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A QUANTITATIVE STUDY OF THE SAPROPHYTIC AND TOTAL BACTERIOPLANKTON IN THE OPEN WATER AND THE LITTORAL ZONE OF LAKE BALATON IN 1968

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Little is known on the annual changes enacted in the bacterioplankton population of lakes. The results of investigations conducted for several years refer to considerable annual changes in the total bacterioplankton (RAZUMOV, 1962; THSHERBAKOV, 1967; IVATIN, 1968) and in the proportion of the total and saprophytic bacterioplankton (KUZNETSOV, 1960).

The surveys of the years 1966—67 were made on conserved samples deriving from the open waters of Lake Balaton (OLÁH, 1969), hence the number of saprophytes could not be established. However, the results of direct countings may serve for the basis of investigations aimed at the annual changes enacted in the amount of the total bacterioplankton.

With this aim in mind, we have continued determinations of the total bacterioplankton, and by the counting of saprophytes we have attempted to gain information about the order of magnitude of the proportion between the total and saprophytic bacterioplankton suitably reflecting the pollution and supply of readily assimilable organic substances (KUSNETZOV, 1960).

The bacteriological examination of the open water presupposes, however, the demarkation of the open water and the littoral zone. Since the amount of bacteria satisfactorily reflect the trophic state of a lake (RAZUMOV, 1962), the study of the trophic conditions of diverse parts of the lake is also concurrently given.

Investigating the amount of bacterioplankton present in the littoral zone with a macrophytic vegetation and the open waters in the lakes of the Ladoga Lake district, RODINA (1961) emphasizes the higher biological productivity of the coastal zone. The morphology of the shallow Balaton with its extensive body of water also resulted in a considerable length of shoreline which, with respect to the magnitude of the coast — water body index (SEBESTYÉN et al. 1951), may increasingly influence the food supply of the lake.

The annual production of the considerable macrophyta stand of the littoral zone is estimated at 8000 tons (ENTZ, 1954). Through the detritic drift (SEBESTYÉN, 1949, 1964), a part of this amount becomes linked up with the matter turnover of also the open waters and during the microbial mineralization appears in the form of detritus at the diverse stages of the foodchain. All this corroborates the importance of the littoral zone of Lake Balaton in the material turnover of the entire lake.

With due attention to these considerations, we began the seasonal quantitative survey of the saprophytic — and the total bacterioplankton participating in these processes, in the five standard sections and one investigated detailed section of Lake Balaton.

Localities and methods

The samples, deriving from 16 sites of the Balatonfüred — Zamárdi transverse section *(Fig. 1)*, were taken monthly or in fortnightly periods, from April till October, 1966. Open water surveys were made at three localities each

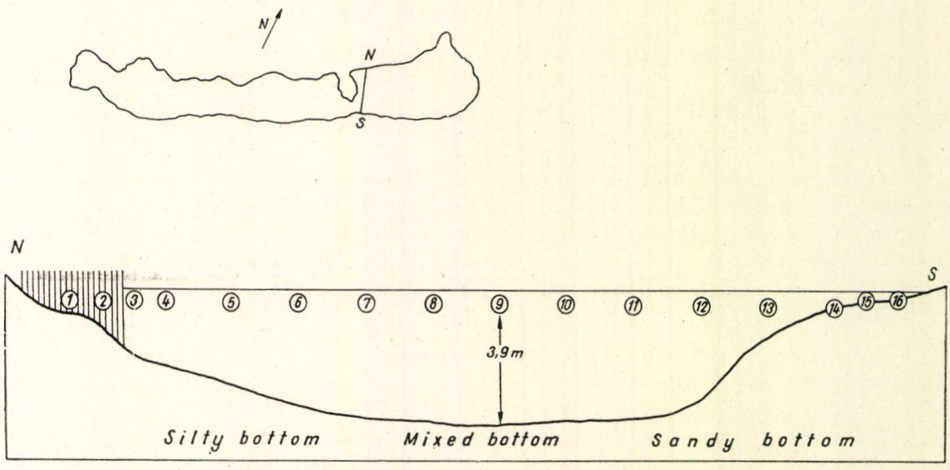

Fig. 1. Sites of sampling, depth and sedimentation conditions in the investigated detailed transect.

Site 1: the Scirpeto-Phragmitetum fontinalosum zone of the reeds;
Site 2: the Scirpeto-Phragmitetum phragmitetosum zone of the reeds;
Site 3: the edge of the reeds;
Site 4: 50 m from the edge of the reeds;
Site 5: 500 m from the edge of the reeds;
Sites 6—13: sampling points removed 6—700 m from one another in the open water;
Site 14: 400 m from the shoreline;
Site 15: 5 m from the shoreline;
Site 16: 2 m from the shoreline.

of the five standard sections of Lake Balaton; the data of the sites of collecting are given in Tamás's paper (1967).

Water samples were taken by Francev's sampler (Kusnetzov, 1952) from a depth of 50 cm, and transferred into a sterile, 250 ml glass with a glass stopper. Applying Razumov's direct method (1932), the amount of the total bacterioplankton was calculated from the samples. The saprophytic microorganisms were counted on nutrient agar and, concurrently with the actinomyces, on Jensen's casein-glucose agar, in repetitions of five.

