake; S = similarity

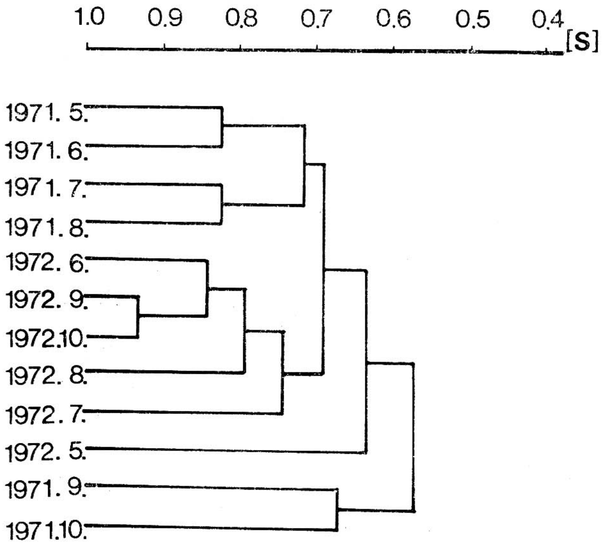

Fig. 4. Dendrogram for the macrofauna cenoses living in the *Potamogeton pectinatus* stands of the isolated small ponds, on the basis of the cluster analysis (Sokal-Mitchener index). S = similarity

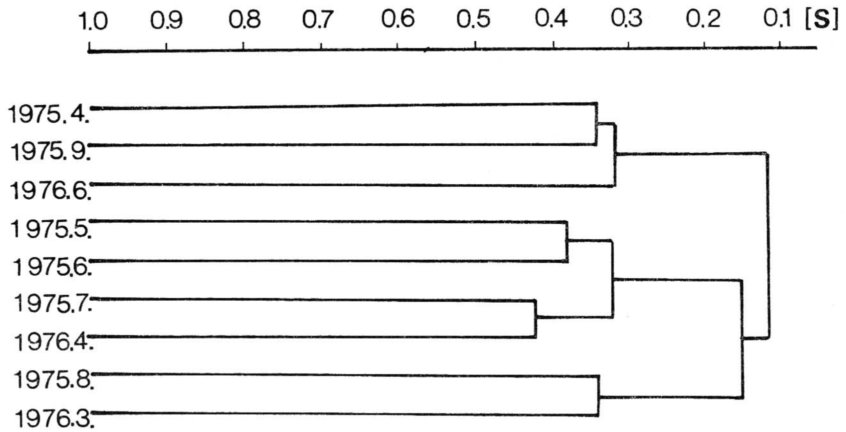

Fig. 5. Dendrogram for the macrofauna cenoses living in the Fertőrákos inlet-water reeds, on the basis of the cluster amalysis (Hummon index). S = similarity

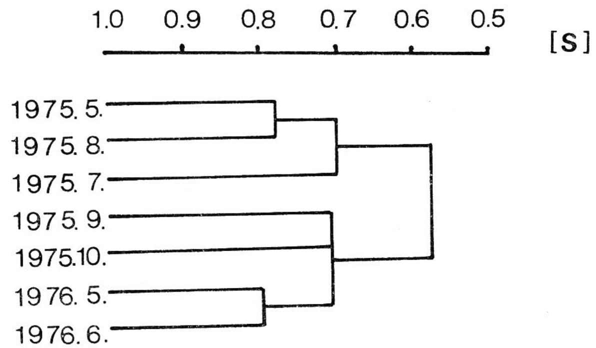

Fig. 6. Dendrogram for the macrofauna cenoses living in *Typha angustifolia* stands of the Fertő rákos inlet on the basis of the cluster analysis (Sokal-Mitchener index). S = similarity

number (ANDRIKOVICS, 1973). The macrofauna living in the *Potamogeton pectinatus* sites of the very differing areas of the pond doesn't form similarity centrums concentrating according to area (Fig. 2). The values for the similarity indices are high but with low ranges of variability (R: 0.35, 0.93 – 0.58). The macrofauna in the *Potamogeton pectinatus* stands is maily represented by the great mass of the Chironomidae (ANDRIKOVICS, 1973, 1979a, b, 1980 – 81a) resulting in numerically low diversity (Talbe 2).

