

## About the spatial distribution of the algae and the quantitative development of periphyton in the Hungarian part of Lake Fertő (Neusiedler See)

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**Abstract:** The periphyton was examined in 4 inner lakes of brownish coloured water in the Hungarian part of Lake Fertő at the autumn aspect. 169 taxa were found (Cyanophyta 13, Bacillariophyceae 130, Euglenophyta 3, Chlorophyta 13). In all the 4 lakes diatoms predominated in numbers and biomass. This phenomenon does not agree with the usual seasonal succession. Periphyton is most similar in floristics, quantity and species variability in the case of Lake Kisherlakni and Lake Atjaro. Lake Hidegsegi differs most from the other three lakes.

**Kurzfassung:** Der Herbstaspekt des Periphytons von 4 Schilflacken des ungarischen Teiles des Fertő wurde untersucht. 169 Taxa wurden gefunden (Cyanophyta 13, Bacillariophyceae 130, Euglenophyta 3, Chlorophyta 13). In Anzahl und Biomasse herrschten die Diatomeen vor, was nicht mit der üblich gefundenen Sukzession übereinstimmt. Artenspektrum, Quantität und Artenvariabilität des Periphytons sind im See Kisherlakni und Atjaro am ähnlichsten; das Periphyton aus dem See Hidegsegi unterscheidet sich von jenem der anderen am stärksten.

### Introduction

The cover forming algae of seaside banks have been examined for a long time both from the taxonomical and ecological point of view (Heijs, 1984; Maples, 1984; Szlávec, 1985). Freshwater periphyton have come to the front only nowadays, however, the epiphytic algae are more significant here even when considering the relative proportion of shoreline environment only. For the time being researchers carried out mainly descriptive works (space pattern, host specificity, seasonal succession), and hence there is an increasing demand on more knowledge about the role of the periphyton in lakes and rivers (Wetzel, 1983). In the case of Fertő, the periphyton is interesting and important especially because of the extended reed-belt, enclosing the grey-coloured open water. Inside this reed-belt, some pools containing brownish water can be found; these are undisturbed by wind. These pools have small surface, high Secchi transparency (and often they are illuminated down to the bottom).

The algological examination of the reeds of Fertő was started by Loub (1955), followed after a longer break by Padisák (1982). Besides valuable floristical data, this paper reports on a rough spatial pattern of periphyton. On the basis of floristical data, Padisák pointed out that in Lake Fertő the quality of water is more determinant for epiphytic algae than the kind of substratum. In this work a quantitative estimation on the biomass of periphyton in terms of Chlorophyll-a content is given also.

The quantitative examination of periphyton was started in 1982, with an analysis of the algal coat of 50 reeds (Buczkó & Padisák, 1980). The substrate specificity of one small inner lake was studied on the basis of quantitative data. Floristical differences were found between the coat of *Schoenoplectus* and



*Phragmites*; periphyton of *Typha* has a greater diversity than that of the two substrates before (Buczko, 1986).

The purpose of the present study is to observe whether the different pools have different periphytic algal flora (in the case of same substrate) and to compare the quantity of periphyton with the quantity of plankton, and to increase the phycological knowledge of Lake Fertő.

## Materials and methods

Our samples of periphyton were collected on 9<sup>th</sup> November 1983 from 4 brownish pools of the reed-belt of the Hungarian part of Lake Fertő (Fig. 1). Among these four pools, lake Herlakni has the largest open water surface (540 000 m<sup>2</sup>), i.e. 0,72 % of the lake Fertő area. The second largest is lake Hidegsegi (0,16%). The third is lake Atjaro (0,036 %), and the smallest (0,030 %) is lake Kisherlakni (Bacsatyai-Markus, 1983).

Every sampling location was sampled 15 times in the following way: the upper parts of the reed stems were cut off, then a glass tube (13 mm diameter, 0,2 m in length), was pulled over the underwater stump and cut off at the end of tube. The lower end of the tube was closed and the section of the stem thus transferred into a collecting jar. These jars were carried to the laboratory within 6 hours, where the samples were fixed in formaldehyde solution. The algal mass was washed or scratched off by knife and then homogenized. Without exact identification, the number of individuals was counted and the ratio of diatoms and other algae determined. For the identification of diatoms permanent diatom slides were prepared with the H<sub>2</sub>O<sub>2</sub> method (Horvath, 1975) and embedded in Styrax. These slides are available in the diatom collection of the Department of Botany of the Hungarian Natural Museum. Four hundred individuals were counted in each sample, that is altogether 6 000 individuals for one pool. For identification the following references were used: Pantocsek, 1912; Hustedt, 1930, 1959a, 1959b, 1959c; Felföldy, 1972; Bartha et al, 1976; Németh, 1980.

The biomass on a reed stem was calculated in the known and accepted way of plankton examinations (immediate measurements, approach by geometrical figures); it was calculated using individual numbers. The surface and dry mass of reed stems was measured (after 2 hours drying on 105 °C). Based on these data, the number of individuals and the biomass with respect to mass or surface of the reed stem can be computed immediately. For comparing the mean values the t-test was used.

The Shannon diversity index (Shannon, 1948) was calculated for each sample. Data were analyzed using cluster analysis based on Hummon's measure (Hummon, 1974), and WPGMA fusion algorithm (Sneath & Sokal, 1973). For the calculations the BP programme package was used (Rajczy & Hajdu, 1981).

## Results

169 taxa were identified: Cyanophyta - 13, Xanthophyta-Bacillariophyceae - 130, Euglenophyta - 3, Chlorophyta - 13 (see Table 1). The ratio of taxa found according to phyla can be seen on Fig. 2. The



great quantity of diatoms are characteristic of the periphyton of all the four lakes (minimum 80 % - Lake Atjaro; maximum 92 % - Lake Herlakni). Considering the number of individuals, the diatom dominance is even more pronounced, the contribution of other algal groups to the total number of individuals are negligible:

|                   | Lake Herlakni | Lake Kisherlakni | Lake Atjaro | Lake Hidegsegi |
|-------------------|---------------|------------------|-------------|----------------|
| Cyanophyta        | 6             | 22               | 96          | 18             |
| Bacillariophyceae | 5982          | 5957             | 5859        | 5981           |
| Euglenophyta      | -             | 1                | 2           | -              |
| Chlorophyta       | 6             | 20               | 63          | 1              |