With recourse to the two kinds of nutrient media a more exact survey of the quantitative distribution f the saprophytes was made possible. On the nutrient agar, the number of colonies was counted on the seventh day, on casein-glucose on the tenth day, and the number of actinomyces on the twentieth day. Incubation took place at 25 C° and the number of colonies was established at a magnification of × 10. Pouring was made directly after the collecting, on board ship.

Results

The investigated detailed section

In April the total bacterioplankton was uniformly 1 — 1,5 million/ml a long the entire section, excepting the Scirpeto-Phragmitetum fontinalosum zone of the reeds (Tóth, 1960) where it reached 3 millions *(Fig. 2)*. The amount

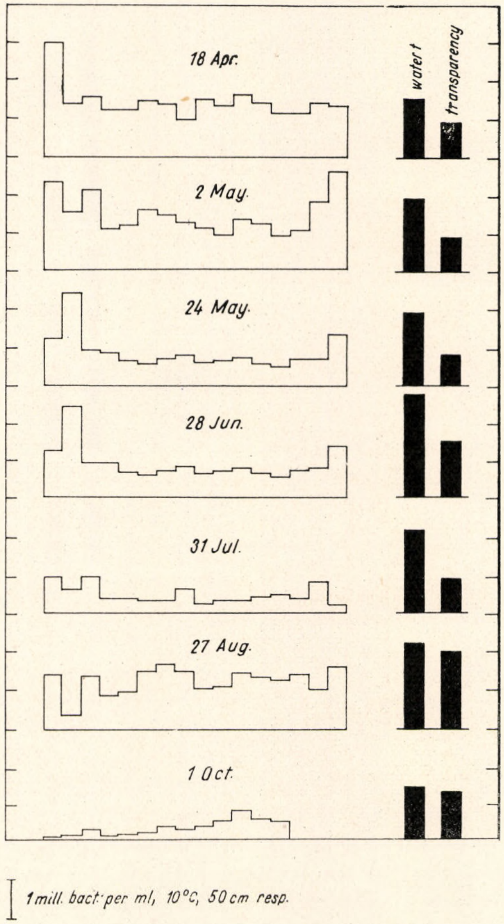

Fig. 2. The seasonal dynamism of the amount of the total bacterioplankton at 16 points of the transect

of saprophytes showed the same distribution on both culture media *(Figs* 3, 4), but higher values were obtained on casein glucose agar. As related to the entire survey, the number of colonies grown on the nutrient agar was only about half of that appearing on the casein-glucose agar.

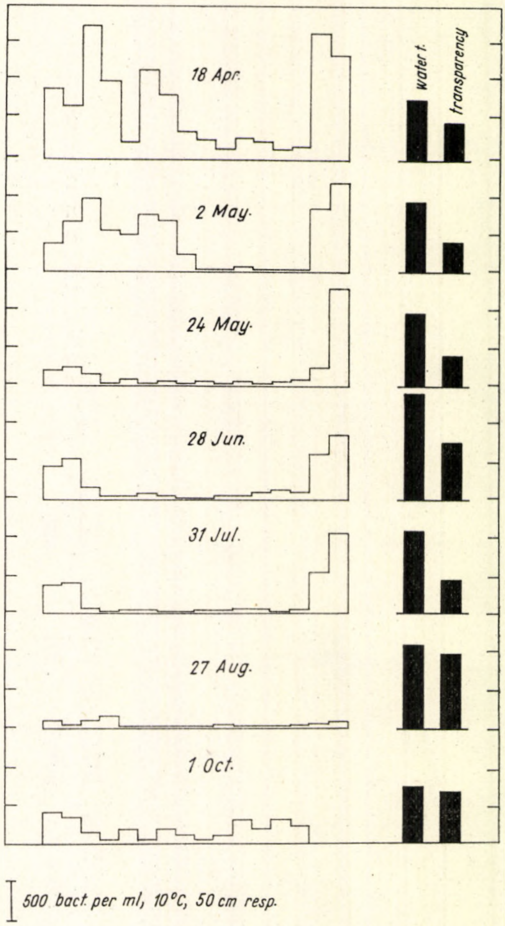

Fig. 3. The seasonal dynamism of the amount of saprophytes counted on nutrient agar at 16 points of the transect

In the open water, the number of saprophytes was 2—300/ml; with respect to the littoral zone, the maximum was 3000/ml on casein-glucose agar. The high number of saprophytic bacteria of the northern shore showed up even 1500 m away from the edge of the reeds. On the southern shore, free of reeds, the high number of saprophytes was delimited to a relatively narrow zone compared to the northern shore.

At the beginning of May, the amount of the total bacterioplankton still exceeded 1 million/ml in the open water, and was above 2 million/ml in both coastal zones, but the number of saprophytes decreased below 100/ml in the open water. However, the maximum values remained high in the littorals, and reached 4200/ml on casein-glucose agar. The extension of the zones was identical with the situation found in April.

