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SHORT-TERM INVESTIGATIONS ON THE PHYTOPLANKTON OF LAKE BALATON AT TIHANY

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Between July 20 and August 18 1976, daily observations were carried out on the number and biomass of the phytoplankton of Lake Balaton, separately for micro- and macroalgae; in addition, organic carbon content, temperature and transparence of the water were measured. Comparable investigations on the Lake Balaton have not been made so far.

The dynamics of certain determined variables reflect the character of a large, extensive and shallow lake. The data presented here draw attention to the difference between the thirty day variations of macro- and microalgae, and point to the differences between information content of the mass variables (numbers and biomass). The organic carbon content, along with some other data, indicates the advanced state of eutrophication of the lake.

Introduction

Aims of the study were daily investigation of the number and biomass of the phytoplankton, taking macro- and microalgae separately into account (algae that do not exceed maximal length of 10 μm are considered to be microalgae and all above that size macroalgae), daily investigations of the particulate organic carbon content, Secchi-transparency and temperature of the water: by application of velocity of wind data for investigation period, an attempt to reveal functional, or at least correlational — stochastic relationships of the above — mentioned variables. Sampling and on-the-spot measurements took place between July 20 and August 18 1976, at Tihany, so data presented here should be considered more or less representative only for the area.

Daily variations of the number and biomass of the phytoplankton of Lake Balaton have not been studied so far but it is becoming of immense importance nowadays, mainly in connection with spatial-temporal structures of coexistential units. The presence and/or the population dynamics of certain component populations are considered in this sense. Apart from the theory, an obviously practical problem arises in connection with Lake Balaton, namely eutrophication. Eutrophication becomes apparent in the quantitative indices without any special interpretation. Besides environmental conservational points of view, eutrophication effects the above-mentioned categories as well: to mention the former example, population dynamics may speed up and characteristic changes may be experienced in the qualitative and quantitative relationships of the component populations. From this aspect, this paper is in close connection with other quantitative investigations on feeding biology.

For the sake of completeness, special attention was paid to the qualitative and quantitative treatment of microalgae in the course of this work, since only estimates have so far been known (HERODEK and TAMÁS 1975).

Answer was sought to the question to what extent the quantity of organic carbon in the study period was determined by planktonic phytomass and whether the effects of weather conditions dominate in the formation of the organic carbon content of the water even in the production period of the producers. The question was the same in connection with SECCHI-transparency, that is, can primary product be characterized by SECCHI-transparency in spite of the peculiar properties of the Lake Balaton (ENTZ and SEBESTYÉN 1942; FELFÖLDY 1963). It is noted here that Lake Balaton with its average depth of 3.0—3.5 m cannot be called a typical lake, in spite of its open water surface of some 600 km^2 and the vertical stratification is not indicative of its classical form, but rather of special, "pannon-type" limnological processes (ENTZ and SEBESTYÉN 1942). A furthermore unsettled question was to what extent the temperature of the water affected the phytoplankton.

Material and methods

Five sampling points were located along the circumference of a circle around an open-water b7oy, situated 1200 m from the water front of the Tihany Institute. The circle was of a radius of 40 m and at all points water depths of 310 cm were measured. Water samples were taken daily over thirty days, always at the same time of the day, between 10 and 12 hours a.m. Samples, 1 liter in volume respectively, were taken from depths of 20 cm, 100 cm, 200 cm and 300 cm at the five sampling points. The total of 20 l of water collected in this way were then poured into a black plastic can and taken to the Institute. On six occasions, due to heavy storms, samples were taken from the same depths and from sampling points of the same distribution, but 400 m, and not 1200 m from the shore. These days were: July 24 and 25 August and 5, 6, 12 and 18 (Fig. 1).

Temperature of the water was measured at the buoy at depths of 40 cm, 90 cm and 160 cm, from which the mean was calculated (on the kind advice of Olga SEBESTYÉN). Water transparency was measured at the bouy as well, by the SECCHI-disc method.

The 20 of water collected daily was thoroughly stirred up after delivery and the particulate organic carbon content was determined from 100 ml quantities taken from this volume (OSTAPENYA 1965), using WHATMAN GF/C glass filter-papers for filtering. Results were expressed in mg · l^{-1}.

For the quantitative and qualitative study of microalgae RAZUMOV's method, originally described for bacterial research, was used (RAZUMOV 1932). This method has been used successfully in Hungary for bacterioplankton studies (OLÁH 1969, 1970, 1971, 1973), but some attempts to use this are known to have been made in microalgae studies (Pál JUHÁSZ-NAGY and Lajos VÖRÖS, personal communication). The authors membrane-filtering investigations started in 1975, the conclusions of which were used to alter some aspects of the originally described method. Difficulties arose from the fact that whereas preservation of the external morphology of the bacterium cell is not the primary aim in bacteriological studies, algological application requires the fixation of the systematically important external morphological characters. The method entails drastic water abstraction, which results in a certain amount of deformation of the cell. In order to enhance identification the original method was altered as follows.

- 100 ml of the stirred up water (20 l) was taken to which 11 ml of 36—38% formalin was added as preservative and this mixture was filtered;
- the quantity of water filtered through the membranefilter (SARTORIUS-Membranfilter GMBH; pore diameter 0.2 μm) depended on the day's reading of SECCHI-transparency, compensating for the filling effect of the stirred up inorganic particles; in the investigation series, quantities of 10, 15, 20 and 40 ml were filtered;
- filtering was carried out in weak vacuum, taking 10—15 minutes for 10 ml of water to pass through;
- membrane-filters were dried at room temperature for 24 hours after filtering and then subjected to 20 minutes post-drying at 60 °C before staining with carbolerithrosin.

Macroalgae were examined with reversed planktonmicroscope (UTERMÖHL 1958).

In both study methods, the number (Number liter^{-1}) of each species was estimated from the size of the examined area, the filtered or the sedimented quantity of water and from the number of algae cells counted.

Biomass was calculated from the number and the volume of the algae species. Calculation of each algae species was done as follows:

1. In the case of those algae species, where the forms could not be likened to geometric bodies, volume — data derived from models were used (SEBESTYÉN 1954; TAMÁS 1955). Such species were: *Ceratium hirundinella*, *Pediastrum boryanum*, *Pediastrum duplex*, *Pediastrum simplex*.