Among the diatoms the Pennales are most characteristic. Only 4 species (11 individuals, 0,05 %) belong to the Centrales. The periphyton biomass forming species of these four pools of Lake Fertő are listed below; only those species are listed, of which more than 1 % (240 individuals) were found (percentage of all the algae counted) the list is made according to the summarized species list of the fifteen reed covers of all the four pools:

|                                                    | Lake Herlakni | Lake Kisherlakni | Lake Atjaro | Lake Hidegsegi |
|----------------------------------------------------|---------------|------------------|-------------|----------------|
| <i>Achnanthes minutissima</i>                      | 10,18         | 6,79             | 4,71        | 17,72          |
| <i>Amphora perpusilla</i>                          | -             | 0,02             | 2,09        | -              |
| <i>Cocconeis pediculus</i>                         | 0,87          | 0,20             | 0,35        | 0,38           |
| <i>Cymbella affinis</i>                            | 2,28          | 0,08             | 0,11        | 0,03           |
| <i>Cymbella lacustris</i>                          | 1,35          | -                | -           | 0,05           |
| <i>Cymbella</i> sp.                                | 0,33          | 0,57             | 1,31        | 0,27           |
| <i>Diatoma elongatum</i>                           | 0,78          | 7,35             | 4,82        | 3,75           |
| <i>Gomphonema</i> sp.                              | 0,70          | 1,69             | 0,58        | 0,43           |
| <i>Navicula cryptocephala</i><br>var <i>veneta</i> | 0,54          | 0,73             | 0,64        | 0,28           |
| <i>Nitzschia amphibia</i>                          | 0,08          | 0,80             | 1,58        | 0,07           |
| <i>Rhoicosphenia curvata</i>                       | 1,92          | 0,51             | 0,96        | 0,08           |
| <i>Synedra acus</i>                                | 0,43          | 0,44             | 0,50        | 0,25           |
| <i>Synedra ulna</i>                                | 0,70          | 1,55             | 1,35        | 0,17           |
| <i>Synedra vaucheriae</i>                          | 1,48          | -                | 0,01        | 0,01           |

It is remarkable, that there are only 3 species that do not occur in all the four pools; on the other hand, there is a significant difference in the occurrence of mass species, and there is a significant difference in the frequency of the species. *Achnanthes minutissima* is dominant in Lake Herlakni and Lake Hidegsegi and only subdominant in the Lake Kisherlakni and Lake Atjaro. In these two latter pools *Diatoma*



*elongatum* is the dominant which is the second in Lake Hidegségi, and only seventh in Lake Herlakni (see Fig. 3). *Amphora perpusilla* is the third in frequency in Lake Atjaro, and is lacking in the two other pools; *Cymbella lacustris* is the fifth in frequency in Lake Herlakni, and is not found in Lake Kisherlakni and Lake Atjaro.

The numbers of species in the pools studied are the following: the poorest in species is Lake Hidegségi with 54 species; there were 85 species in Lake Herlakni and 103 species both in Lake Kisherlakni and Lake Atjaro. (See Table 1 for the details of occurrence.)

Results of cluster analysis show that the periphyton of the four pools studied is different (fig. 4), that is the 4 x 15 samples are strictly separated from each other. Samples of Lake Kisherlakni and Lake Atjaro are the most similar. Note that these two pools have the largest number of individuals. Among the 4 sample-series, the one originating from Lake Hidegségi is the most separated from others on the dendrogram. This separation is indicated by its low diversity too (Fig. 5).

### Quantitative features of periphyton

The quantity of periphyton is shown in Table 2. To relate to surface unit has a sensible biological meaning but its measurement is less exact, while measuring the mass can be very exact but its interpretation is questionable. In general, quantities are given in relation to surface unit, but we have some data relating to dry mass just from Lake Fertő (Sommer, 1977). The individual numbers are the same at a = 10 % level of significance in Lake Kisherlakni and Lake Atjaro. All the other pairs of pools show significant differences.

### Discussion

On the basis of the above results, the four pools studied are significantly different. This fact confirms the hypothesis that though these pools are close to each other in distance, they have their own life. Plankton examinations in these pools (Padisák, 1983) gave similar results. The results show the role of reed as a filter, i.e. it can separate waters of different water quality. Periphyton is most similar in case of Lake Kisherlakni and Lake Atjaro. These two pools are the smallest of the 4 pools studied, their periphyton is similar in the floristic aspect and the quantitative and species variability.

It is difficult to explain the predominance of diatoms. Most of the papers concerning seasonal succession of periphyton report a diatom peak in spring both on artificial (Hooper-Reid & Robinson, 1978) and natural (Jones & Mayer, 1983) substrates. According to these references the quantity of diatoms is decreasing continuously in summer and autumn, while the quantity of blue-green algae is increasing.

Appearance of heterocystic blue-green algae, which can be expected in late summer or early autumn (like in case of planktonic-algae) correlate with nitrogen limitation (Hooper-Reid & Robinson, 1978). Nitrogen-fixing blue-green algae can be totally absent in plankton, while in periphyton they can be as numerous as they can fix 50 % of the whole amount of nitrogen fixed by algae. Heterocystic blue-green



algae are missing from periphyton in every season of the year (Padisák, 1982; Khondker & Dokulil, 1986). To solve this question a detailed examination of seasonal succession is needed.

Results of both, quantitative and qualitative examinations show good similarity with the results of artificial (Goldsborough & Robinson, 1985) and natural (Duthie & Hamilton, 1983) substrate examinations. About  $10^3$  algal cells/m<sup>2</sup> of surface of substrate are found while, in plankton, the number of individuals per litre is about  $10^5$  -  $10^6$  (Padisák, 1983). That means about 1 000 - 10 000 times more algae live in the reed belt on one square metre surface of reed stems immediately under the water surface, than in one litre of open water. In terms of biomass, the difference may be even more pronounced, since in periphyton the size of algae can be larger (e.g. *Spirogyra*). Unfortunately, we do not have a basis for comparison for this in the case of the inner lakes of Fertő. It is worth to note that a reed-stem, close to the water surface can carry as much as 10 % of its mass as algal cover.