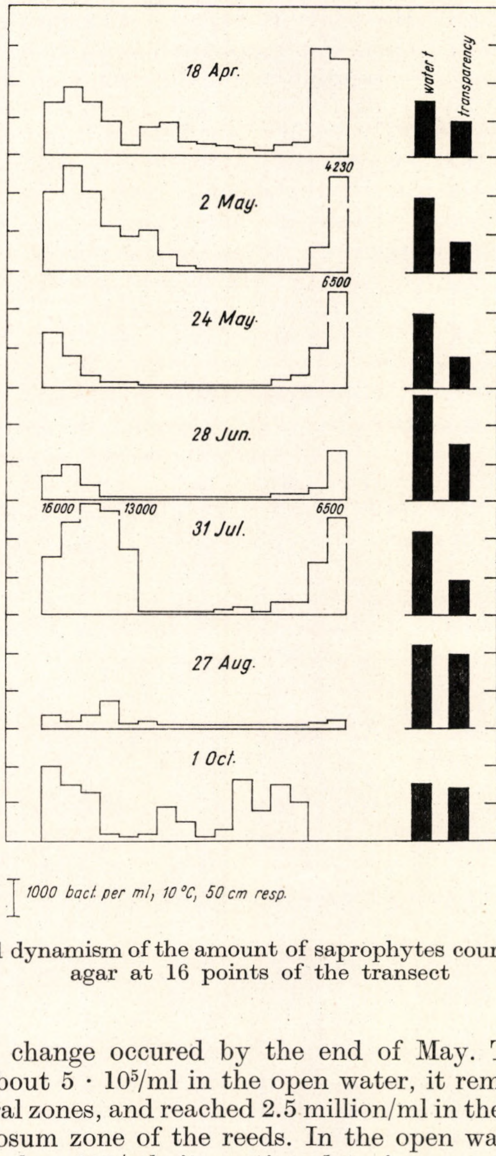

Fig. 4. The seasonal dynamism of the amount of saprophytes counted on casein-glucose agar at 16 points of the transect

An essential change occured by the end of May. The total bacterioplankton varied about $5 \cdot 10^5$/ml in the open water, it remained above 1 million/ml in the littoral zones, and reached 2.5 million/ml in the Scirpeto-Phragmitetum phragmitetosum zone of the reeds. In the open water, the number of saprophytes was below 100/ml; it continued to increase along the southern shore free of reeds, but a considerable decrease showed on the northern shore with a maximum of 1400/ml on casein-glucose agar. The littoral zone of high saprophytic content, as related to that of the open water, became narrower and delimited to the area of the reeds.

By the end of June, the amount of the total bacterioplankton and the number of saprophytes decreased even further. The number of saprophytes sunk below 50/ml in the open water and diminished from 6500 to 1300 in the littoral of the southern shore. In the shallow water of the sandy bottom along the southern shore, the slight increase found at the end of May still persisted.

By the end of July, the amount of the total bacterioplankton decreased to $3 - 4 \cdot 10^5$/ml in the open water, and remained below 1 million in the littoral zones. The number of saprophytes on nutrient agar exhibited the picture shown in June, but a most conspicuous rise could be observed in those developing on casein-glucose agar. The ratio of the littoral zones and the open water was identical with that experienced in the spring, whereas the maximum number of saprophytes reached 16,000/ml.

At the end of August, the amount of the total bacterioplankton increased over 1 million/ml both in the open water and the coastal zones. The number of saprophytes was low on both culture media, and the littoral zones were quantitatively hardly differing from the open water.

At the beginning of October, it could be seen from the data of the 14 points along the transect that the amount of the total bacterioplankton decreased to its lowest level with respect to the investigated period, and that it was essentially higher in the open water than in the northern littoral zone. As related to August, the number of saprophytes increased and by their quantity the coastal zone and the open water hardly differed.

The relatively high springtime values of the actinomyces present in the plankton gradually decreased and appeared in insignificant numbers during the summer months.

Table 1

The amount of actinomyces present in the plankton of the detailed section

Sites of sampling	Date of sampling						
	18 April	2 May	24 May	28 June	31 July	27 Aug.	1 Oct.
1.	75	40	0	8	7	2	3
2.	70	10	3	1	3	1	0
3.	50	30	10	3	0	0	0
4.	50	20	0	0	1	1	0
5.	3	20	0	0	0	2	0
6.	10	3	0	1	1	0	2
7.	60	20	1	0	1	0	1
8.	3	10	0	0	3	0	0
9.	10	3	2	3	0	0	1
10.	15	0	0	2	0	0	1
11.	0	3	3	0	1	3	0
12.	10	0	1	0	0	0	2
13.	20	3	1	4	3	0	4
14.	10	10	2	1	2	1	0
15.	130	3	20	0	0	0	0
16.	90	120	40	12	9	4	8

The open water

In May, the amount of the total bacterioplankton was above $5 \cdot 10^5$/ml *(Fig. 5)*, reaching or exceeding in some cases one million per ml. It was only at two points of section K that lower values were found ($3 - 3{,}5 \cdot 10^5$/ml).

The number of saprophyta grown on nutrient agar *(Fig. 6)* varied between 10 and 80 per ml the lowest occurring in section A. On casein-glucose agar *(Fig. 7)*, values below 100/ml were found for sections G, A and E, but above 100/ml for sections M and K.