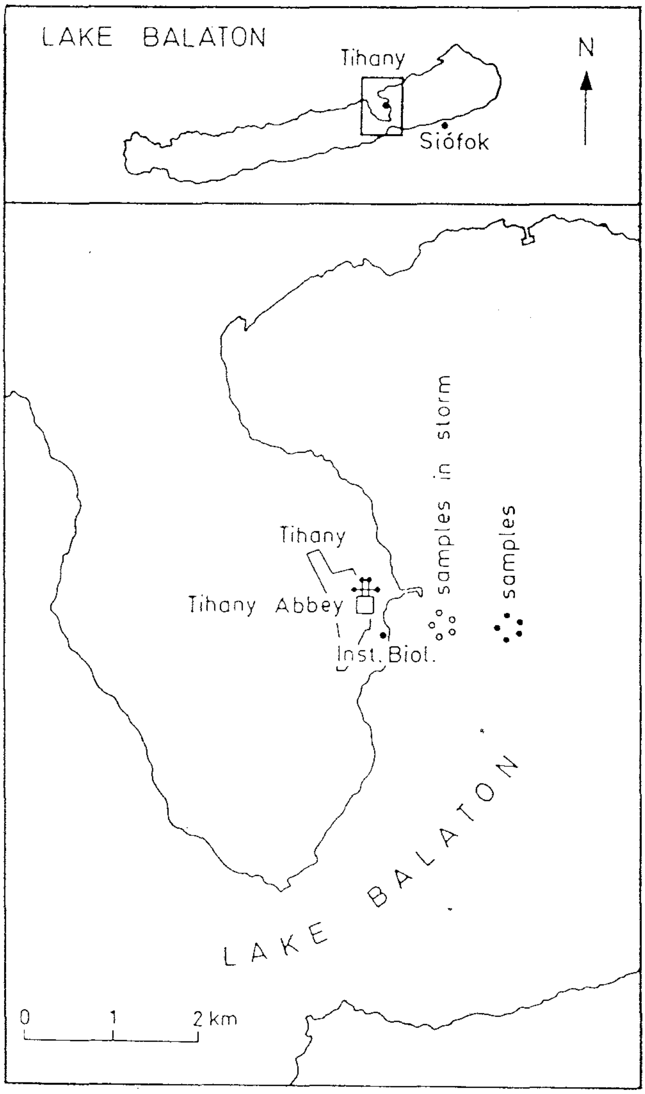

Fig. 1. Location of the sampling points

2. Volumes of filamentous algae were in all cases calculated on the basis of cylindrical models.

3. Volumes of other algae species were estimated from the geometrical body or bodies, to which the forms showed greatest resemblance. The mean sizes determined in the study were used and not the average of compiled data of the literature.

It is noted here that the volume of each alga species was calculated according to the common particle in Hungary, that is, without the possibly present mucilaginous sheath. Biomass values were calculated from the volumes by taking the specific gravity of the protoplasm to be 1.00, and finally expressing it in mg liter^{-1}.

Daily velocity of wind data, registered at the Meteorological Station of Siófok, were supplied by the National Institute of Meteorology. Daily average velocity of wind values were calculated by averaging readings taken at three hour intervals from 12 noon of the previous day to 12 noon of the given day.

Results and evaluation I.

With the two methods outlined above, 67 species, 7 varieties and 2 forms belonging to 57 genera were identified in thirty water samples (Table 1).

Exact numbers of genera, species, varieties and forms appear in Table 2, which also shows the two quantitative algological methods. It must be noted however that the two results are of different taxonomical value. Whilst application of UTERMÖHL's microscope with suitable preliminary studies yields taxonomically correct results, the membrane-filtering method, in most cases renders identification possible only to the genus with any reliability. In spite of all this, several factors necessitated the application of the latter method (it is sufficient to bring up one example, the large quantities of debris stirred up in storms).

In connection with quantitative results, the following remarks are necessary.

Table 1

Distribution of identified taxa in six taxonomical phyla

	Genus	Species	Varietas	Forma
Cyanophyta	9	9	1	1
	6 *Chroococcales*	6 *Chroococcales*		
	3 *Hormogonales*	3 *Hormogonales*	1 *Chroococcales*	1 *Chroococcales*
Euglenophyta	3	3	—	—
	3 *Euglenales*	3 *Euglenales*		
Chrysophyta	22	29	4	—
	1 *Xanthophyceae*	1 *Xanthophyceae*		
	1 *Chrysophyceae*	2 *Chrysophyceae*		
	20 *Bacillariophyceae*	26 *Bacillariophyceae*	4 *Bacillariophyceae*	
Pyrrophyta	5	5	—	—
	3 *Cryptophyceae*	3 *Cryptophyceae*		
	2 *Dinophyceae*	2 *Dinophyceae*		
Chlorophyta	17	21	2	1
	15 *Chlorococcales*	17 *Chlorococcales*	1 *Chlorococcales*	1 *Chlorococcales*
	2 *Zygnematales*	4 *Zygnematales*	1 *Zygnematales*	
Caulobacteriales	1	1	—	—
	1 *Caulobacteriales*	1 *Caulobacteriales*		

Aphanisomenon flos-aquae f. *klebahni*, a permanent component of the summer phytoplankton of Lake Balaton was not found in any of the water samples between July 22 and 29. This phenomenon seems to be related to the fact that the investigation period was preceded by a stretch of unusually warm and dry weather, the effect of which could still be felt in the first few days.

Aphenisomenon issatschenkoi, not long ago described from the Lake Balaton, also occurred in our samples.

The category "Other *Chlorococcales*", demarcated by 3 μm–6 μm size interval, covers one form only, the phytomass of which is considerable in the less than 10 μm size group, and the specific identity of which apart from order, could not be determined.

Apart from the previous point, collective categories, such as "Other *Chlorococcales*" and "other species", contain unidentified species and small frowth forms of various algae species (autospores, zoospores etc.).

Due to the intensive character of the study, detailed information was obtained with regard to the temporal behaviour of each algal species, which can be fitted into five main types. Characteristic increase is shown in the abundance of *Peridinium inconspicum*, *Anabaena* sp. and *Aphanisomenonflos-aquae* f. *klebahni*., of similar extent is shown by *Staurastrum paradoxum*, *Nitzschia acicularis* and *Dinobryon divergens*, *Criptomonas* sp. reaches a maximum in abundance at the middle of the study, whilst the temporal distribution of *Euglena acus* and *Euglena caudata*, in spite of their oscillating numbers, can be considered even. The picture thus obtained — although the taxonomical accuracy of this work does not render detailed analysis possible — justifies the assumption of a dynamics of algae association and of component populations. Figure 2 serving merely as an approach, shows the complete range of phytoplankton, where each line represents a formation, and a characteristic size distribution, with its dynamics, is apparent.

Wherever information was available, the biological indication of each trophic state was entered besides the taxon in Table 2, where ✳ ✳ ✳ indicates strongly eutrophic, ✳ ✳ stands for definitely eutrophic and ✳ means weakly eutrophic under Hungarian conditions (Uherkovich in Bartha et al. 1976, Pénzes 1976).

In connection with increasing eutrophication of the Lake, the not strictly algological observation should be noted that *Paraphysomonas vestita*, under certain conditions an indicator of eutrophic water, continually occurred in the samples and which has so far only been described in Lake Balaton (Hajdu 1975). It is an important fact with respect to the eutrophication process, since the sampling points were located in an area considered to be less eutrophic Herodek and Tamás 1976).