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Table 1: List of periphytic algae found in the four studied lakes. (I = Lake Herlakni, II = Lake Kisherlakni, III = Lake Atjaro, IV = Lake Hidegsegi, a: number of individual, min: 1, max: 6000, b: number of occurrences, min: 1, max: 15)

|                                                                              | I    |    | II   |    | III  |    | IV   |    |
|------------------------------------------------------------------------------|------|----|------|----|------|----|------|----|
|                                                                              | a.   | b. | a.   | b. | a.   | b. | a.   | b. |
| <u>CYANOPHYTA</u>                                                            |      |    |      |    |      |    |      |    |
| 1. <i>Chroococcus minutus</i> (Kg.) Näg.                                     | -    | -  | -    | -  | -    | -  | 1    | 1  |
| 2. <i>Chroococcus turgidus</i> (Kg.) Näg.                                    | -    | -  | 1    | 1  | 5    | 2  | -    | -  |
| 3. <i>Gomphosphaeria lacustris</i> Chodat                                    | -    | -  | 1    | 1  | -    | -  | -    | -  |
| 4. <i>Lyngbya martensiana</i> Menegh.                                        | -    | -  | 9    | 5  | 3    | 2  | -    | -  |
| 5. <i>Lyngbya</i> sp.                                                        | 2    | 2  | 4    | 3  | 13   | 3  | -    | -  |
| 6. <i>Microcystis</i> sp.                                                    | -    | -  | -    | -  | 3    | 2  | 8    | 3  |
| 7. <i>Oscillatoria amphibia</i> Agh.                                         | -    | -  | -    | -  | -    | -  | 1    | 1  |
| 8. <i>Oscillatoria limnetica</i> Lemm.                                       | -    | -  | -    | -  | 1    | 1  | -    | -  |
| 9. <i>Oscillatoria</i> sp. 1                                                 | 2    | 1  | -    | -  | 45   | 11 | 0    | 3  |
| 10. <i>Oscillatoria</i> sp. 2                                                | -    | -  | -    | -  | 21   | 3  | -    | -  |
| 11. <i>Pseudanabaena catenata</i> Lauterb.                                   | -    | -  | -    | -  | 3    | 2  | -    | -  |
| 12. <i>Spirulina maior</i> Kg.                                               | 2    | 2  | -    | -  | -    | -  | -    | -  |
| 13. <i>Spirulina subsalsa</i> Oerst.                                         | -    | -  | 7    | 5  | -    | -  | -    | -  |
| <u>XANTHOPHYTA - BACILLARIOPHYCEAE</u>                                       |      |    |      |    |      |    |      |    |
| 14. <i>Achnanthes exigua</i> Grun.                                           | -    | -  | 2    | 1  | -    | -  | -    | -  |
| 15. <i>Achnanthes grimmei</i> Krasske                                        | -    | -  | 6    | 6  | -    | -  | -    | -  |
| 16. <i>Achnanthes minutissima</i> Kütz.                                      | 2442 | 15 | 1629 | 15 | 1131 | 15 | 4253 | 15 |
| 17. <i>Amphiprora alata</i> Kütz.                                            | 41   | 13 | 12   | 8  | 29   | 12 | -    | -  |
| 18. <i>Amphiprora costata</i> Hust.                                          | -    | -  | -    | -  | -    | -  | 2    | 1  |
| 19. <i>Amphiprora paludosa</i> W.Smith                                       | -    | -  | 1    | 1  | -    | -  | -    | -  |
| 20. <i>Amphora coffeaeformis</i> Agardh.                                     | -    | -  | 5    | 5  | -    | -  | -    | -  |
| 21. <i>Amphora commutata</i> Grun.                                           | 8    | 5  | 4    | 4  | 1    | 1  | -    | -  |
| 22. <i>Amphora delicatissima</i> Krasske                                     | -    | -  | 1    | 1  | -    | -  | -    | -  |
| 23. <i>Amphora ovalis</i> Kütz.                                              | 1    | 1  | 1    | 1  | 78   | 15 | -    | -  |
| 24. <i>Amphora ovalis</i> var. <i>pediculus</i> Kütz.                        | 6    | 5  | 6    | 3  | 29   | 7  | 6    | 5  |
| 25. <i>Amphora perpusilla</i> Grun.                                          | -    | -  | 5    | 4  | 501  | 15 | -    | -  |
| 26. <i>Amphora veneta</i> (Kütz.)                                            | -    | -  | 2    | 2  | 19   | 10 | -    | -  |
| 27. <i>Anomoeoneis sphaerophora</i> (Kütz.)<br>Pfitzner                      | 6    | 5  | 1    | 1  | 1    | 1  | -    | -  |
| 28. <i>Anomoeoneis sphaerophora</i><br>var. <i>polygramma</i> (Ehr.) O.Müll. | 2    | 1  | 1    | 1  | 2    | 2  | -    | -  |