In June, the amount of the total bacterioplankton sank below 5 · 10^5/ml; a figure about 1 million was found only in one site. Saprophytes deriving from

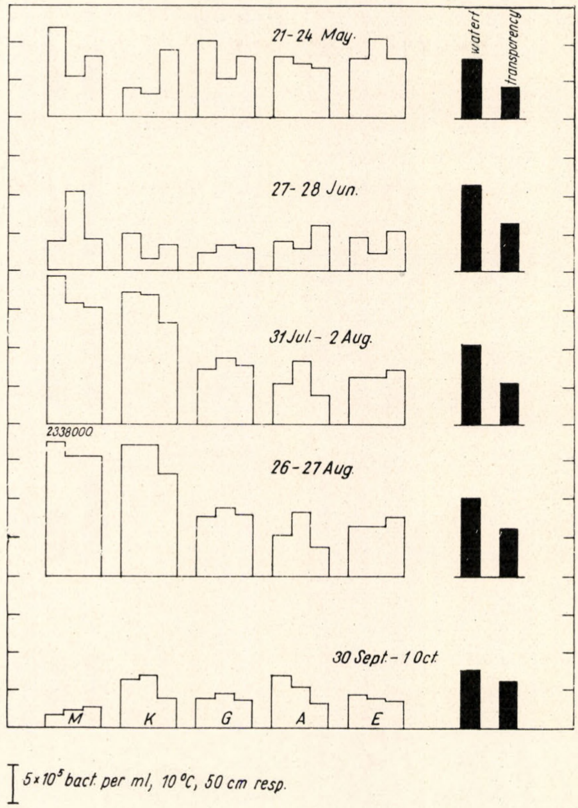

Fig. 5. The seasonal dynamism of the amount of total bacterioplankton at three sites of the 5 standard sections (M, K, G, A) of Lake Balaton

sections G, A and E decreased in numbers on both culture media, but for sections M and K the value obtained in May increased nearly by a thousand fold. On nutrient agar, 40—16,000/ml, on casein-glucose agar, 44—19,000/ml saprophytic bacteria were counted.

In July, the amount of the total bacterioplankton rose above 5 · 10^5/ml in sections G, A and E and to 1.5 millions per ml in sections M and K. The number of saprophytes increased further on casein-glucose agar for sections M and K, reaching 120,000 per ml, while on nutrient agar the value remained high, similarly to the situation in June. The exceedingly high values extended also to section G, but no essential changes occurred in sections A and E.

In August, the amount of the total bacterioplankton of sections G, A and E remained unchanged as related to that of July; in sections M and K the high value characterizing July again persisted, indeed, it reached 2.3 millions per ml at one point of section M. The high saprophyte numbers, characterizing June and July, ended in sections M, K and G, so that low values were received, excepting a slight rise in section E, for the entire area of the lake.

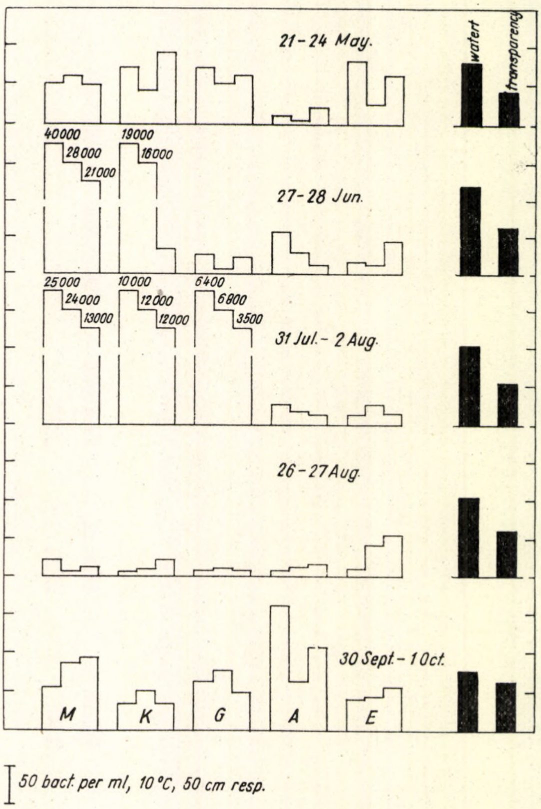

Fig. 6. The seasonal dynamism of the amount of saprophytes counted on nutrient agar at three sites of the 5 standard sections (M, K, G, A, E) of Lake Balaton

Table 2

The amount of actinomyces present in the plankton of the open water

Date of sampling	Sites of sampling														
	M			*K*			*G*			*A*			*E*		
	1	0	2	0	1	2	1	0	2	1	0	2	1	0	2
	number of individuals per ml														
21—24 May	16	10	13	3	18	13	3	0	3	2	2	1	0	0	3
27—28 June	8	7	16	4	0	3	1	4	1	0	0	3	1	0	0
31 July—August	2	0	8	0	1		0	0	1	1	0	1	3	0	1
30 Sept.—						4									
1 October	0	2	11	0	3	2	1	0	1	1	0	2	1	2	0

By the end of September and the beginning of October, the amount of the total bacterioplankton decreased, with the lowest value showing in section M ($2 \cdot 10^5$/ml). On the other hand, the number of saprophytes increased as related to the preceding month, reaching 400—800/ml on casein-glucose agar.