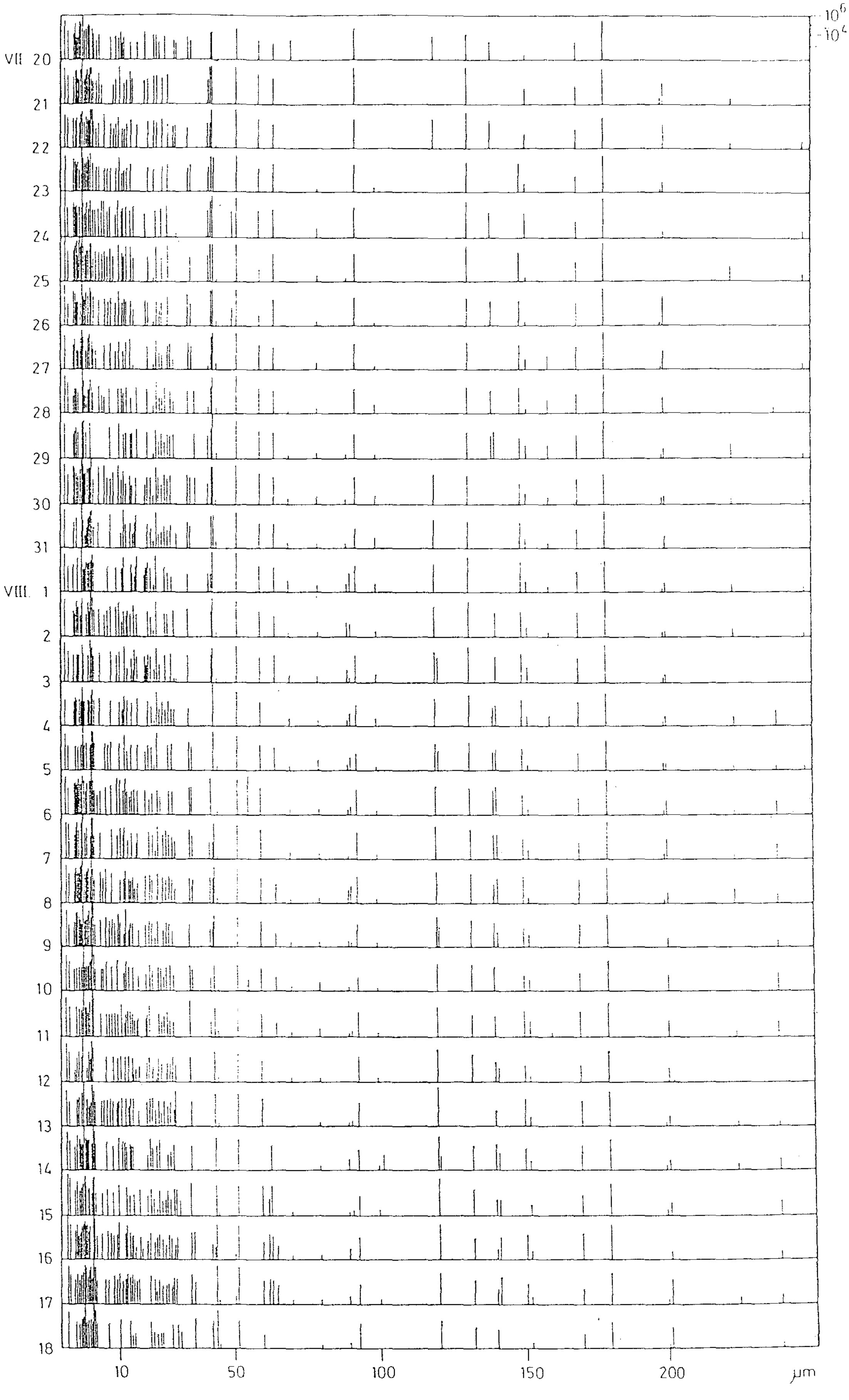

Fig. 2. The spectrum of numbers and sizes of algae in the study period

Results and evaluation II.

To describe spatial-temporal structures of producers, various algological studies employ numbers or phytomass, depending on the nature of the study. It nearly counts as an exception to use both. The two approaches on no account can be taken as equal as it is apparent when considering their qualitative differences. The quantitative algological results of this study show the latter conclusion.

The mean value of the total number in the study period is high, $60.41 \cdot 10^5$ $I \cdot l^{-1}$ (where $I \cdot l^{-1}$ = number $\cdot$ l^{-1}). Daily readings fluctuated, showing increasing and decreasing tendencies in alternating two-three day periods. For the study period as a whole, the total number tended to increase. Viewing the number of microalgae separately, although this is considered to be the results of a preliminary investigation, the high mean value of $47.67 \cdot 10^5 \cdot I \cdot l^{-1}$ is pointed out, which is the first and at the same time rather high actual value of this order from Lake Balaton. To dispell suspicion of bacterioplankton, which the applied method would justify, the variety of form microalga should be noted; 42 different forms could be allocated to 21 genera (also see Table 3 and Fig. 2). The mean of $I \cdot l^{-1}$ of microalgae, $12 \cdot 76 \cdot 10^5$, corresponds with results of previous studies of the Lake (HERODEK and TAMÁS 1973; TAMÁS 1969, 1973).

Distributions of phytomass and numbers in various taxonomical phyla appear in Fig. 3, both according to size interval and totals. The areas of circle diagrams are proportional to the thirty days mean of the given variable.

The phytomass of *Caulobacteriales* is negligible with respect to macroalgae phytomass as well as total phytomass.

The thirty days' mean of planktonic phytomass is 1.99 mg $\cdot$ l^{-1}, from this microalgae account for 0.28 mg $\cdot$ l^{-1}, whilst macroalgae make up for 1.71 mg $\cdot$ l^{-1}, with large fluctuations of readings as well.

It could be further be inferred that the phytomass of microalgae showed increasing, and the phytomass of macroalgae showed decreasing tendencies (Fig. 4) and the circle diagrams clearly illustrate that the distribution of total numbers was to a certain extent determined by the microalgae and the total phytomass was determined by macroalgae. Subsequently, the monthly feature of numbers is rather like microalgae, whereas the feature of total phytomass is like macroalgae. This inference is valid for relationships with other factors as well (Fig. 6, Table 3).

The above are accounted for by the facts that in the study period microalgae made up for 79% of total numbers whilst for only 14% of the total phytomass (this 14% is more than what had previously been persumed and in view of production and feeding biology it could be important).