Table 1 continued

|                                                                             | I   |    | II.  |    | III. |    | IV. |    |
|-----------------------------------------------------------------------------|-----|----|------|----|------|----|-----|----|
|                                                                             | a.  | b. | a.   | b. | a.   | b. | a.  | b. |
| 29. <i>Bacillaria paradoxa</i> Gmelin                                       | 71  | 72 | 72   | 12 | 12   | 6  | 76  | 14 |
| 30. <i>Campylodiscus clypeus</i> Ehr.                                       | 73  | 14 | 5    | 4  | 4    | 4  | 2   | 2  |
| 31. <i>Cocconeis nuda</i> Pant.                                             | 2   | 2  | -    | -  | -    | -  | -   | -  |
| 32. <i>Cocconeis pediculus</i> Ehr.                                         | 208 | 15 | 48   | 11 | 83   | 14 | 90  | 13 |
| 33. <i>Cocconeis placentula</i> (Ehr.)                                      | 24  | 11 | 5    | 3  | 42   | 11 | -   | -  |
| 34. <i>Cocconeis placentula</i><br>var. <i>euglypta</i> (Ehr.) Cleve        | -   | -  | -    | -  | -    | -  | 2   | 1  |
| 35. <i>Cocconeis thumensis</i> A.Mayer                                      | -   | -  | -    | -  | -    | -  | 1   | 1  |
| 36. <i>Cyclotella catenata</i> Brun.                                        | 1   | 1  | 2    | 2  | 2    | 2  | -   | -  |
| 37. <i>Cyclotella glomerata</i> Bachmann                                    | -   | -  | 1    | 1  | -    | -  | -   | -  |
| 38. <i>Cyclotella kützingiana</i> Thwaites                                  | -   | -  | 2    | 1  | -    | -  | -   | -  |
| 39. <i>Cyclotella meneghiana</i> Kütz.                                      | -   | -  | -    | -  | 3    | 3  | 1   | 1  |
| 40. <i>Cymbella affinis</i> Kütz.                                           | 547 | 15 | 18   | 10 | 27   | 13 | 8   | 4  |
| 41. <i>Cymbella amphicephala</i> Naegeli                                    | 1   | 1  | 7    | 6  | -    | -  | -   | -  |
| 42. <i>Cymbella aspera</i> (Ehr.) Cleve                                     | 1   | 1  | 9    | 5  | 17   | 7  | -   | -  |
| 43. <i>Cymbella brehmii</i> Hust.                                           | -   | -  | 2    | 2  | 61   | 12 | -   | -  |
| 44. <i>Cymbella cistula</i> (Hemprich) Grun.                                | 32  | 9  | 6    | 5  | 38   | 12 | 1   | 1  |
| 45. <i>Cymbella cistula</i><br>var. <i>maculata</i> (Kütz.) v. Heurck       | 4   | 4  | 14   | 9  | 8    | 5  | -   | -  |
| 46. <i>Cymbella hustedtii</i> Krasske                                       | 1   | 1  | 14   | 7  | 8    | 2  | -   | -  |
| 47. <i>Cymbella lacustris</i> (Agardh.) Cleve                               | 324 | 15 | -    | -  | -    | -  | 13  | 4  |
| 48. <i>Cymbella lanceolata</i> (Ehr.) v. Heurck                             | -   | -  | -    | -  | 15   | 6  | -   | -  |
| 49. <i>Cymbella microcephala</i> Grun.                                      | 2   | 2  | 11   | 7  | -    | -  | 9   | 4  |
| 50. <i>Cymbella prostrata</i> (Berkeley) Cleve                              | -   | -  | 2    | 2  | 6    | 4  | 5   | 3  |
| 51. <i>Cymbella pusilla</i> Grun.                                           | -   | -  | -    | -  | -    | -  | 13  | 10 |
| 52. <i>Cymbella tumidula</i> Grun.                                          | -   | -  | -    | -  | -    | -  | 1   | 1  |
| 53. <i>Cymbella turgida</i> (Gregory) Cleve                                 | 2   | 1  | -    | -  | 1    | 1  | -   | -  |
| 54. <i>Cymbella ventricosa</i> Kütz.                                        | 5   | 3  | 101  | 15 | 185  | 15 | 39  | 13 |
| 55. <i>Cymbella</i> sp.                                                     | 80  | 14 | 137  | 15 | 305  | 15 | 64  | 13 |
| 56. <i>Diatoma elongatum</i> Agardh                                         | 186 | 15 | 1763 | 15 | 1156 | 15 | 900 | 15 |
| 57. <i>Diatoma vulgaris</i> var. <i>ovalis</i> (Fricke) Hust.               | -   | -  | -    | -  | 1    | 1  | -   | -  |
| 58. <i>Diploneis ovalis</i> (Hilse) Cleve                                   | 1   | 1  | -    | -  | -    | -  | -   | -  |
| 59. <i>Epithemia argus</i> Kütz.                                            | 1   | 1  | -    | -  | -    | -  | -   | -  |
| 60. <i>Epithemia sorex</i> Kütz.                                            | 3   | 2  | -    | -  | -    | -  | -   | -  |
| 61. <i>Epithemia turgida</i> (Ehr.) Kütz.                                   | -   | -  | -    | -  | 17   | 7  | -   | -  |
| 62. <i>Epithemia zebra</i> (Ehr.) Kütz.                                     | 2   | 2  | -    | -  | 2    | 2  | -   | -  |
| 63. <i>Epithemia zebra</i> var. <i>saxonica</i> (Kütz.) Grun.               | 3   | 2  | -    | -  | -    | -  | -   | -  |
| 64. <i>Epithemia</i> sp.                                                    | 4   | 2  | 1    | 1  | 44   | 13 | -   | -  |
| 65. <i>Eunotia gracilis</i> (Ehr.) Rabenhorst                               | -   | -  | 3    | 3  | 5    | 3  | -   | -  |
| 66. <i>Eunotia lunaris</i> (Ehr.) Grun.                                     | -   | -  | 7    | 4  | -    | -  | -   | -  |
| 67. <i>Eunotia lunaris</i> var. <i>subarcuata</i> (Naeg.) Grun.             | -   | -  | 1    | 1  | -    | -  | -   | -  |
| 68. <i>Fragilaria bicapitata</i> A.Mayer                                    | 12  | 1  | -    | -  | 22   | 3  | -   | -  |
| 69. <i>Fragilaria brevistriata</i><br>var. <i>inflata</i> (Pantocsek) Hust. | 7   | 5  | -    | -  | -    | -  | -   | -  |



