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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 signific nt 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:

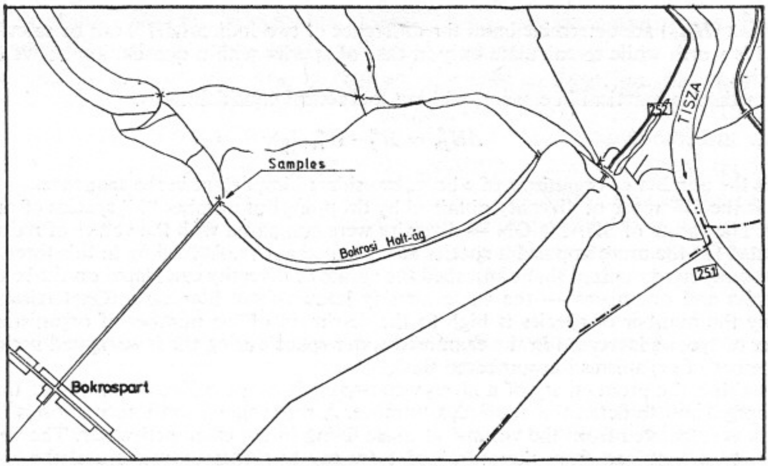
Cyanophyta, Diatomae, Chlorophyta and others: Chrysophyceae, Euglenophyta, Pyrrophyta, Xanthophyceae. During the months of January and February the presence of small-volumed blue algae (*Merismopedia* species 83 000i/l) and a flagellate green alga were dominant in the water. During the spring months (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