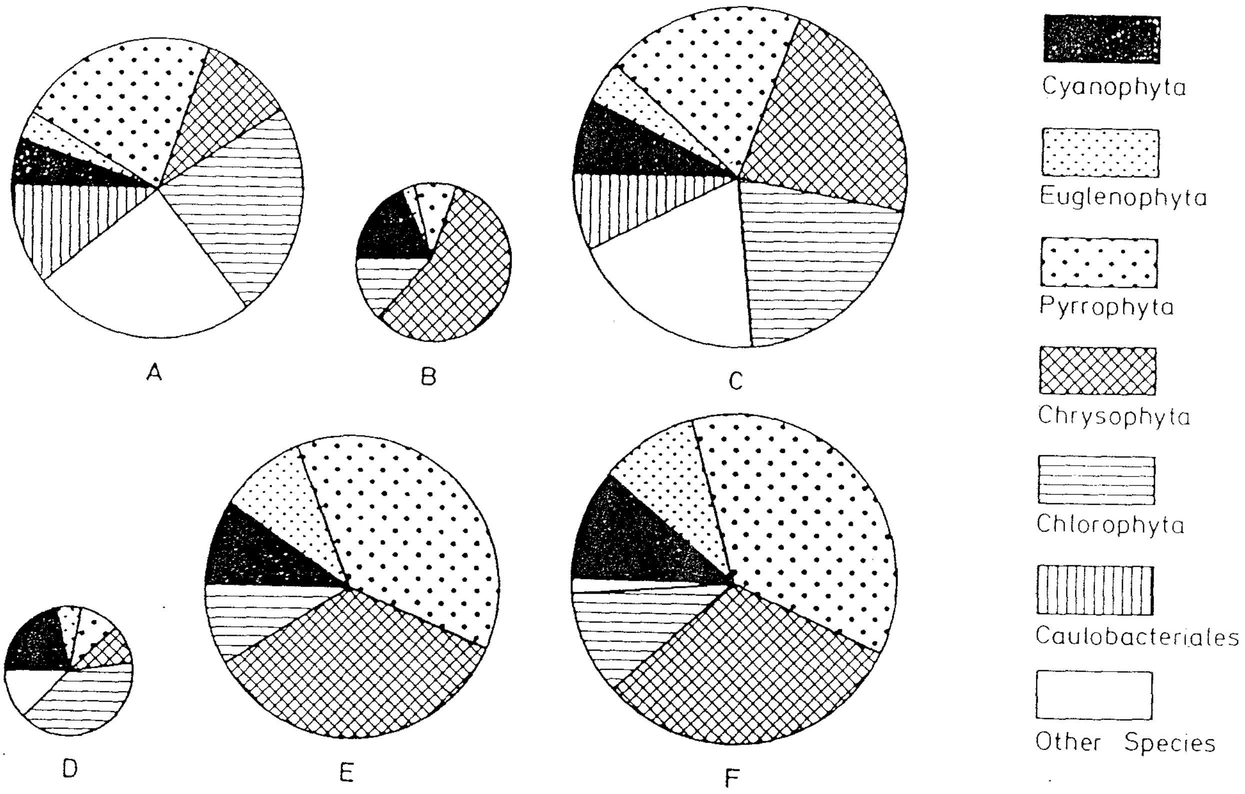

Fig. 3. Distributions of mean of thirty days' data of numbers and phytomass in each taxonomical phyla. A. microalgae $I \cdot l^{-1}$; B. phytomass of microalgae; C. macroalgae $I \cdot l^{-1}$; D. phytomass of macroalgae; E. total $I \cdot l^{-1}$; F. total phytomass

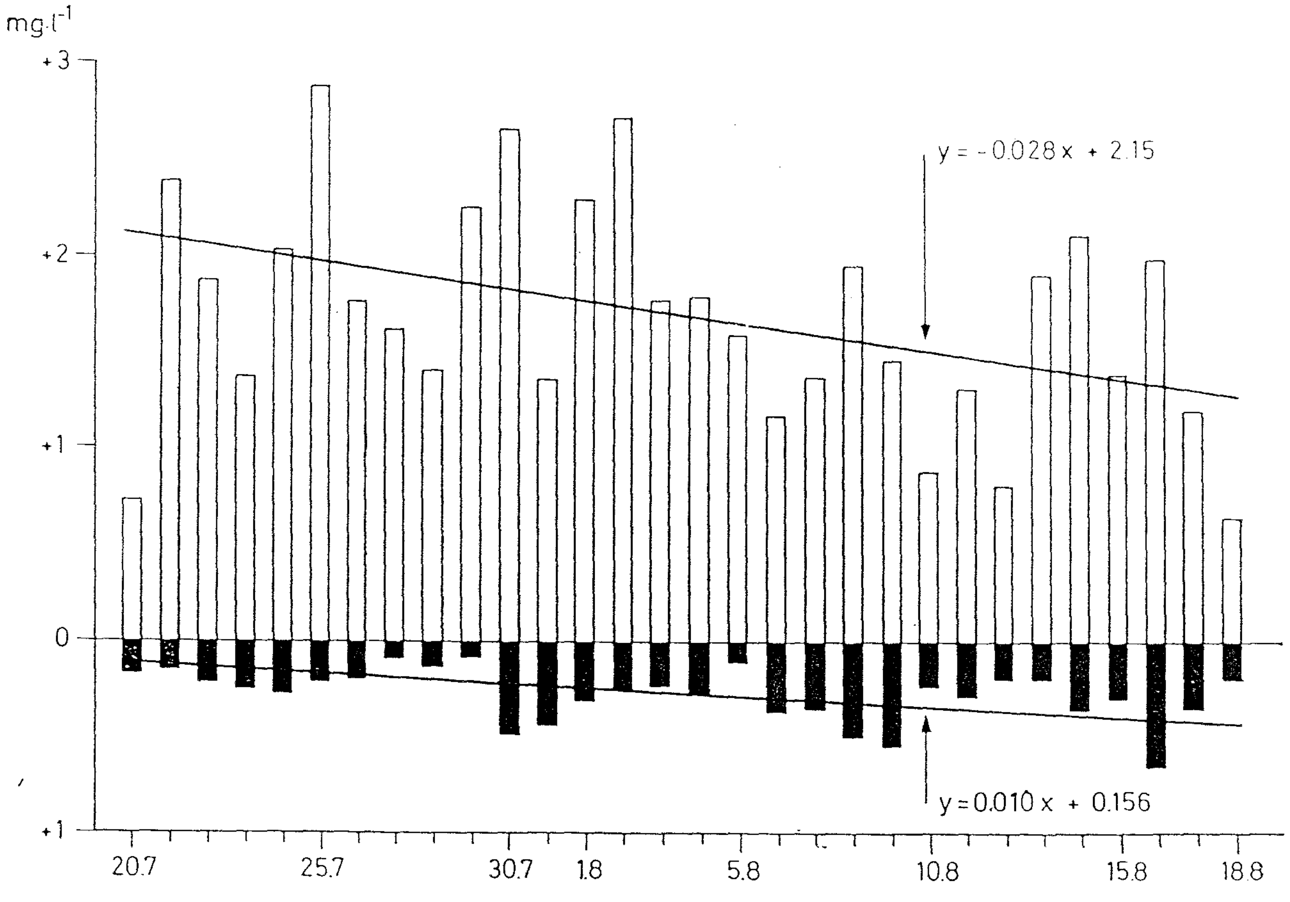

Fig. 4. Histogram of biomass of macroalgae (light) and microalgae (dark)