Table 1 continued

|                                                                                    | I.  |    | II. |    | III. |    | IV. |    |
|------------------------------------------------------------------------------------|-----|----|-----|----|------|----|-----|----|
|                                                                                    | a.  | b. | a.  | b. | a.   | b. | a.  | b. |
| 70. <i>Fragilaria construens</i> (Ehr.)Grun.                                       | 10  | 8  | -   | -  | 1    | 1  | -   | -  |
| 71. <i>Fragilaria construens</i><br>var. <i>binodis</i> (Ehr.)Grun.                | -   | -  | 2   | 2  | -    | -  | 1   | 1  |
| 72. <i>Fragilaria construens</i> var. <i>subsalina</i> Hust.                       | -   | -  | 2   | 1  | -    | -  | -   | -  |
| 73. <i>Fragilaria intermedia</i> Grun.                                             | -   | -  | -   | -  | 1    | 1  | -   | -  |
| 74. <i>Fragilaria pinnata</i> Ehr.                                                 | 4   | 3  | -   | -  | 7    | 2  | -   | -  |
| 75. <i>Fragilaria pinnata</i> var. <i>lanzettula</i> Hust.                         | 4   | 1  | -   | -  | -    | -  | -   | -  |
| 76. <i>Fragilaria virescens</i> Ralfs                                              | -   | -  | -   | -  | 13   | 5  | -   | -  |
| 77. <i>Fragilaria</i> sp.                                                          | -   | -  | 3   | 1  | 16   | 2  | -   | -  |
| 78. <i>Gomphocymbella</i> sp.                                                      | -   | -  | -   | -  | 18   | 1  | -   | -  |
| 79. <i>Gomphonema acuminatum</i><br>var. <i>brebissonii</i> (Kütz.) Cleve          | -   | -  | 6   | 4  | 1    | 1  | 1   | 1  |
| 80. <i>Gomphonema augur</i> Ehr.                                                   | -   | -  | -   | -  | 1    | 1  | -   | -  |
| 81. <i>Gomphonema apiculatum</i> Ehr.                                              | -   | -  | 14  | 7  | -    | -  | -   | -  |
| 82. <i>Gomphonema intricatum</i> Kütz.                                             | 1   | 1  | 4   | 3  | -    | -  | -   | -  |
| 83. <i>Gomphonema intricatum</i> var. <i>pumila</i> Grun.                          | -   | -  | 2   | 2  | -    | -  | -   | -  |
| 84. <i>Gomphonema lanceolatum</i> Ehr.                                             | -   | -  | 5   | 5  | 2    | 2  | -   | -  |
| 85. <i>Gomphonema longiceps</i> Ehr.                                               | -   | -  | 1   | 1  | 3    | 1  | -   | -  |
| 86. <i>Gomphonema longiceps</i> var. <i>subclavata</i> Grun.                       | -   | -  | 1   | 1  | -    | -  | 2   | 1  |
| 87. <i>Gomphonema longiceps</i> var. <i>subclavata</i><br>f. <i>gracilis</i> Hust. | -   | -  | 3   | 2  | -    | -  | 4   | 3  |
| 88. <i>Gomphonema olivaceum</i> (Lyngbye) Kütz.                                    | 13  | 7  | 63  | 13 | 17   | 6  | -   | -  |
| 89. <i>Gomphonema olivaceum</i> var. <i>calcareum</i> Cleve                        | 12  | 2  | 88  | 14 | 42   | 10 | 1   | 1  |
| 90. <i>Gomphonema parvulum</i> Kütz.                                               | -   | -  | -   | -  | 9    | 6  | -   | -  |
| 91. <i>Gomphonema parvulum</i> var. <i>micropus</i> (Kütz.)Cleve                   | -   | -  | 2   | 1  | -    | -  | -   | -  |
| 92. <i>Gomphonema</i> sp.                                                          | 168 | 15 | 406 | 15 | 140  | 15 | 103 | 13 |
| 93. <i>Gyrosigma spencerii</i> (W.Smith) Cleve                                     | 1   | 1  | -   | -  | -    | -  | -   | -  |
| 94. <i>Gyrosigma</i> sp.                                                           | -   | -  | -   | -  | -    | -  | 1   | 1  |
| 95. <i>Mastoglia smithii</i> var. <i>amphiocephala</i> Grun.                       | 7   | 5  | 4   | 4  | 1    | 1  | -   | -  |
| 96. <i>Navicula cari</i> Ehr.                                                      | 40  | 9  | -   | -  | -    | -  | -   | -  |
| 97. <i>Navicula cryptocephala</i> Kütz.                                            | 12  | 9  | 9   | 8  | 15   | 9  | 3   | 2  |
| 98. <i>Navicula cryptocephala</i> var. <i>intermedia</i> Grun.                     | 24  | 8  | 27  | 7  | 16   | 7  | -   | -  |
| 99. <i>Navicula cryptocephala</i><br>var. <i>veneta</i> (Kütz.) Grun               | 129 | 15 | 174 | 14 | 153  | 15 | 68  | 13 |
| 100. <i>Navicula cuspidata</i> Kütz.                                               | 1   | 1  | 1   | 1  | -    | -  | 1   | 1  |
| 101. <i>Navicula cuspidata</i> var. <i>ambigua</i> (Ehr.)Cleve                     | 1   | 1  | -   | -  | 1    | 1  | 1   | 1  |
| 102. <i>Navicula gothlandica</i> Grun.                                             | -   | -  | 1   | 1  | -    | -  | -   | -  |
| 103. <i>Navicula gregaria</i> Donkin                                               | -   | -  | -   | -  | -    | -  | 1   | 1  |
| 104. <i>Navicula halophila</i> (Grun.) Cleve                                       | 4   | 3  | 28  | 10 | 14   | 7  | -   | -  |
| 105. <i>Navicula halophila</i> f. <i>robusta</i> Hust.                             | 3   | 3  | 1   | 1  | 1    | 1  | -   | -  |
| 106. <i>Navicula hungarica</i> Grun.                                               | 3   | 2  | 2   | 1  | 1    | 1  | -   | -  |
| 107. <i>Navicula oblonga</i> Kütz.                                                 | 13  | 9  | 7   | 5  | 36   | 14 | 2   | 2  |
| 108. <i>Navicula protracta</i> Grun.                                               | 3   | 3  | -   | -  | -    | -  | -   | -  |
| 109. <i>Navicula pupula</i> var. <i>capitata</i> Hust.                             | -   | -  | 1   | 1  | 5    | 3  | -   | -  |
| 110. <i>Navicula radiosa</i> Kütz.                                                 | 15  | 9  | 55  | 15 | 41   | 14 | 10  | 6  |
| 111. <i>Navicula salinarum</i> f. <i>capitata</i> Schulz.                          | 4   | 4  | -   | -  | 1    | 1  | -   | -  |
| 112. <i>Navicula simplex</i> Krasske                                               | -   | -  | -   | -  | 3    | 3  | -   | -  |
| 113. <i>Navicula</i> sp.                                                           | 1   | 1  | -   | -  | -    | -  | 1   | 1  |
| 114. <i>Nitzschia acicularioides</i> Hust.                                         | -   | -  | 1   | 1  | -    | -  | -   | -  |
| 115. <i>Nitzschia admissa</i> Hust.                                                | -   | -  | 3   | 3  | 2    | 1  | 1   | 1  |
| 116. <i>Nitzschia amphibia</i> Grun.                                               | 20  | 7  | 191 | 15 | 380  | 15 | 17  | 8  |