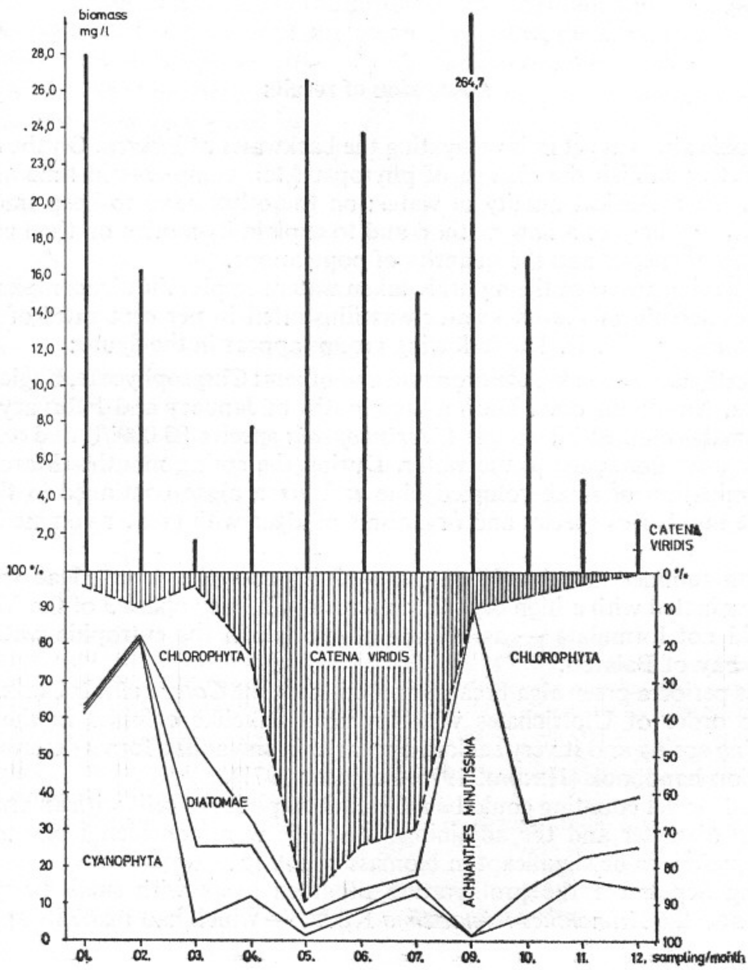


Fig. 1. Seasonal changes of phytoplankton complex

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

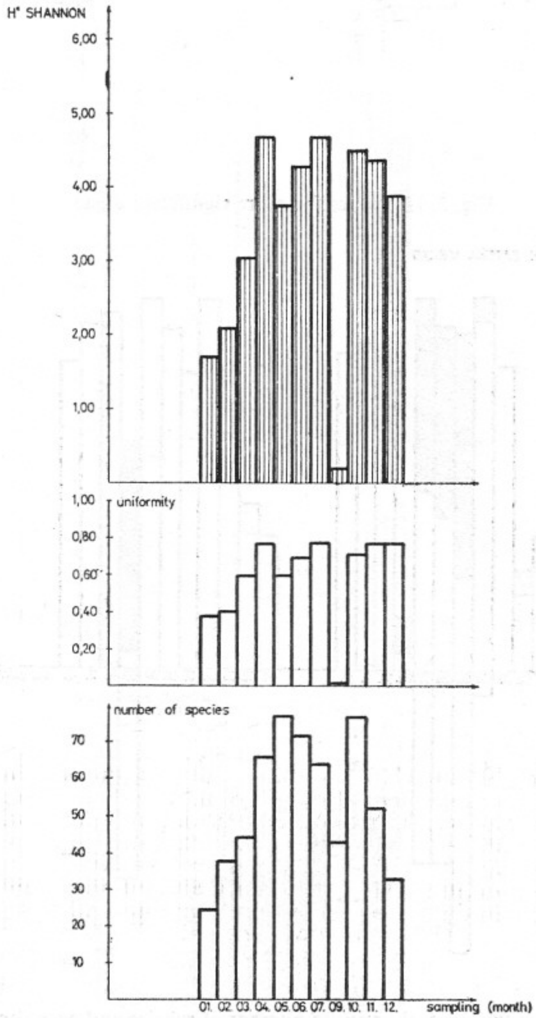


Fig. 2. Diversity of alga organism number

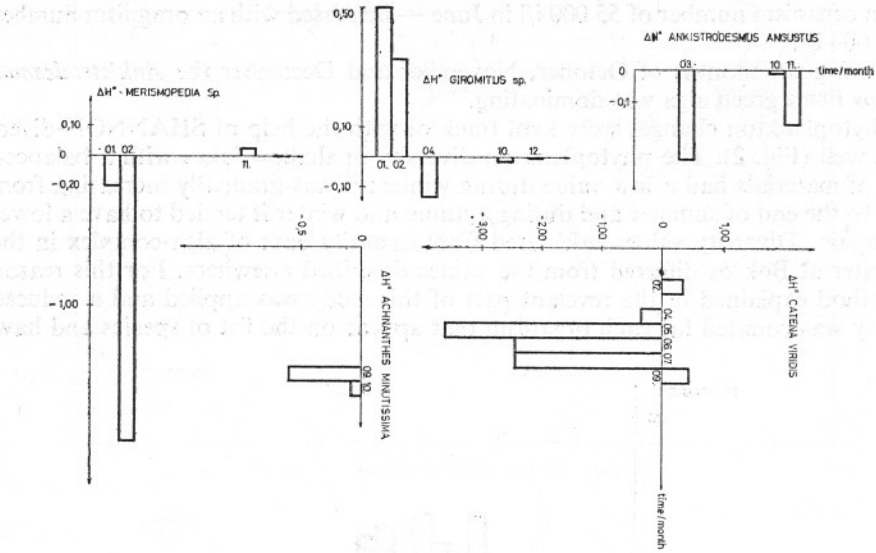


Fig. 3. H″ values for more significant algae

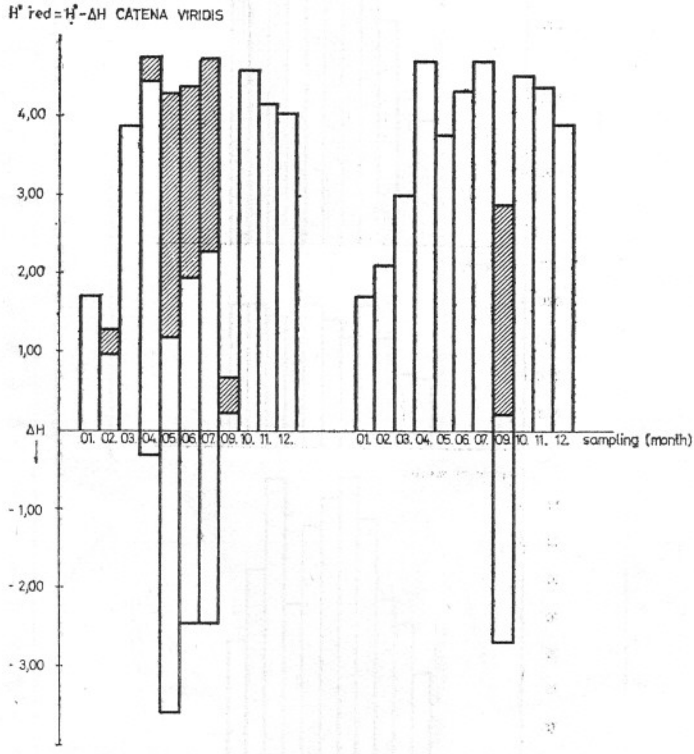


Fig. 4. Reduced diversity of number of species and organisms
Biomass diversity and the reduced H'' for Achnanthes

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.