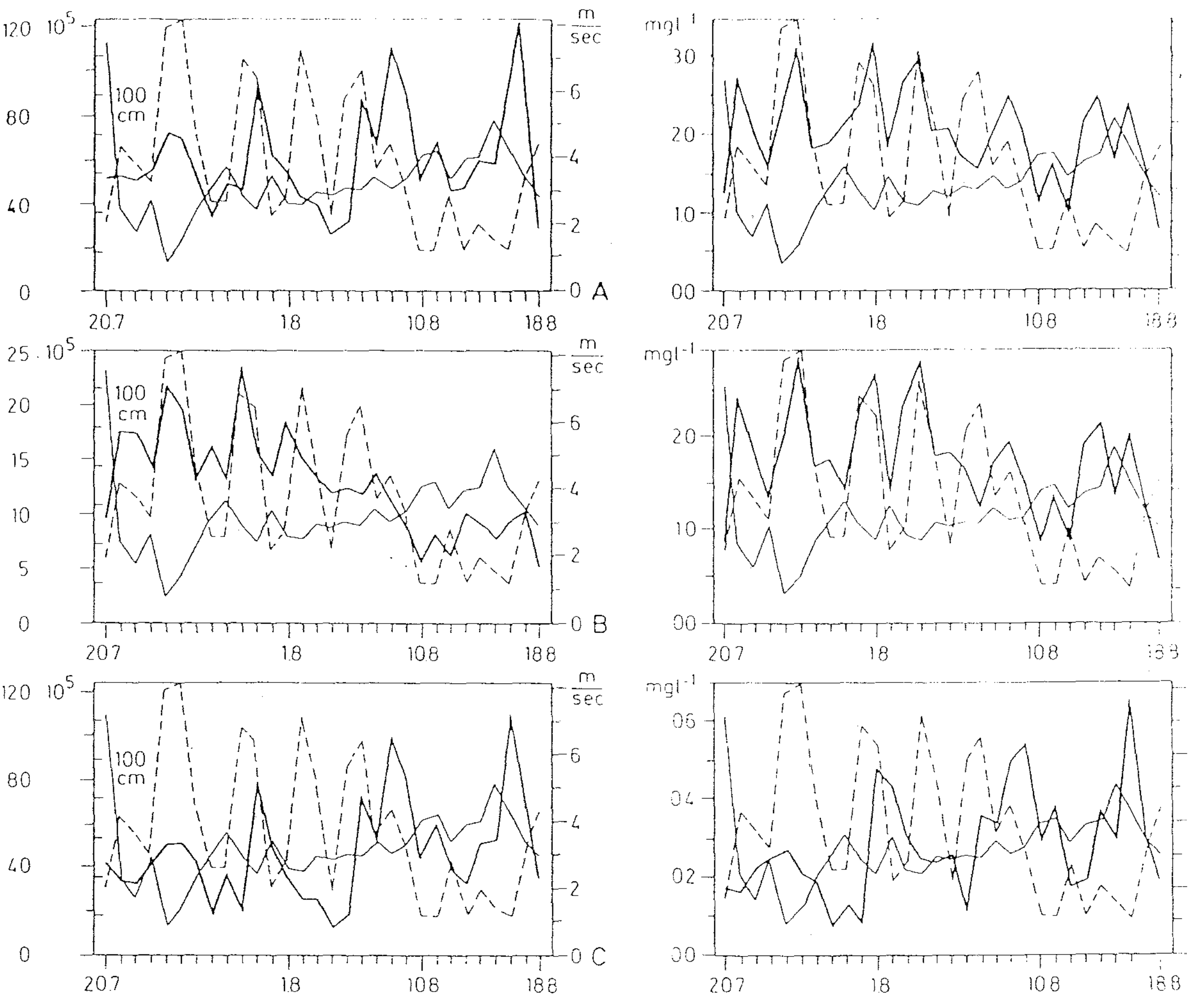

Fig. 5. Numbers and biomass of phytoplankton in the study period, with environmental factors indicated; velocity of wind — dashed line; SECCHI transparency — grey line; A — total numbers; B — numbers of macroalgae; C — numbers of microalgae; D — total planktonic phytomass; E — phytomass of macroalgae; F — phytomass of microalgae

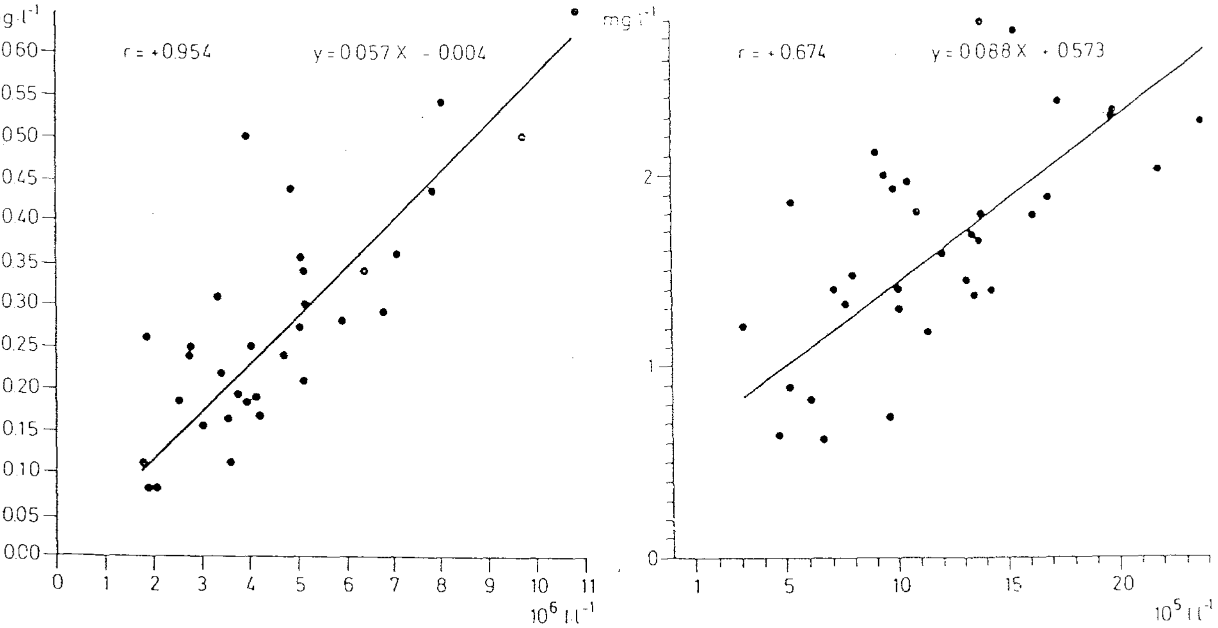

Fig. 6 a, b

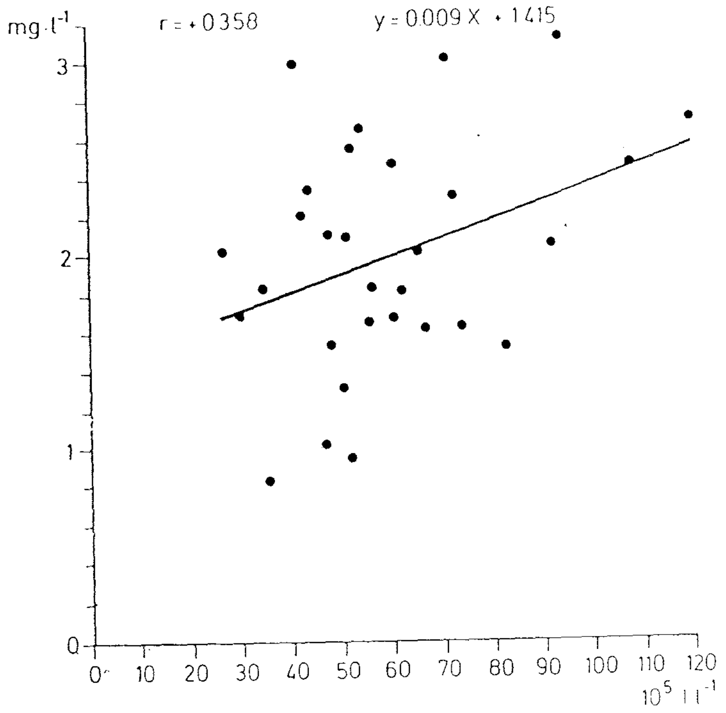

Fig. 6c

Fig. 6. a) Straight line of regression carried out on numbers and phytomass of microalgae (y) and the correlation coefficient (r); b) Straight line of regression carried out on numbers and phytomass of macroalgae (y) and the correlation coefficient (r); c) Straight line of regression carried out on total numbers and total phytomass (y) and the correlation coefficient (r)