Table 1 continued

|                                                                 | I.  |    | II. |    | III. |    | IV. |    |
|-----------------------------------------------------------------|-----|----|-----|----|------|----|-----|----|
|                                                                 | a.  | b. | a.  | b. | a.   | b. | a.  | b. |
| 117. Nitzschia angustata (W.Smith) Grun.                        | 46. | 11 | 1   | 1  | 2    | 2  | 2   | 1  |
| 118. Nitzschia apiculata (Gregory) Grun.                        | 62  | 14 | 2   | 1  | -    | -  | -   | -  |
| 119. Nitzschia commutata Grun.                                  | 1   | 1  | -   | -  | -    | -  | -   | -  |
| 120. Nitzschia filiformis (W.Smith) Hust.                       | 24  | 2  | -   | -  | -    | -  | -   | -  |
| 121. Nitzschia kützingiana Hilse                                | -   | -  | -   | -  | 5    | 2  | -   | -  |
| 122. Nitzschia kützingioides Hust.                              | 25  | 10 | 20  | 7  | 13   | 5  | -   | -  |
| 123. Nitzschia obtusa W.Smith                                   | -   | -  | 1   | 1  | -    | -  | 1   | 1  |
| 124. Nitzschia palea (Kütz.) W.Smith                            | 2   | 2  | 4   | 2  | 9    | 4  | 1   | 1  |
| 125. Nitzschia sigmoidea (Ehr.) W.Smith                         | 2   | 2  | 22  | 10 | 18   | 10 | -   | -  |
| 126. Nitzschia sublinearis Hust.                                | -   | -  | 1   | 1  | -    | -  | -   | -  |
| 127. Nitzschia tryblionella Hantzsch.                           | 3   | 3  | -   | -  | -    | -  | -   | -  |
| 128. Nitzschia tryblionella var. levidensis<br>(Arnott) A.Mayer | -   | -  | 1   | 1  | -    | -  | -   | -  |
| 129. Nitzschia sp.                                              | -   | -  | 1   | 1  | 3    | 1  | 7   | 4  |
| 130. Pinnularia appendiculata (Agardh) Cleve                    | -   | -  | 1   | 1  | -    | -  | -   | -  |
| 131. Pinnularia divergens W.Smith                               | -   | -  | 1   | 1  | -    | -  | -   | -  |
| 132. Rhoicosphaeria curvata (Kütz.) Grun.                       | 461 | 15 | 122 | 14 | 130  | 14 | 118 | 13 |
| 133. Rhopalodia gibba (Ehr.) O.Müll.                            | 10  | 8  | 1   | 1  | 11   | 6  | -   | -  |
| 134. Rhopalodia gibba var. ventricosa (Ehr.) Grun.              | 3   | 3  | 1   | 1  | 2    | 2  | -   | -  |
| 135. Stauroneis anceps Ehr.                                     | -   | -  | 2   | 2  | -    | -  | -   | -  |
| 136. Surirella ovalis Brébisson                                 | -   | -  | 1   | 1  | -    | -  | -   | -  |
| 137. Surirella ovata Kütz.                                      | 4   | 3  | -   | -  | -    | -  | -   | -  |
| 138. Surirella peisonis Pantocsek                               | -   | -  | 1   | 1  | -    | -  | -   | -  |
| 139. Synedra acus Kütz.                                         | 104 | 15 | 106 | 14 | 120  | 15 | 60  | 12 |
| 140. Synedra affinis Kütz.                                      | -   | -  | 107 | 13 | 29   | 7  | 12  | 7  |
| 141. Synedra affinis var. fasciculata (Kütz.) Grun.             | -   | -  | 1   | 1  | -    | -  | -   | -  |
| 142. Synedra amphicephala Kütz.                                 | 8   | 3  | 18  | 6  | 22   | 7  | 2   | 1  |
| 143. Synedra capitata Ehr.                                      | 10  | 8  | 15  | 9  | 12   | 9  | -   | -  |
| 144. Synedra pulchella Kütz.                                    | 1   | 1  | -   | -  | 144  | 15 | -   | -  |
| 145. Synedra rumpens Kütz.                                      | 1   | 1  | -   | -  | -    | -  | -   | -  |
| 146. Synedra ulna (Nitzsch.) Ehr.                               | 167 | 15 | 373 | 15 | 323  | 15 | 41  | 13 |
| 147. Synedra ulna var. amphirynchus (Ehr.) Grun.                | -   | -  | -   | -  | -    | -  | 2   | 1  |
| 148. Synedra ulna var. danica (Kütz.) Grun.                     | 8   | 5  | 67  | 12 | 23   | 9  | -   | -  |
| 149. Synedra vaucheriae Kütz.                                   | 335 | 15 | -   | -  | 3    | 1  | 2   | 1  |
| 150. Bacillariophyceae sp.                                      | 85  | 14 | 60  | 13 | 89   | 15 | -   | -  |

EUGLENOPHYTA

|                            |   |   |   |   |   |   |   |   |
|----------------------------|---|---|---|---|---|---|---|---|
| 151. Euglenophyta sp.      | - | - | 1 | 1 | - | - | - | - |
| 152. Phacus hamatus Pochm. | - | - | - | - | 1 | 1 | - | - |
| 153. Phacus sp.            | - | - | - | - | 1 | 1 | - | - |



Table 1 continued

|                                                  | I. |    | II. |    | III. |    | IV. |    |
|--------------------------------------------------|----|----|-----|----|------|----|-----|----|
|                                                  | a. | b. | a.  | b. | a.   | b. | a.  | b. |
| <u>CHLOROPHYTA</u>                               |    |    |     |    |      |    |     |    |
| 154. <i>Chlorococcales</i> sp.                   | 1  | 1  | -   | -  | 27   | 6  | -   | -  |
| 155. <i>Chlorella</i> sp.                        | -  | -  | 2   | 1  | -    | -  | -   | -  |
| 156. <i>Cosmarium</i> sp.                        | -  | -  | -   | -  | 1    | 1  | -   | -  |
| 157. <i>Crucigenia</i> sp.                       | -  | -  | -   | -  | 1    | 1  | -   | -  |
| 158. <i>Pediastrum boryenium</i> (Turp.) Menegh. | 1  | 1  | -   | -  | -    | -  | -   | -  |
| 159. <i>Protococcus</i> sp.                      | -  | -  | -   | -  | 2    | 2  | -   | -  |
| 160. <i>Scenedesmus ecornis</i> (Ralfs) Chod.    | -  | -  | -   | -  | 1    | 1  | -   | -  |
| 161. <i>Scenedesmus quadricauda</i> Chod.        | 1  | 1  | 1   | 1  | 11   | 6  | -   | -  |
| 162. <i>Scenedesmus spinosus</i> Chod.           | -  | -  | -   | -  | 3    | 3  | -   | -  |
| 163. <i>Scenedesmus</i> sp.                      | -  | -  | -   | -  | 3    | 3  | 1   | 1  |
| 164. <i>Spirogyra</i> sp.                        | -  | -  | 5   | 3  | 6    | 5  | 1   | 1  |
| 165. <i>Ulotrichales</i> sp.                     | 3  | 3  | 3   | 2  | 6    | 5  | -   | -  |
| 166. <i>Charachium</i> sp.                       | -  | -  | 9   | 5  | 2    | 2  | -   | -  |