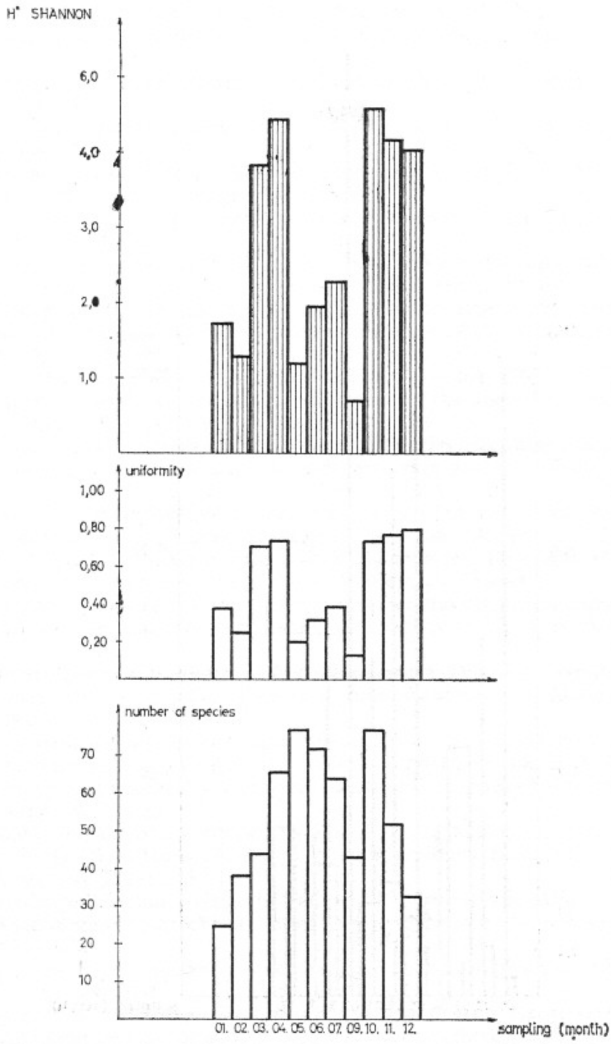


Fig. 5. Diversity of alga biomass

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.

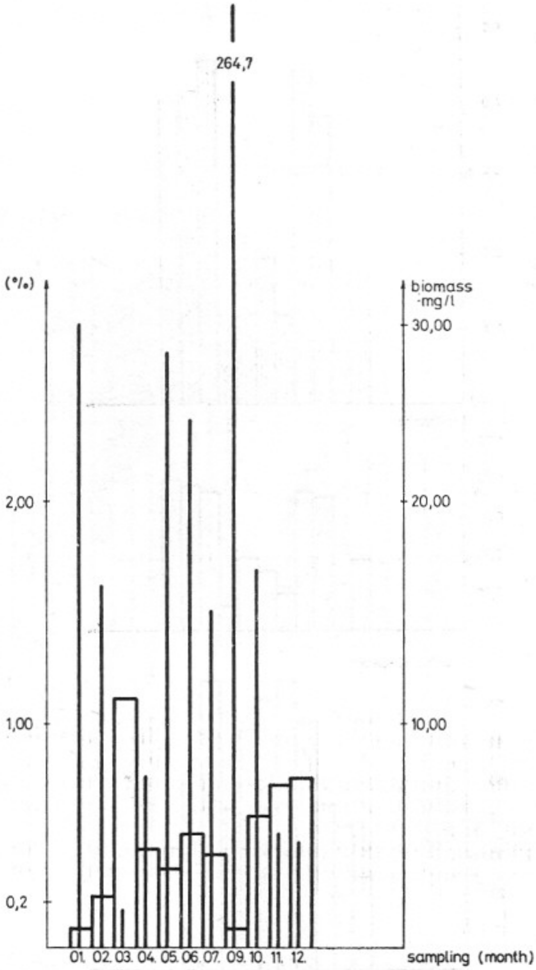


Fig. 6. Seasonal changes in the chlorophyll contents of alga biomass (%)

References

BARTHA, ZS. (1977): Phytoplankton investigations on Lake Velence (Algal counts and biomass). — Acta Bot. Hung. *23*, 1—11.

DOBLER, E.—KOVÁCS, K. (1984): Results of the preliminary investigations on the algacommunities in the backwater of the Tisza at Alpár. — Tiscia (Szeged) *19*, 59—68.

FELFÖLDY, L. (1980): A biológiai vízminősítés (Biological water qualification). 3rd edition. — Vízdok, Budapest.

HAJDÚ, L. (1977): Szemelvények az algakutatás eredményeiből, feladataiból (Selections of the results and from the tasks of algal research). — A biologia aktuális problémái (Actual Problems of Biology). *10*, 100—101.

HERODEK, S.—TAMÁS, G. (1976): A fitoplankton tömege, termelése és a Balaton eutrofizációja (The biomass. primary production of phytoplankton and the eutrofication of Lake Balaton). — Hidrológiai Közl. *5*, 219—228.