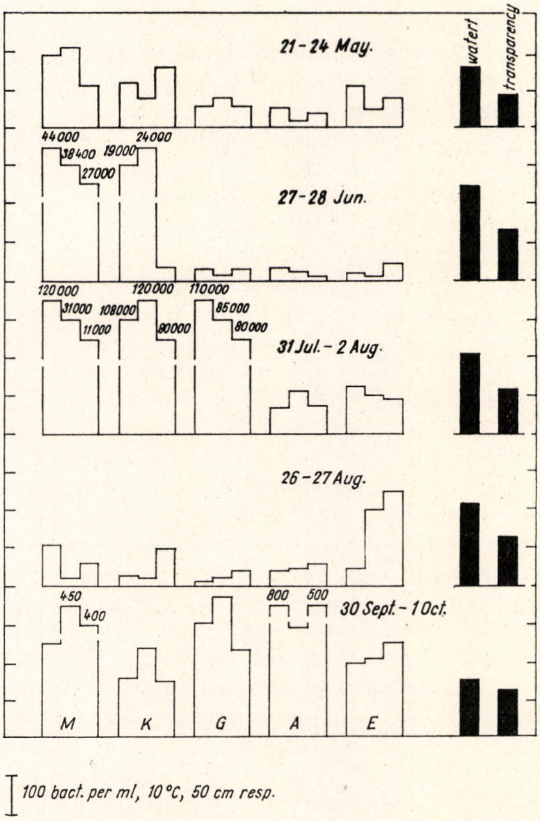

Fig. 7. The seasonal dynamism of the amount of saprophytes counted on Jensen's casein-glucose agar at three sites of the 5 standard sections (M, K, G, A, E) of Lake Balaton

Discussion

The investigated detailed section

The comparative bacteriological conditions of the open water and the littoral zone of Lake Balaton were studied by HARANGHY (1941); his data, referring to saprophytes developing on gelatine and HEYDEN-albumose agar (HESSE and NIEDER, 1898), reveal a higher number of bacteria present in the coastal zone.

Within the section studied here, a definite distribution with respect to the amount of both the saprophytes and the total bacterioplankton can be found. Similarly to the situation 30 years ago (HARANGHY, 1941), the content of saprophytic bacteria was low in the open water, being 50/ml during the summer months. On the other hand, values about, or occasionally considerably exceeding, an average 1000/ml was obtained in the littoral zones. Whereas merely double or triple amounts of differences existed in the total bacterioplankton prevailing between the open water and the coastal zones, the number of saprophytes was found to be, especially on casein-glucose agar, 40 to 120 times higher in the littorals.

It is known that the saprophytic microflora reacts rather sensitively in respect of quantity to changes in concentration of organic substances easily assimilable by bacteria. It was on this basis that KRISS (1968) studied, by the amount of saprophytes counted on fish-pepton agar, the distribution of "unstable" organic matter in pelagic waters. Indubitably, the analysis of the number of saprophytes makes possible the study of processes no further traceable merely by the number of the total bacteria (OLÁH, to be published).

The subdividing or configuration according to bacteria and their numbers of the littoral zone and the open water was most conspicuous during the spring months. By the end of summer and the beginning of autumn, it decreased to a certain extent. The summer minima, well known from literature, occurred regularly at all points of the open water (HENRICI, 1938; POTAYENKO, 1968), but smaller to greater maxima evolved in the reeds also during the summer months.

The stronger springtime extension of the littoral zone richer in bacterioplankton along the reed covered northern shore and the springtime maximum appearing generally also in the open water can be explained by the higher concentration of nutritive substances and the higher temperature of the water.

During autumn, a significant amount of organic substances gets from the reeds into the water; part of them arrives, by the detritic drift in a disintegrated state, also to the open water areas (SEBESTYÉN, 1964) so a sedimentary zone rich in organic matter is formed (MOON, 1933; ENTZ et al 1963).

Our data clearly show that the extent of the wide coastal zone, of high bacterial content evolved during springtime, coincides with this mud zone richer in organic substances *(Figs. 1, 3, 4)*.

Owing to the low winter temperatures, the utilization of the nutritive substances deriving from the mineralization of the organic substances having arrived into the water during autumn is slower, thus an accumulation of food substances occurs, as related to the summer months. With the rising springtime temperature, this causes a more intense bacterial activity. However, by the rise of temperature, the food-supply is quickly utilized and the quantity of bacteria significantly decreases, that is, the coastal zone becomes delimited to the area of the reeds, by the end of May. EDMONDSON (1968) states that the high winter and early spring concentration of nutritive substances is characteristic of most waters. The springtime maximum of the phytoplankton can be explained by similar phenomena (LUND, 1965). According to KONSTANTINOV (1967), the essential element of the biological spring in these waters are the higher concentration of biogeneous materials and the stimulating effects of the increasing temperature.