Table 2: The mean and standard deviation of number of individuals and biomass of periphyton related to surface unit and mass unit of reed. (P = periphyton, M = makrophyta)

|                                  |                                     | Lake Herlakni |                  | Lake Kisherlakni |                  | Lake Atjaro |                  | Lake Hidegsegi |                 |
|----------------------------------|-------------------------------------|---------------|------------------|------------------|------------------|-------------|------------------|----------------|-----------------|
|                                  |                                     | x             | S <sub>n-1</sub> | x                | S <sub>n-1</sub> | x           | S <sub>n-1</sub> | x              | S <sub>n1</sub> |
| individual of P<br>surface of M  | 10 <sup>9</sup> ind.m <sup>-2</sup> | 6,24          | 5,33             | 3,18             | 1,16             | 3,40        | 1,79             | 4,87           | 3,81            |
| individual of P<br>dry mass of M | 10 <sup>6</sup> ind.g <sup>-1</sup> | 25,38         | 26,18            | 7,65             | 2,74             | 14,94       | 10,58            | 19,67          | 19,9            |
| biomass of P<br>surface of M     | 10 <sup>2</sup> g.m <sup>2</sup>    | 23,14         | 27,55            | 6,05             | 2,61             | 19,39       | 22,81            | 2,90           | 3,48            |
| biomass of P<br>dry mass of M    | 10 <sup>-3</sup> g.g <sup>-1</sup>  | 89,14         | 118,36           | 15,20            | 8,59             | 89,87       | 115,94           | 29,65          | 72,9            |

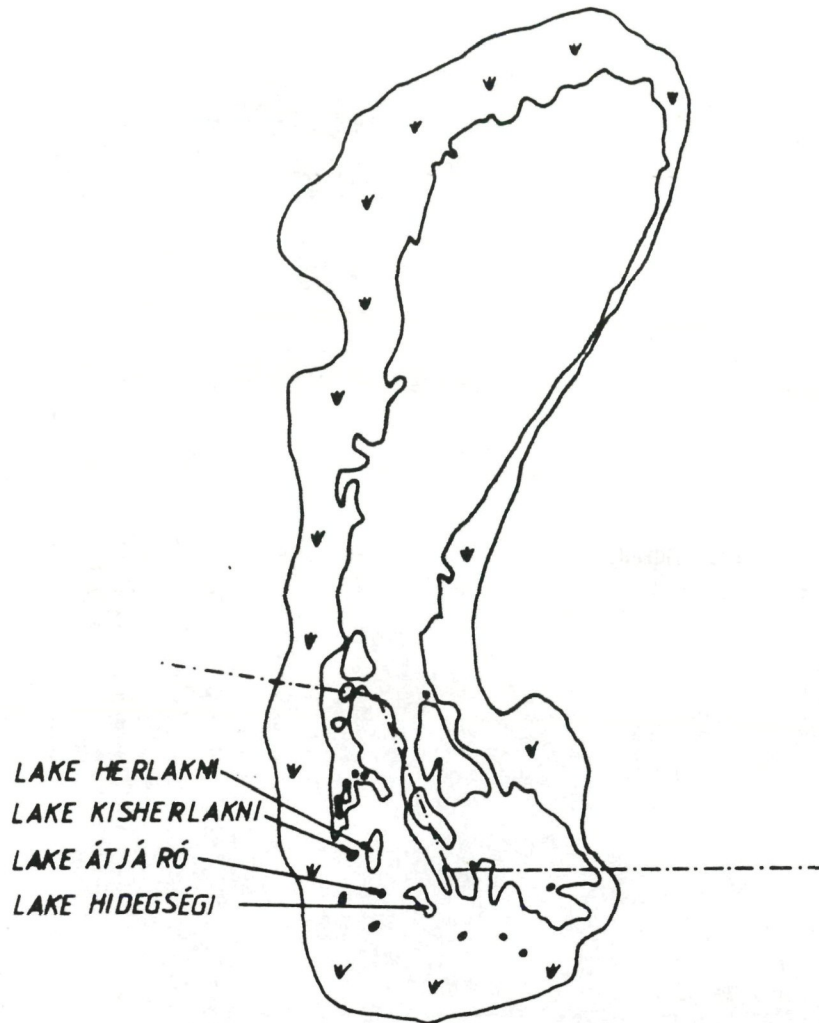


Fig. 1: Sampling locations

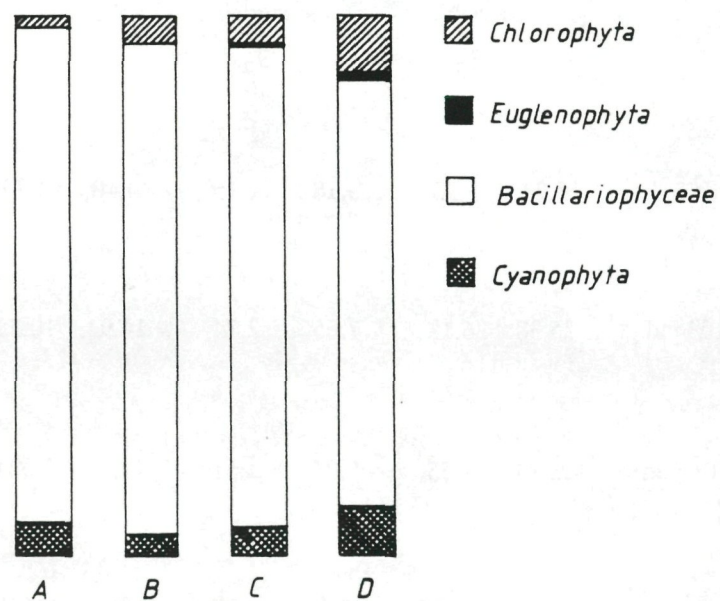


Fig. 2: The ratio of number of taxa found according to phyla. (A = Lake Herlakni, B = Lake Kisherlakni, C = Lake Atjáró, D = Lake Hidegségi).