HINDAK, F. (1975): Kluc na urcovanie vytrusnych rastlin. I. fiel, Riasy. — Bratislava.

HORTOBÁGYI, T. (1957): Újabb adatok a Szegedi Fehértó mikrovegetációjához (Recent data to microvegetation of Fehértó at Szeged). — Egri Ped. Főisk. Évk. *3*, 341—343.

— (1957): Algák a Szilvásváradi vizekből (Algae from Szilvásvárad). — Egri Ped. Főiskolai Évk. *3*, 345—359.

— (1959): Adatok Magyarország moszataihoz III. (Data to algae of Hungary III). — Egri Ped. Főisk. Évk. *5*, 531—551.

— (1960): Adatok Magyarország moszataihoz IV. (Data to algae of Hungary IV). — Egri Ped. Főisk. Évk. *6*, 359—391.

KISS, I. (1979a): Seltene *Strombomonas* - Arten den toten Armen der Tisza (Theiss) am mittleren und oberen Flusslauf. — Tiscia (Szeged) *14*, 63—70.

— (1979b): Algological investigations in the dead arms of the river Tisza at Tiszaalpár and Tiszaug. — Tiscia (Szeged) *14*, 41—61.

KISS, K. T. (1984): Special problems in studying phytoplankton associations (Occurence and ecological evolution of *Hyaloraphdium contortum*). — Acta Bot. Hung. *30*, 269—276.

KOVÁCS, K.—DOBLER, E. (1984): Studies on the qualitative and quantitative compositions on the seasonal changes of phytoplankton at three sampling areas of the dead Tisza at Lakitelek. — Tiscia (Szeged) *19*, 69—78.

MARGALEF, R. (1978): Diversity. — Phytoplankton manual, 251—260. UNESCO, Paris.

NÉMETH, J.—VÍZKELETY, É. (1977): Ecological investigations on the algal communities in the catchment area of river Zala I. — Acta Bot. Hung. *23*, 143—166.

NÉMETH, J.—VÖRÖS, L. (1984): Módszertan és koncepció felszíni vizek algológiai monitoringjához (Methodology and conception to algal research of surface water). — Környezetvédelmi Int., Budapest.

RAJCZY, M.—PADISÁK, J. (1983): DIVDROP analysis — a new method — for the interpretation of species importance in diversity changes. — Ann. Hist.—Nat. Mu. Nation. Hung, *75*, 97—105.

SCHMIDT, A. (1977): Adatok Dél-magyarországi vizek algáinak ismeretéhez I. (Data to the review of algae in waters of South-Hungary I.). — Bot. Közlem. *64*, 183—195.

UHERKOVICH, G. (1965): Gödöllői halastavi trágyázási kísérletekkel kapcsolatos mennyiségi fitoplankton elemzések (Quantitative phytoplankton analysis at Gödöllő, fish-lakes) — Hidr. Közl. *5*, 9—35.

— (1978): A Tiva-tó és a Nagyberek (Barcs- és Borókás) algáiról (Die Algenvegetation der Gewasser der "Wachholderheide bei Barcs" 1. Tiva-Teich und Nagyberek). — Dunántúli Dolg. Term. tud. sorozat (Pécs) *1*, 9—35.

— (1978): Adatok a Baláta-tó (Somogy megye) algáinak ismeretéhez (Data to the alga flora of Lake Baláta, County Somogy, Hungary). — Janus Pannonius Múz. Évk. (Pécs) *22*, 7—12.

— (1979): Az öcsi Nagy-tó limnológiája (Die Limnologie des Grossen Seen von Öcs). A — Veszprém megyei Muz. Közl. *14*, 25—53.

— (1981): A Szűrőhely-folyás (Barcsi borókás) Tőzegmohás tavacskáinak algái (on the Algae of the Pond „Szűrőhely-folyás" in the Juniper Woodland of Barcs, Hungary). — Dunántúli Dolg. Természettud. Sorozat (Pécs) *2*, 5—23.

— (1982): A Fekete-hegy (Balatonfelvidék) Kerek-tava algavegetációja (Die Algenvegetation des Kerek (Rund)-Seen vom Fekete (Schwarz)-Berg (Balaton Oberland). — A Bakonyi Természettud. Múz. Közl. *1*, 81—110.

VÖRÖS, L. (1981): A balatoni fitoplankton változása (Phytoplankton changes at Lake Balaton). — Vízügyi Közlem. *2*, 259—304.

— (1984): A fitoplankton mennyiségi jellemzőinek értékelése vízminőségi szempontból balaton mérések alapján (Bewrtung der quantitativen Parameter des Phytoplanktons aus den Aspekten der Gewasserqüte anfarund der Balaton — Massungen). — Hidr. Közl. *3*, 157—162.

A Bokrosi holtág fitoplanktonjának szezonális változása

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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

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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.