The mineralization of the macrophytic vegetation of the littoral zone, especially as regards shallow waters, is an important ecological process — come about by the rise in trophic level of the water area — also with respect to the entire lake (GORBUNOV, 1953; KRASENINIKOVA, 1958). The higher biological production evolved by these means (RODINA, 1961) appeared to any extent, according to our data, only during the spring months (within the investigated period) in the specific conditions of Lake Balaton.

In the constantly disturbed water of Lake Balaton, strongly heated during summer and saturated with oxygen even on the surface of the muddy bottom, bacteria rapidly utilize the easily assimilable nutritive substances. The high lime content also quickens mineralization (PROWSE, 1966), favouring, at the same time, the formation of insoluble precipitation complexes more stable against bacterial activity.

If KRISS's contention (1968), namely that the proliferation of bacteria in a closed glass container filled with lake-water is in direct proportion with the amount of "stable" organic matter present in the water, is accepted then the preponderantly greater portion of organic substances present in Lake Balaton exists in this form. According to ZIH (1929), the amount of the saprophytic bacterioplankton contained in the waters of Lake Balaton increases to 400—500 times of its original quantity in a few days in a closed glass container.

In our opinion, this is the explanation of the intensive self-purifying ability of the water of Lake Balaton. It is due to this process that during the summer months the open water conditions with a saprophyte content characterizing oligotrophic lakes prevail already at a distance of no more than a few meters from the reedless southern coast, even in waters excessively disturbed by bathing people. The shrinking of the northern littoral zone into the stripe of reeds during the summer months can be explained by the same causes.

The open water

The results of monthly investigations conducted in 1966/67 failed to give an unequivocal picture of the seasonal dynamics of the total bacterioplankton (OLÁH, 1969). The entire process can in details be exposed only by short-period surveys; however, some rules seem to be inferable also from the monthly surveys of the three years in question.

Changes occurring in the amount of the bacterioplankton present in the diverse sections of Lake Balaton cannot be dovetailed into each other. Within the investigated period, the maximum appeared in a very definite form in sections A and E in May, whereas the maxima of July and August showed in sections M and K. The June and November minima formed in all sections.

In 1968, the amount of the total bacterioplankton was higher than in the years 1966/67. Whereas the values received for these latter varied about $2{,}3 \cdot 10^5$/ml (OLÁH, 1969), they have been over $5 \cdot 10^5$/ml — excepting June — in 1968. The increase was especially large in Keszthely-bay and its neighbourhood, with their maxima above 1.5 millions and 2.3 millions, respectively, in July and August, — values which belong to the order of magnitude of the mesotrophic lakes (KUZNETSOV, 1952; THSHERBAKOV, 1967).

Agreeing with ZIH's (1929) and HARANGHY's (1941) data, our also show a low saprophyta content of Lake Balaton. On the other hand, the exceedingly high numbers appearing in sections M and K in June, and in sections M, K and G in July, refer to the more intricate conditions of Keszthely-bay and its neigbourhood, at the same time ensuring the intensive self-purifying ability of the water.

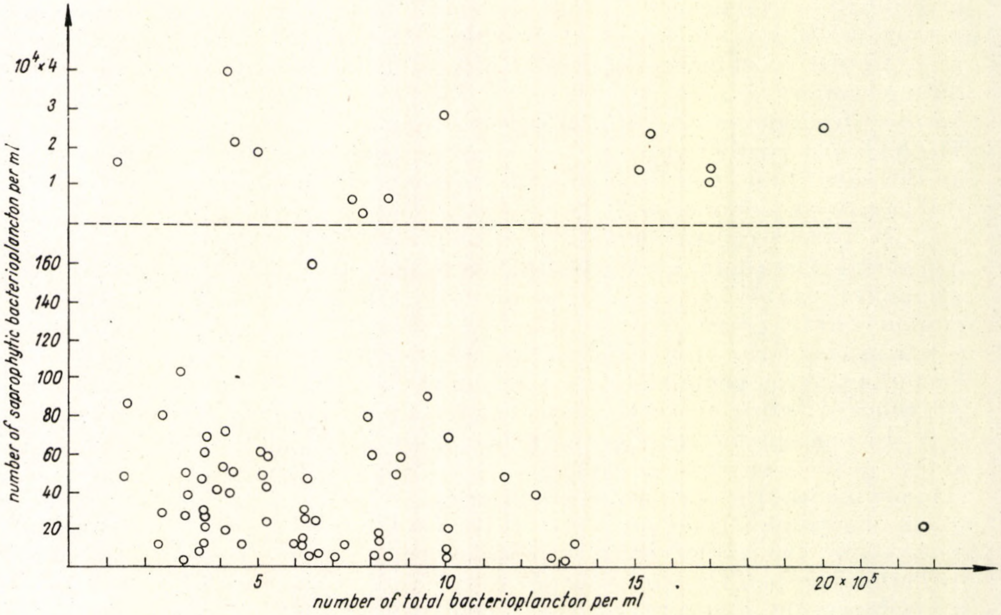

Fig. 8. The ratio of the total bacterioplankton and the number of saprophytes counted on nutrient agar