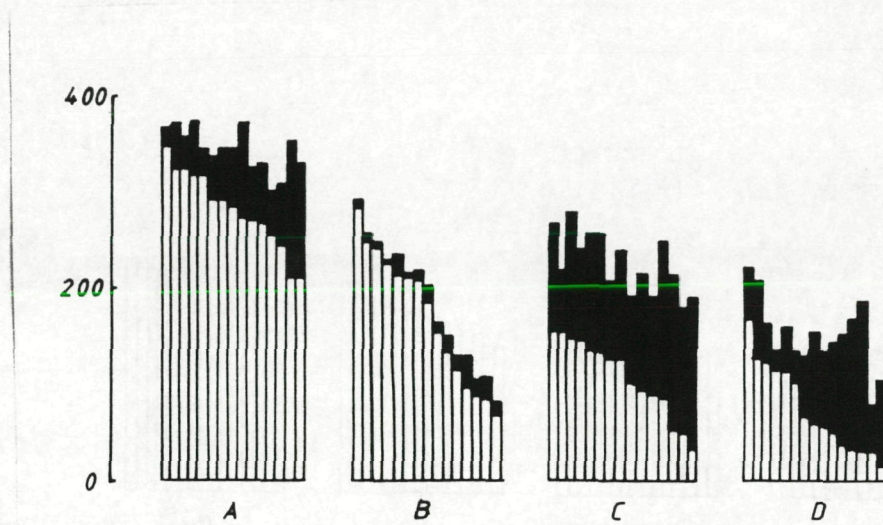


Fig. 3: The ratio of the two most frequent species in the 4 studied lakes. (White column = the number of *Achnanthes minutissima*, black column = number of *Diatoma elongatum*, A = Lake Hidegségi, B = Lake Herlakni, C = Lake Kisherlakni, D = Lake Atjáro),

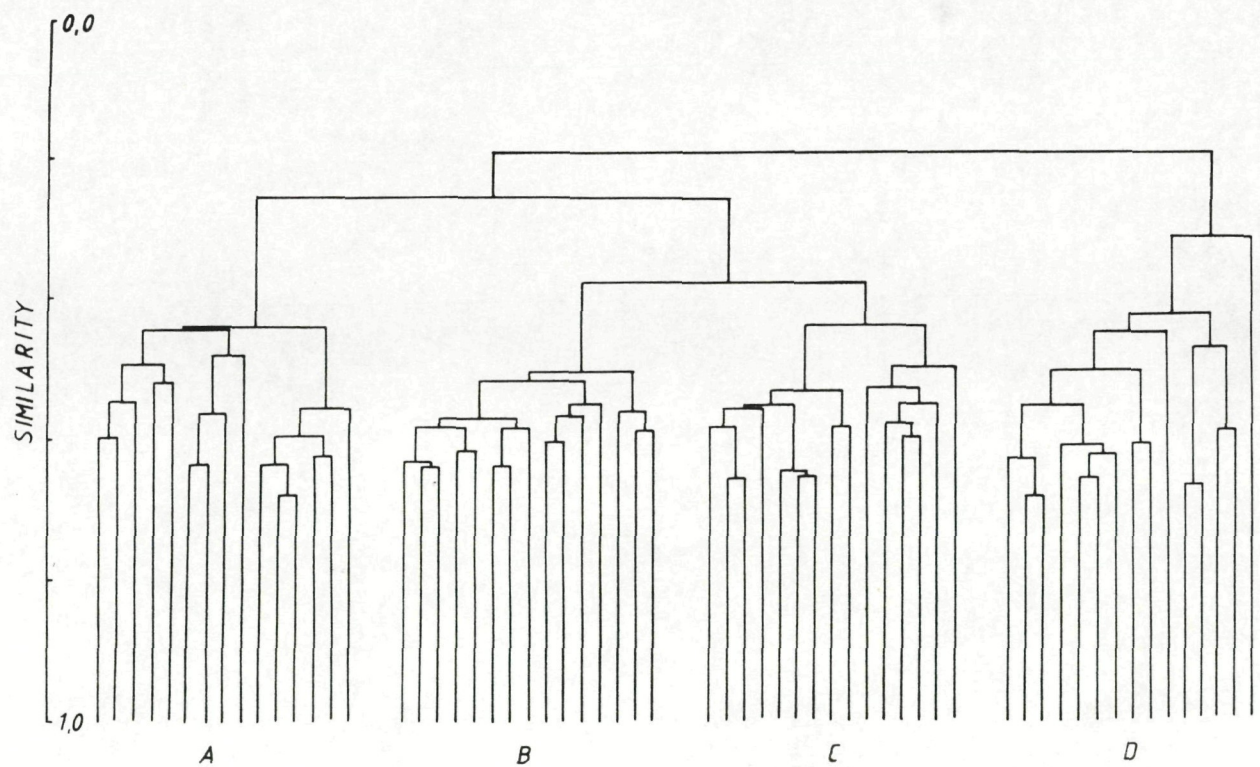


Fig. 4: Dendrogram of the diaphyctic samples using Hummon's similarity index. (A = Lake Herlakni, B = Lake Kisherlakni, C = Lake Atjáro, D = Lake Hidegségi).

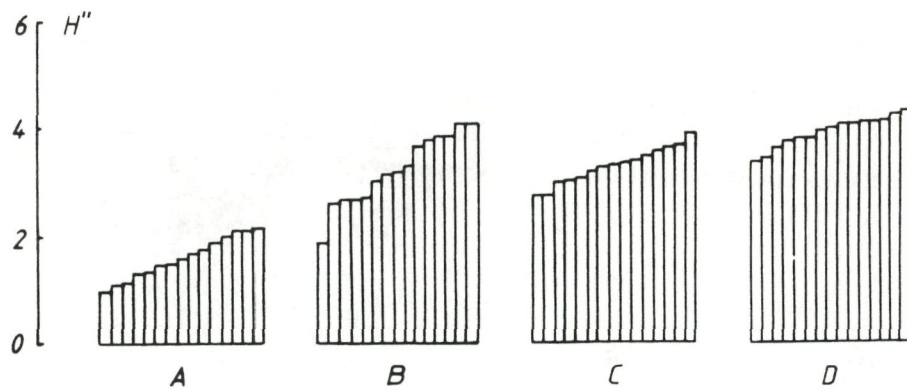


Fig. 5: Diversity distribution of the periphytons. (A = Lake Herlakni, B = Lake Kisherlakni, C = Lake Atjáró, D = Lake Hidegségi).



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Zoologisch-Botanische Datenbank/Zoological-Botanical Database

Digitale Literatur/Digital Literature

Zeitschrift/Journal: [BFB-Bericht \(Biologisches Forschungsinstitut für Burgenland, Illmitz 1](#)

Jahr/Year: 1989

Band/Volume: [71](#)

Autor(en)/Author(s): Buczko K.

Artikel/Article: [About the spatial distribution of the algae and the quantitative development of periphyton in the Hungarian part of Lake Fertő \(Neusiedler See\) 111-124](#)