The 1971/72 data for the macrofauna living in the *Potamogeton pectinatus* stands of the Herlakni pond formed a common summer-autumn group. No between-year differences were noted in this area (Fig. 3). However, the macrofauna living in the *Potamogeton pectinatus* stands of the small ponds revealed between-year differences among the similarity groups (Fig. 4).

The macrofauna groups of the within-water reeds showed very little similarities during the various stages of the year. The values for the similarity indices are low (Fig. 5). The within-water reeds contained zoocenoses rich in species but with relatively low number of individuals.

Table 1. Diversity (H") and evenness (I") of the macrofauna living in the reeds, bulrush and the mud of Fertőrákos inlet

Sample	Number of species	Diversity (H")	Evenness (I")
1975.04. reed	12	2,11	0,59
05. reed	17	3,03	0,74
06. reed	19	2,44	0,57
07. reed	13	2,06	0,56
08. reed	14	1,70	0,45
09. reed	7	1,43	0,51
1976.03. reed	14	2,94	0,77
04. reed	12	1,86	0,52
05. reed	10	1,05	0,32
1975.05. bulrush	8	0,75	0,25
06. bulrush	18	2,43	0,58
07. bulrush	14	2,29	0,60
08. bulrush	11	1,52	0,44
09. bulrush	11	1,37	0,39
10. bulrush	10	1,59	0,48
1976.05. bulrush	7	0,44	0,16
06. bulrush	9	1,11	0,35
1975.06. mud	2	0,87	0,87
07. mud	3	0,64	0,40
08. mud	3	0,87	0,55
09. mud	2	0,32	0,32

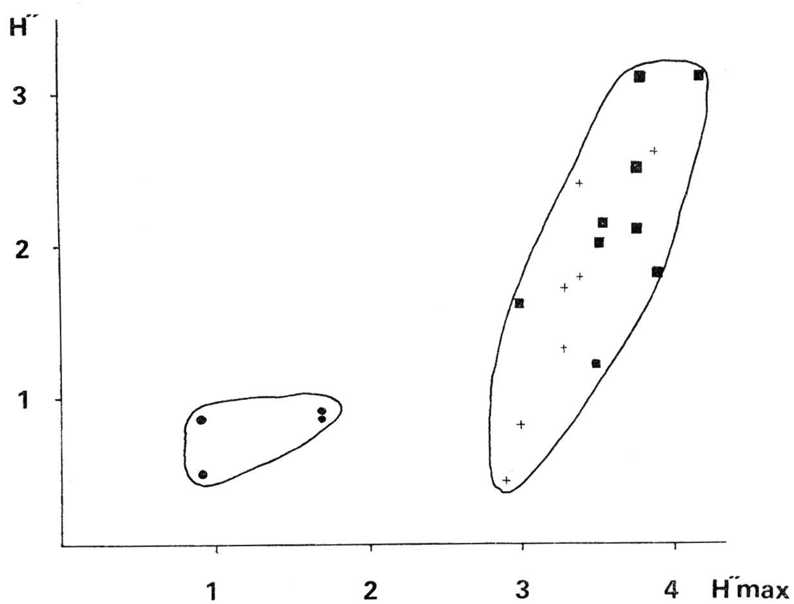

Fig. 7. Related diversity and diversity maximum values for the macrofauna groups living in the reed and bulrush stands of the Fertőrákos inlet, 1975–1976. ■ = reed, + = bulrush, ● = mud

The macrofauna groups living in *Typha angustifolia* stands appeared more homogeneous during the various seasons of the year, compared to those of the reed-belts, and didn't follow a seasonal trend (Fig. 6).

Based on diversity, the reed and bulrush stands are not separated from one another and as cluster analysis revealed their macrofauna are not distinguished (Table 1 and Fig. 7).

Among the submerz vegetations of the isolated small ponds, only *Najas marina* stands' macrofauna constitutes a close similarity group (Fig. 8). Above *Najas marina* stands frequently occur extensive *Utricularia vulgaris* stands.