When interpreting Fig. 6/a, 6/b and 6/c, the values of regression coefficients should be noted, where $a_a > a_b > a_c$, and $b_a < b_b < b_c$ (appropriate values for the regression equation of the figure) in the present case are measures of the indescribability of planktonic phytomass solely by numbers. In other words it means that a certain phytomass value cannot be coordinated with a given value of numbers. The more heterogenous the size distribution of the algae association (its spectrum) in the sample, the weaker the correlation between numbers and biomass. It should be noted here that a straight line of 45° from the origin would be obtained if the relationships between numbers and phytomass were separately investigated for each species.

The extreme illustrations in Figs 7 and 8 in which biomass maxima of macroalgae occur one day shifted compared to number maxima, led to the establishment of the above. This is related to the fact that treating algae above 10 μm size intervals, a "great collector" of variable content is dealt with, in which more sensitive algae dominate in featuring of numbers then in the featuring of biomass.

This thought is closely related to what has been said in connection with 6/a, b, c. The validity of the above conclusion can also be seen if the phytoplankton above 10 μm is divided into 10—40 μm and 40 μm - size intervals, and from the latter substracting the values of the largest algae of Balaton, *Ceratium hirundinella*, which moreover, reaches the maximum of its number

Table 3

The results of correlation analysis. Code: 1. Particulate organic carbon content (mg · l^{-1}); 2. The velocity of wind (m · s^{-1}); 3. The Secchi*-transparency (cm); 4. The temperature of water (°C); 5. The numbers of total algae (I · l^{-1}); 6. The numbers of microalgae (I · l^{-1}); 7. The number of macroalgae (I · l^{-1}); 8. The number of algae between 10 µm and 40 µm (I · l^{-1}); 9. Numbers of algae above 40 µm (I · l^{-1}); 10. Numbers of algae above 40 µm minus Ceratium hirundinella (I · l^{-1}); 11. Total planktonic phytomass (mg · l^{-1}); 12. The biomass of microalgae (mg · l^{-1}); 13. The biomass of macroalgae (mg · l^{-1}); 14. The planktonic phytomass between 10 µm and 40 µm (mg · l^{-1}); 15. The planktonic phytomass above 40 µm (mg · l^{-1}); 16. The planktonic phytomass above 40 µm minus Ceratium hirundinella (mg · l^{-1})*

Code	2	3	4	5	6	7	11	12	13	14	15	16
1	0.180	—0.440	—0.210				0.180	—0.299	0.302			
2		—0.503	0.024	0.111	—0.010	0.796	0.530	—0.206	0.532			
3			0.360	—0.009	0.080	—0.781	—0.510	—0.139	—0.536			
4				—0.265	—0.802	—0.384	—0.380	—0.738	—0.201			
5							0.358					
6								0.954				
7									0.674			
8										0.760		
9											0.300	
10												0.920

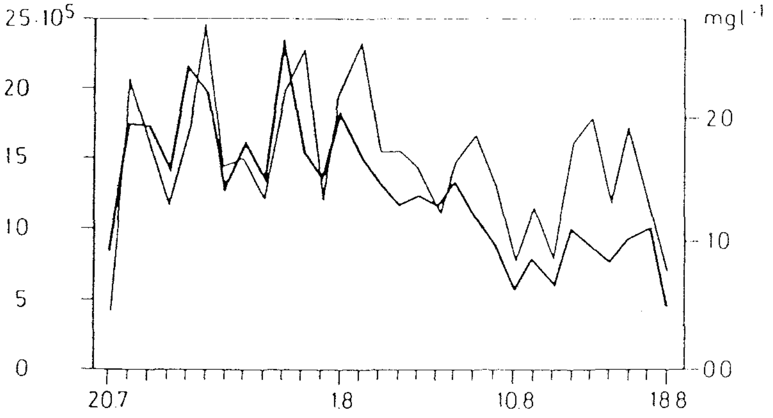

Fig. 7. Numbers (dark) and biomass (grey) of microalgae in the study period

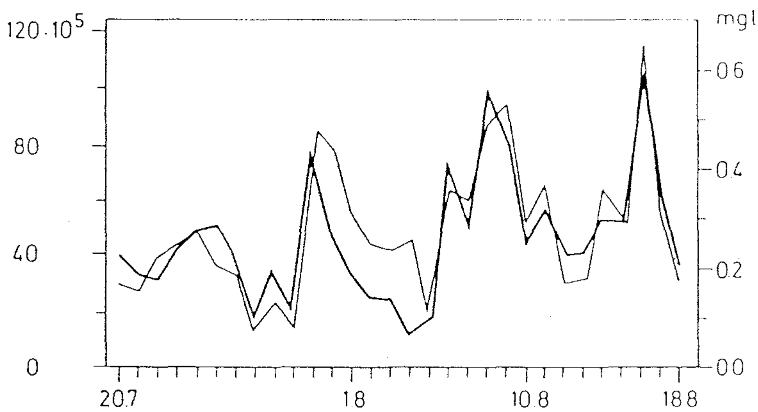

Fig. 8. Numbers (dark) and biomass (grey) of macroalgae in the study period

during the study period. The obtained picture with the correlation coefficie
of the appropriate biomass-number pairs as follows:

$r = +0.300$
above 40 μm ⟶ $r = +0.920$
above 40 μm
minus *Ceratium hirundinella*
↑
$r = +0.674$
above 10 μm ⟶ $r = +0.760$
10 μm—40 μm
↑
$r = +0.358$
total numbers-
total biomass ⟶ $r = +0.954$
below 10 μm

Thus it can be inferred that *Ceratium hirundinella* greatly influen
the daily values of biomass, it reacts differently from, or at least more slo
than other algae species to environmental changes. It could be said t
Ceratium hirundinella is characterised by a certain productional inertia.

The above makes it imperative that attention be drawn to the probl
of sample evaluation and partitionings related to it, which are just probl

of theoretical ecology of today. To be concise, application of some arbitrary partitionings (I · l^{-1}, etc.) should be reviewed when describing open-water planktonic relationships.