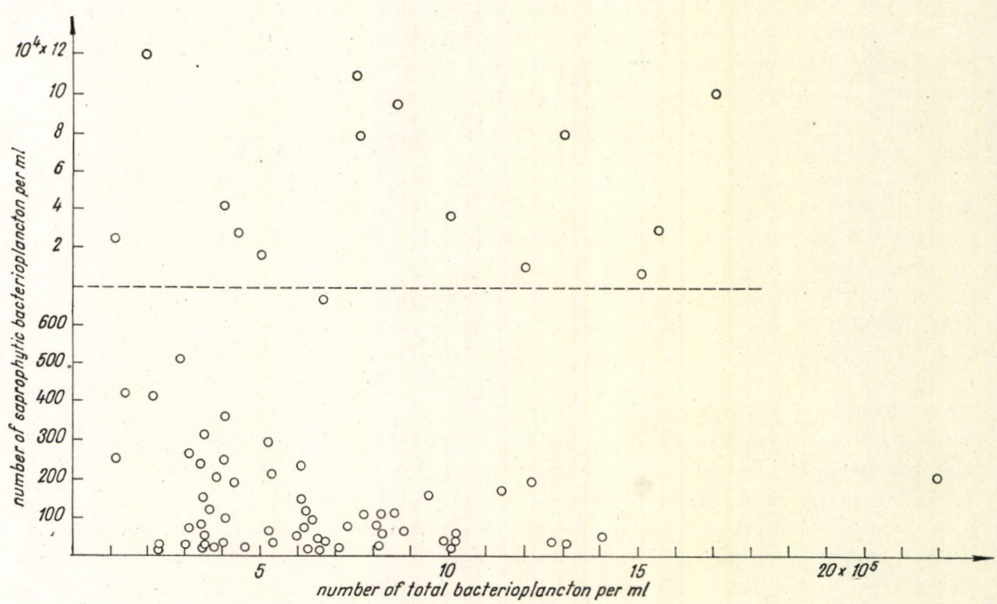

Fig. 9. The ratio of the total bacterioplankton and the number of saprophytes counted on casein-glucose agar

Similarly to some other saprophyta groups, the actinomyces *(Table 2)* are excellent indicators of the quantity of decomposing organic substances. The oxygen consumption of Lake Balaton water is 2 — 4 mg/l (ENTZ, 1949—50, 1953) so that the quantity of the actinomyces in the plankton is not significant, according to our measurements. They have been present in relatively higher numbers in the plankton of sections M and K during the spring.

The ratio between the total bacterioplankton and the number of saprophytes was used by KUZNETSOV (1960) as an index of the maturity of water reservoirs, since the saprophytes react most sensitively to changes in the concentration of easily assimilable organic substances (KRISS, 1968). Owing to the low concentration of nutritive substances in Lake Balaton, the ratio is about ten thousand, indicating a favourable water purity; however, the ratio decreased to 40—50 in Keszthely-bay and its neighbourhood in June, July, 1968, and then reached 100,000 in August.

It seems therefore that the generally low bacterial content of Lake Balaton implies a not continuously available accumulation of nutritive supply, especially in Keszthely-bay and the neighbouring waters, giving rise to an extremely high number of the saprophytes or the mass proliferation of algae.

Concomitantly with the rise in quantity of the total bacterioplankton, the number of saprophytes generally also increase (RODINA and KUZMITSKAYA, 1968). The data of our investigations conducted in Lake Balaton do not follow this relationship but refer to rather an inverse ratio *(Figs. 8, 9)*. Probably this phenomenon is also explainable by the special physico-chemical properties of Lake Balaton.

Summary

1. By the application of plate-pouring and the direct method, the seasonal quantitative conditions of the saprophytes and the total bacterioplankton have been investigated in five standard and one investigated detailed sections of Lake Balaton.

2. On the basis of the amount of both saprophytes and the total bacterioplankton, a definite differentiation can be found between the litoral zone and the open water. The quantity of the bacterioplankton was 2—3, that of the saprophytes 40—120 times greater in the former zone. The differentiation was the most conspicuous during the spring.

3. The littoral zone of high bacterial content was narrow along the reedless southern shore during the entire period of investigation. On the other hand, the littoral zone of high saprophyta content along the northern shore margined with reeds is wide during springtime (1500 m), but shrink to the area of the reeds during summer. The considerable springtime expanse of the northern coastal zone coincides with the wide sedimentary zone, rich in organic substances, extending before the shoreline.

4. The quantitative dynamics of the saprophytes and the total bacterioplankton reveals the intensive self-purifying ability of Lake Balaton; its most important factors are the high summer temperatures of the water, the full oxygen saturation, the constant movement of the water, and the high lime content.

5. In the open water, the amount of the total bacterioplankton was above $5 \cdot 10^5$/ml, and the maximum value reached was 2.3 millions. These data are essentilly greater than those obtained in 1966/67.

6. The saprophyta content of the open waters of Lake Balaton is generally low, 10—100/ml on nutrient agar, and 20—500/ml on casein-glucose agar. Both mediums yielded very high values (10,000—40,000/ml) for Keszthely-bay and its neighnourhood during June and July.

7. The amount of actinomyces present in the plankton is not significant.

8. The ratio of the total bacterioplankton and the saprophytes is favourable with respect to the purity of the water (10,000); however, this ratio decreases to 40—50 in Keszthely-bay and its neighbouring waters during June and July.