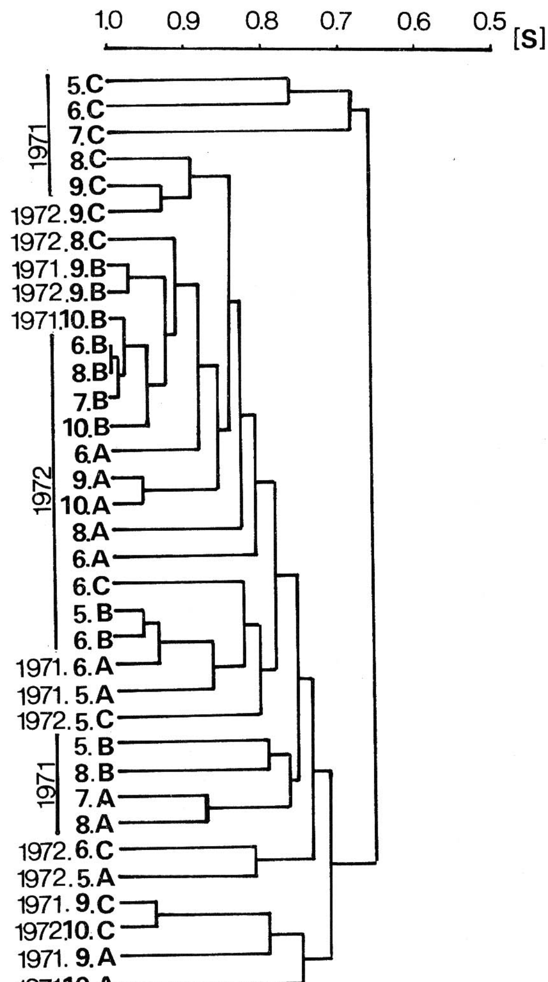

Fig. 8. Dendrogram for the macrofauna cenoses living in the *Potamogeton pectinatus*, *Najas marina* and *Utricularia vulgaris* stands of the isolated small ponds, on the basis of the cluster analysis (Sokal-Mitchener index). A = *Potamogeton pectinatus;* B = *Najas marina ;* C = *Utricularia vulgaris;* S = similarity

Table 2. Diversity (H'') and evenness (I'') of the macrofauna living in the Potamogeton pectinatus and Najas marina stands of the Herlakni pond

Sample	Number of species	Diversity (H'')	Evenness (I'')
1975.06. *Potamogeton*	9	0,32	0,10
07. *Potamogeton*	10	0,60	0,18
08. *Potamogeton*	16	0,78	0,20
09. *Potamogeton*	19	1,23	0,29
10. *Potamogeton*	11	0,41	0,12
1975.07. *Najas*	5	0,82	0,35
08. *Najas*	12	2,82	0,79
09. *Najas*	10	1,90	0,57