To return to Fig. 6, it should be noted in connection with the heterogeneity that its extent is also influenced by an algae lawn, which has already been proved to form on the bottom of the Lake in periods of calm (PANTOCSEK 1902) and which is stirred up by wind and waves from time to time and thus appears in the plankton samples. The benthic algae species, which appear on stormy days are: *Surilella robusta* var. *splendida*, *Cymatopleura solea*, *Cymatopleura elliptica*, *Diatoma vulgare*, *Navicula cryptocephala* and *Campylodiscus* sp.

Studying the planktonic phytomass and numbers separately in relation to temperature, SECCHI-transparency and mean wind velocity, the third proved to be the most decisive by numerical analysis, besides which the effect of water temperature — a degrading effect — is considerable (Table 3).

Since the correlational coefficients provide information merely for the degree of the stochastic relationship between the investigated factors, and make no mention of its nature, it seemed right to say that graphically, variables converge or diverge. For instance, comparison of phytomass and numbers with temperature proved to be difficult.

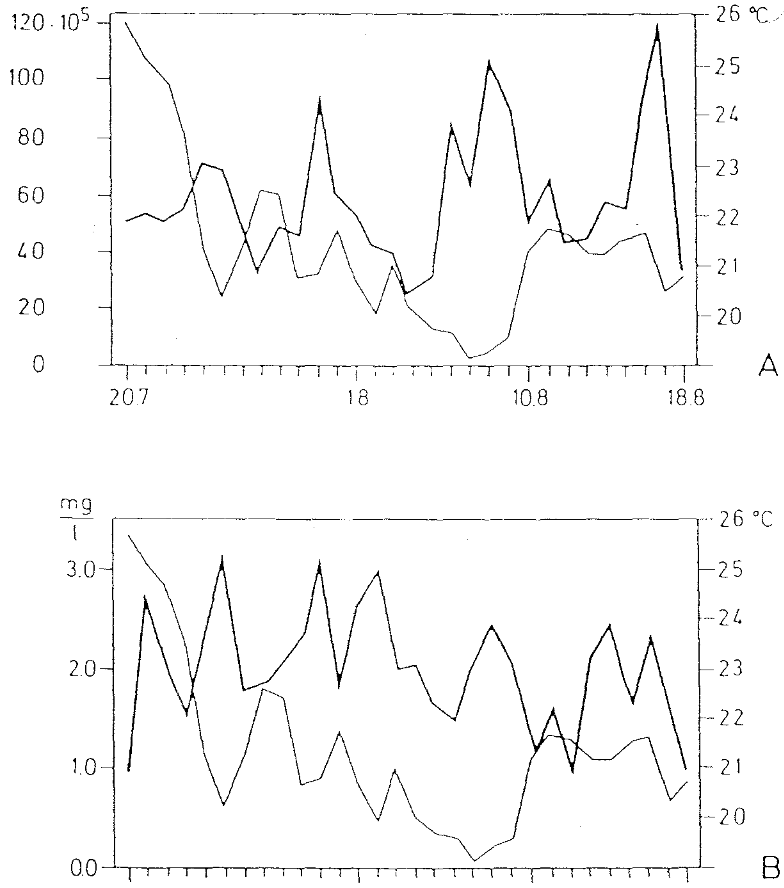

Fig. 9. A — Thirty day variations of phytoplankton numbers (dark) and water temperature (grey); B — Thirty day variations of planktonic phytomass (dark) and water temperature (grey)

Numbers and biomass showed opposite tendencies in relation to tempe ture, which is supported by the correlation coefficients. Assuming the presen of the already mentioned benthic algae-lawn, the following explanation c be given for the phenomenon: winds stir up the water, although no great vertical stratification in temperature was experienced, and cooled it acco panied by stirring up of the benthic algae-lawn, thus increasing both numb and biomass. It should be emphasized that this is only a partial explanati taking relatively small amounts of algae into account. HERODEK and TAM (1975) experienced a similar phenomenon yearly.

The dependency of water transparency on atmospheric conditions d to the shallow mean depth of the Lake was as expected from data of t literature (CHOLNOKY and LÓCZY 1900—1912).

Correlation coefficients of $r = -0.503$ between SECCHI-transparency an velocity of wind and of $r = -0.781$ between SECCHI-transparency and nu bers of macroalgae indicate stirring up of the benthic alga-lawn. Table is an attempt to summarize, and from another aspect, tu support what h been said so far by carrying out a Path-analysis (SVÁB 1972) of paramete (temperature, SECCHI-transparency, velocity of wind) in relation to tot planktonic phytomass. Special attention should be paid to the bottom lin of Table 4, where besides the $(P_3) = -0.227$ Path coefficient of SECCHI-tran parency — total planktonic phytomass relation, an indirect $X_2 = -0.21$ value is substracted by the stirring up effect of the wind, thus supporting th well-known stirring up effect of algae.

In connection with the Path diagram (Fig. 10) the fairly large valu of $Ps = +0.557$ should be emphasized, which includes the effect of zo plankton and other factors not studied here and which, at the same tim points out the fact that the factors studied in the investigation are not suff cient for even a full description of synphenobiological aspects.

On the basis of the reasons in the introduction a separate investigatio served to determine the particulate organic carbon content of the deliminate

Table 4

Results of Path-analysis with regard to total planktonic phytomass

The velocity of wind ($m \cdot sec^{-1}$) (X_1)	direct	—0.298
	indirect X_2	—0.009
	indirect X_3	—0.082
The temperature of water (°C) (X_2)	direct	—0.424
	indirect X_1	—0.059
	indirect X_3	0.113
The SECCHI-transparency (cm) (X_3)	direct	—0.227
	indirect X_1	—0.107
	indirect X_2	—0.212