9. The increase of the amount of the total bacterioplankton was not followed by a similar increase in the number of saprophytes.

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A SZAPROFITA ÉS TELJES BAKTERIOPLANKTON MENNYISÉGI VISZONYAI A BALATON NYÍLTVIZÉBEN ÉS PARTI ZÓNÁJÁBAN 1968-BAN

Oláh János

Összefoglalás

1. A Balaton öt standard szelvényén és egy részletes keresztszelvényén lemezöntéssel és direkt módszerrel vizsgáltuk a szaprofita és teljes bakterioplankton szezonális mennyiségi viszonyait.

2. A szaprofita és a teljes bakterioplankton mennyisége alapján egyaránt határozott tagolódást találtunk a parti zóna és a nyíltvíz között. Az előbbi zónában a teljes bakterioplankton 2—3-szor, a szaprofiták 40—120-szor nagyobb mennyiségben fordultak elő. A tagolódás a tavaszi hónapokban volt a legszembetűnőbb.

3. A nádasmentes déli parton a magas baktériumtartalmú parti zóna az egész vizsgált periódusban keskeny volt. A nádassal szegélyezett északi oldalon a magas szaprofita-tartalmú parti zóna a tavaszi hónapokban széles (1500 m), nyáron a nádas területére zsugorodik. Az északi parti zóna erőteljes tavaszi kiterjedése egybeesik a part előtt húzódó széles, szervesanyagokban gazdag üledék-zónával.

4. A szaprofita és a teljes bakterioplankton mennyiségi dinamikája bizonyítja a Balaton intenzív öntisztuló képességét, amelyben a magas nyári vízhőmérséklet, a teljes oxigén telítettség, a víz állandó mozgása és a magas mésztartalom játszanak döntő szerepet.

5. A nyíltvízben a teljes bakterioplankton mennyisége milliliterenként 5 . 10^5 fölött volt és a csúcsérték elérte a 2,3 milliót. Ezek az adatok az 1966/67. éviekhez viszonyítva lényegesen magasabb értékek.

6. A Balaton nyílt vizének szaprofita tartalma általában alacsony, nutrient agaron 10—100/ml, kazein-glükóz agaron 20—500/ml. A Keszthelyi-öbölben és környékén június-július folyamán rendkívül magas értékeket mértünk mindkét táptalajon (10—40 ezer/ml).

7. A sugárgombák mennyisége a planktonban nem jelentős.

8. A teljes és szaprofita bakterioplankton aránya a víz tisztasága szempontjából kedvező (10 ezer), a Keszthelyi-öbölben és környékén azonban az arány június-július hónapokban 40—50-re csökken.

9. A teljes bakterioplankton mennyiségének növekedését a szaprofiták számának növekedése nem követte.

КОЛИЧЕСТВЕННЫЕ ОТНОШЕНИЯ СОПРОФИТОВ И ОБЩЕГО БАКТЕРИОПЛАНКТОНА В ОТКРЫТОЙ ВОДЕ И ЛИТОРАЛЕ ОЗЕРА БАЛАТОН В 1968 ГОДУ

Я. Олах

1. Сезонные количественные отношения сопрофитов и общего бактериопланктона были изучены на 5 стандардных поперечных сечениях озера Балатон с помощью посева и прямого метода.

2. По количеству сопрофитов и общего бактериопланктона побережная и открытая вода сильно различаются друг от друга. В побережной зоне общее количество бактериопланктона в 2—3 раза, а количество сопрофитов в 40—120 раза выше, чем в открытой воде. Эта разница было наиболее выражена в весенние месяцы.

3. На южном литорале лишенном тросника зона, характеризующаяся высоким числом бактерий, была низкая в изученном периоде. На северном литорале покрытом тросником зона с высоким числом бактерий была широкая в весенние месяцы (1500 ск), а потом ограничивалась зоной зарослей тросника.

Весной широкая зона высоким содержанием бактерий северного литорала совпадает зоной ила богатой органическими веществами.

4. Количественное изменение сапрофитов и общего бактериопланктона свидетельствуют об интенсивности процесса самоочищения воды озера Балатон. В этом процессе важную роль играют высокая летняя температура, насыщение с кислородом, постоянное движение воды и высокое содержание $CaCO_3$.

5. В открытой воде количество общего бактериопланктона было в среднем около 5.10^5 мл/мл, а самое высокое значение было 2,3 мил.

6. В открытой воде содержание сапрофитов довольно низко, на МПА 10—100/мл, а на агаре с казеином и глюкозой 20—500/мл. В Кестхейском заливе и его окрестности численность сопрофитов в июне и июле была неожиданно высокой на обеих средах (10—40 тыс/мл).

7. Количество актиномицетов в планктоне незначительно.

8. Соотношение числа сопрофитов и общего бактериопланктона в отношении чистоты воды благополучно (10 тыс.) в заливе Кестхей и его окрестностях: это соотношение снижается до 40—90 в июне и июле.

9. Не был найден параллелизм в возрастании количества общего бактериопланктона и числа сапрофитов.