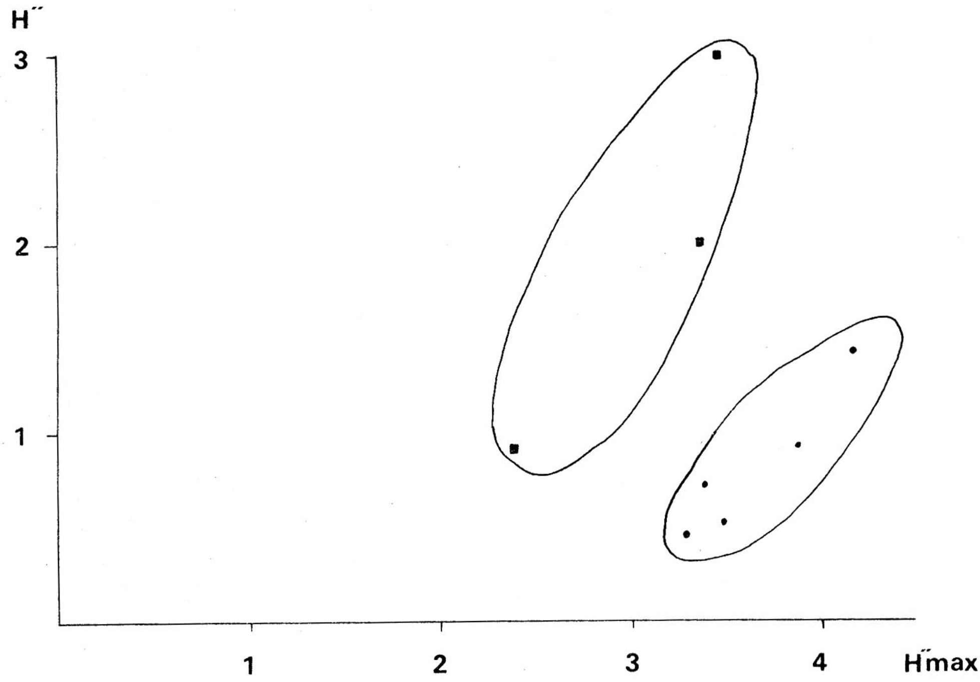

Fig. 9. Related H'' and H_{max} values for the macrofauna living in the *Potamogeton pectinatus* and *Najas marina* stand of the Herlakni pond, 1975–1976. ○ = *Potamogeton pectinatus;* □ = *Najas marina*

Despite of the close spatial distance, the *Najas* and the *Utricularia* macrofauna don't form a similarity group, i.e. mixed habitats such as are not suitable for the formation of district zoocenoses.

Similarly, the macrofauna of the *Potamogeton pectinatus* stands forms also no similarity group.

In the Herlakni pond, the H''–H'' max values for the macrofauna of the *Potamogeton pectinatus* and *Najas marina* sides establish disjunct groups (Fig. 9).

Based on diversity and cluster analysis the following statements can be concluded:

The within-water reeds carry out varied animal groups but with low number of individuals (H'' arithmetic mean: 2.06, H'' max: 3.02, H'' min: 1.04; see Table 1).

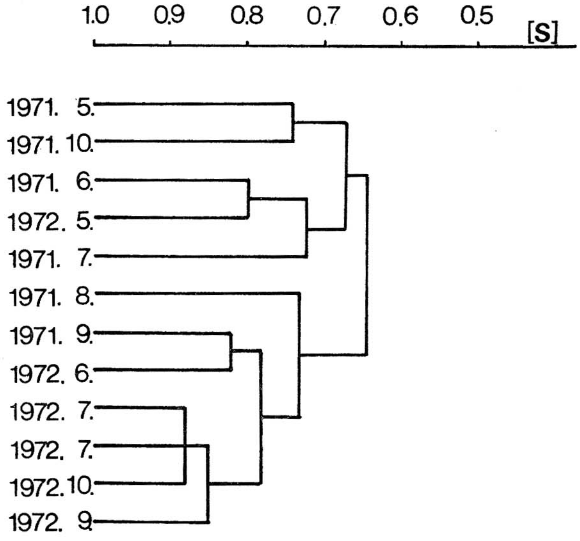

Fig. 10. Dendrogram for the macrofauna cenoses living in the *Potamogeton pectinatus* stands of the Herlakni pond, on the basis of the cluster analysis (Sokal-Mitchener index). S = similarity

The presence of zoocenoses of great species number and diversity suggests the importance of the reed margin as a refuge area promoting the inhabitance of the open water habitats during spring time. This suggestion is also consistent with the peak diversity values.

Based on the results, the bulrush stands showed low seasonal differences, probably due to the greater food supply of the habitat.

The macrofauna of the plant stands examined showed usually summer similarity groups in close connection with the spring and autumn months. These latters are the periods of formation and desintegration of the macrofauna groups.

In case of the most frequent plant stand, *Potamogeton pectinatus*, no spatial heterogenity was noted in the macrofauna. This fact emphasizes clearly the importance of the substrate against the various water-chemistry conditions.

The repression of the weed-stands was commenced at the beginning of the seventies. The impact of this on the structure of the macrofauna cenoses resulted in the distinction of the macrofauna of the small isolated ponds according to year as early as in 1971 and 1972, whilst the phenomenon was not noted in the same period in the Herlakni pond and the open water weed stands, either (Fig. 10).

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