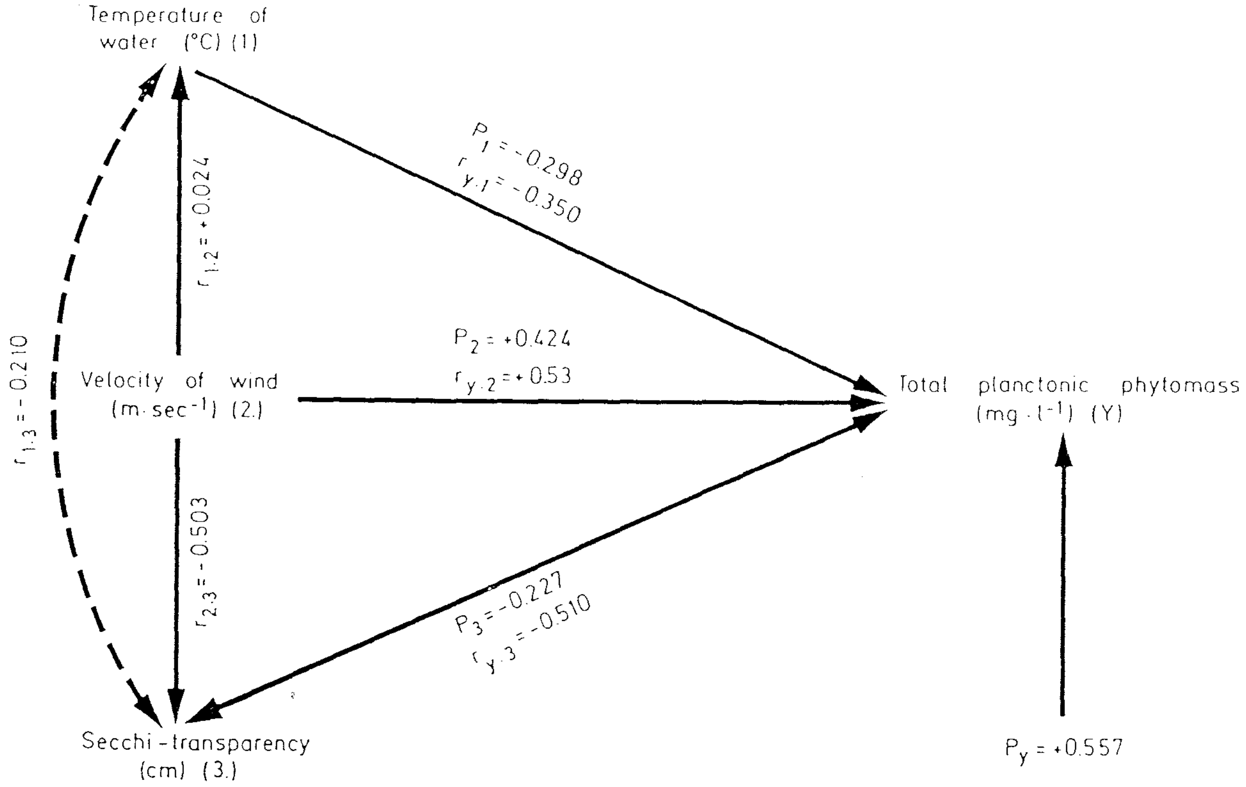

Fig. 10. The Path diagram

water area, which included organic debris and organic materials living at the time of sampling. Values, similar to other variables, greatly fluctuated. The average of 1.424 mg · l^{-1}, which is well into the values characterising eutrophe waters, supports the problem of eutrophication which has been mentioned in the introduction and which has been referred to in recent years. On two occasions during the study period, hypertroph values have been determined (readings above 2.00 mg · l^{-1}). It must be noted however that these two readings do not in any way indicate that the Lake is on the verge of hypertrophy, because on the one hand these values can be attributed to be the result of local pollution, and on the other hand the non-classic character of the Lake evokes an eutrophication process differing from the classical form. For instance, the development of the clinograde oxygen curve cannot be expected, whereas this is one of the strongest indications of eutrophication of classical lakes.

In order to reveal the relationships between planktonic phytomass and particulate organic carbon content, it was necessary to determine the carbon content of the phytoplankton (Winberg 1971) and the following were obtained: the value of total particulate organic carbon content was one order larger than the one calculated for the phytoplankton (Fig. 11), thus providing hardly any information, but both showing similar tendencies. Taking into consideration the fact that values of particulate organic carbon content show abrupt increase on windy days, the decisive effect of wind conditions can be inferred from this aspect as well. To support this, the correlation coefficient between

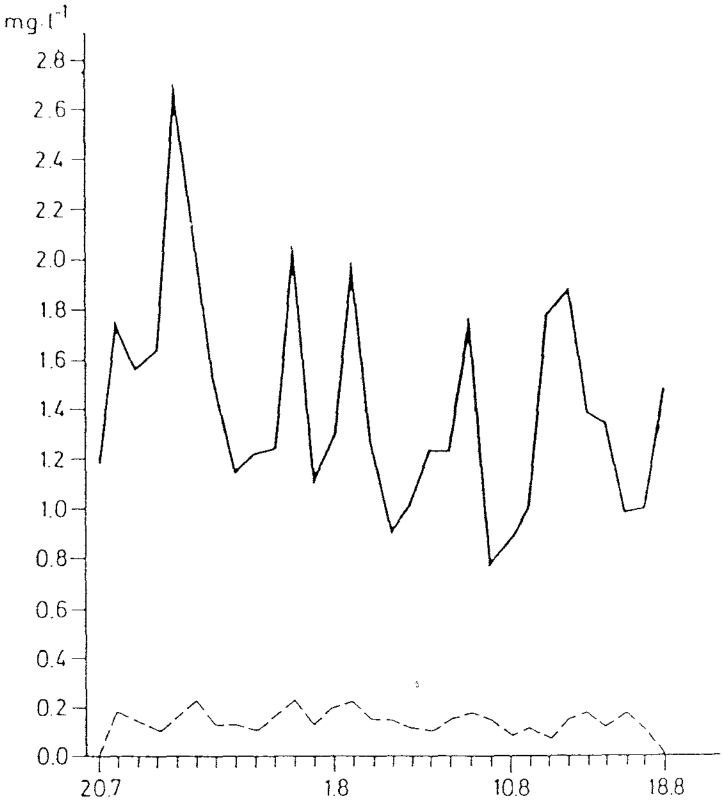

Fig. 11. Particulate organic carbon content of the water (dark) and calculated carbon con of planktonic phytomass (dashed line) in the study period

particulate organic carbon content and total planktonic phytomass is = +0.180, but with a partial transformation which excludes the effect wind, it can be increased to $r_{1\cdot 12\cdot 2} = +0.330$ (factors represented by appropriate indices of r are in Table 3). Since this is also not a remarka close value, a permanently present and accumulating organic mass is persun (on the basis of organic carbon measurements carried out in the area in rec years, but unpublished so far)!

It was established that values of Secchi-transparency were determi by weather conditions and were primarily dependent on the amount of detri stirred up in the water by waves. The correlation coefficient between Secc transparency and planktonic phytomass cannot be desribed as high, just stands for $r_{3.12.1.2} = -0.33$ obtained by partial transformation which exclu the effect of wind.

Discussion

The previous section combined Results and evaluation because this thought to be most effective way of treating the results, since compara short-term studies have not been made on Lake Balaton. However it is ne sary to supplement the previous chapter with a short discussion, which s marizes the major conclusions only.

Daily sampling in itself resulted in great fluctuations of all the studied variables, in which increase and decrease phases alternate in two-three-day periods. Daily values of planktonic phytomass show a standard deviation as it has also been shown. These conclusions bring up the problem of sampling intervals, which is a fundamental question in the planning of all ecological studies.

Difference in information content between numbers and planktonic phytomass caution investigators that this aspect must be approached thoroughly and in accordance with the requirements of the given study.

The applied membrane filtering technique, with all its draw-backs (i.e. taxonomically unaccurate), is more suitable for the quantitative investigation of microalgae of the Lake Balaton than UTERMÖHL's technique, since the disturbing effect of the ever-present detritus content of the Lake is eliminated. This method has revealed quantities of algae below the 10 μm size interval that exceeded previous expectations (HERODEK 1975). This fact requires that studies be carried out on microalgae from aspects of diversity and feeding biology. This has been a wish of the zoologists for some years (PÓNYI, personal communication), by means of which a sight into the mass and energy system of the Lake could be obtained. Moreover environmental factors not studied here could be taken into consideration, namely exact metering of light conditions and a parallel study of zooplankton as consumers.

High values of floating particulate organic carbon content of the water indicate eutrophication but some of the other data pointed to this as well.

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