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DISTRIBUTION OF ORGANIC MATTER AND BACTERIA IN THE UPPER LAYER OF BOTTOM DEPOSIT IN THE OPEN WATER OF LAKE BALATON

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There is only one work (ENTZ et al., 1963) that provides information on the organic matter content of the bottom deposit of Lake Balaton. These investigations have been made along transversal section M, intersecting the Bay of Keszthely in north-south direction. It is not possible to draw conclusions on the basis of these data concerning Lake Balaton as a whole, because the properties of the bottom deposit in the Bay of Keszthely greatly differ from other areas of the lake (MÜLLER, 1969; PONYI, 1971).

The present contribution continues earlier investigations on sediments (MÜLLER, 1969; PONYI, 1971). The purpose of these investigations was to establish the horizontal distribution of organic matter and of the bacteria participating in their decomposition in the bottom deposit of the open water of the lake.

Collecting places and methods

Bottom samples were collected with the Ekman-Birge dredge at seven points of each of the 9 transversal sections of the lake. The aliquots taken from the homogenizate of the upper 5 cm layer of bottom were examined *(Fig. 1)*. Five of the transversal sections were identical with the sites of previous examinations. Detailed description of location and nomination of the transversal sections is given in the works of SEBESTYÉN (1960) and MÜLLER (1969).

The distances between the points of collections marked on the transversal sections was different, and even the points nearest to the shore were at least 500 m off the shoreline.

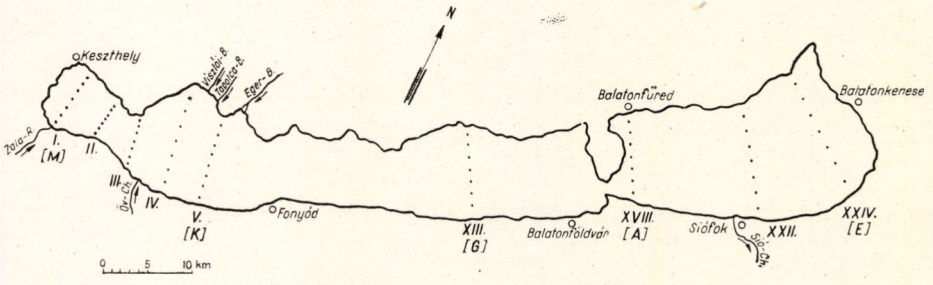

Fig. 1. Collecting places in Lake Balaton

Organic matter content was determined by the method of ENTZ et al. (1963), and the organic carbon content was obtained by computation (BALLENEGER and MADOS, 1944; HANSEN, 1959).

Total N-content was determined by Kjeldahl's method, and bacterial count by the technique recommended by KUZNETSOV and ROMANENKO (1963). Counts of particulate organic matter (3—15 μ and 15—40 μ fractions) were made on membrane filters, using staining with erythrosine and by means of a green colour filter.

Results

1. *Distribution of organic matter in the lake*

Comparison of average values of organic matter content of the different transversal sections *(Table 1)* shows that in the greatest part of the lake the values are nearly identical (3—4%), except in the Bay of Keszthely where the values are twice as high (8—9%).

Significant deviation ($0{,}05 > P > 0{,}02$) in organic matter content was found in two of the transversal sections (I,II) widely differing from the rest. The amounts of Kjeldahl-N are nearly identical (0,3—0,5%) in the bottom in different areas *(Table 1)*.

TABLE 1

Average values of the components examined in the different transversal sections

Transversal section N°	% of materials dissolved in 10% HCl	% of organic materials	% of organic C	% of Kjeldahl-N	C/N
I.	50.70	8.32	4.82	0.36	13.97
II.	46.25	9.37	5.43	0.32	16.88
III.	50.95	3.22	1.86	0.46	3.80
IV.	63.98	4.11	2.57	0.26	8.01
V.	64.02	3.57	2.06	0.38	5.46
XIII.	69.55	3.21	1.86	0.29	5.73
XVIII.	51.73	2.86	1.65	0.29	5.66
XXII.	61.19	2.70	1.56	0.25	6.42
XXIV.	61.26	3.04	1.76	0.31	5.86

The amounts of materials dissolved in 10% HCl solution (largely CO_3^{2-}) ranged between 46—51% in the Bay of Keszthely and its vicinity (transversal sections I—III), while in the other aresa of the lake — except for one transversal section — their amounts were above 60%.

A significant quantitative difference in organic matter content between the different points of the individual transversal sections was only registered in the Bay of Keszthely *(Fig. 2)*. In the other areas of the lake the values of organic matter content generally varied between 1—5%. There was not, however, any significant difference in the distribution of Kjeldahl-N content within the individual transversal sections. Noteworthy differences ranging from 0,2 to 0,6% N were only observed along transversal section III.

In the graphs of the derivatographic analyses of bottom samples from the Bay Kis in front of the Biological Research Institute, Tihany, only peaks

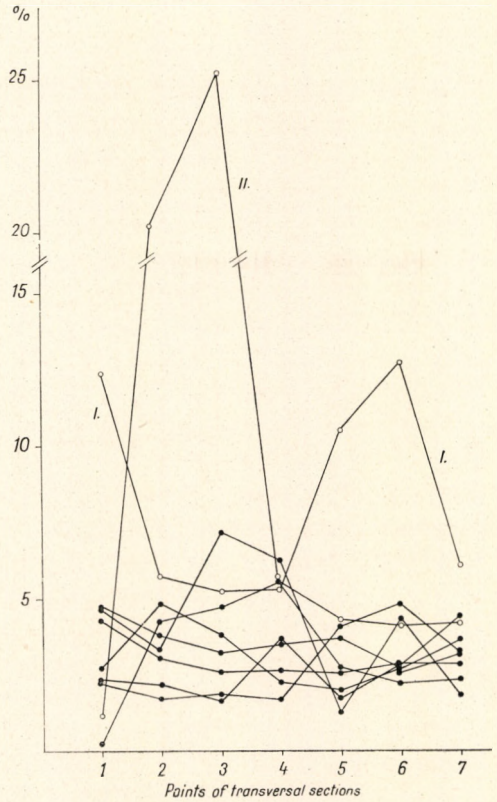

Fig. 2. Changes in organic matter content along the transversal sections investigated

for quartz (570—590°C) and dolomite (800—900°C) appear. Gradation for loss of weight indicating the presence of organic matter was not observed *(Fig. 3)*.

The amounts of HCl-soluble substances increase from the southern shore towards north in the majority of transversal sections. Especially high values were registered between the depth axis and the northern shore rich in macrovegetation.

2. *Distribution of bacteria and particulate organic materials in the bottom deposit*

Average values of bacterial count are greater in the Bay of Keszthely and its neighbourhood (transversal sections I—V) than at other points of the lake, except for transversal section XVIII where the values for bacterial count were as high as those obtained in the Bay of Keszthely *(Table 2)*. Particulate organic materials, especially fractions of 3—15 μ size were found to be of similar horizontal distribution.

The quantitative distribution of bacteria and particulate organic materials in the transversal sections was heterogeneous *(Table 3)*. At points near

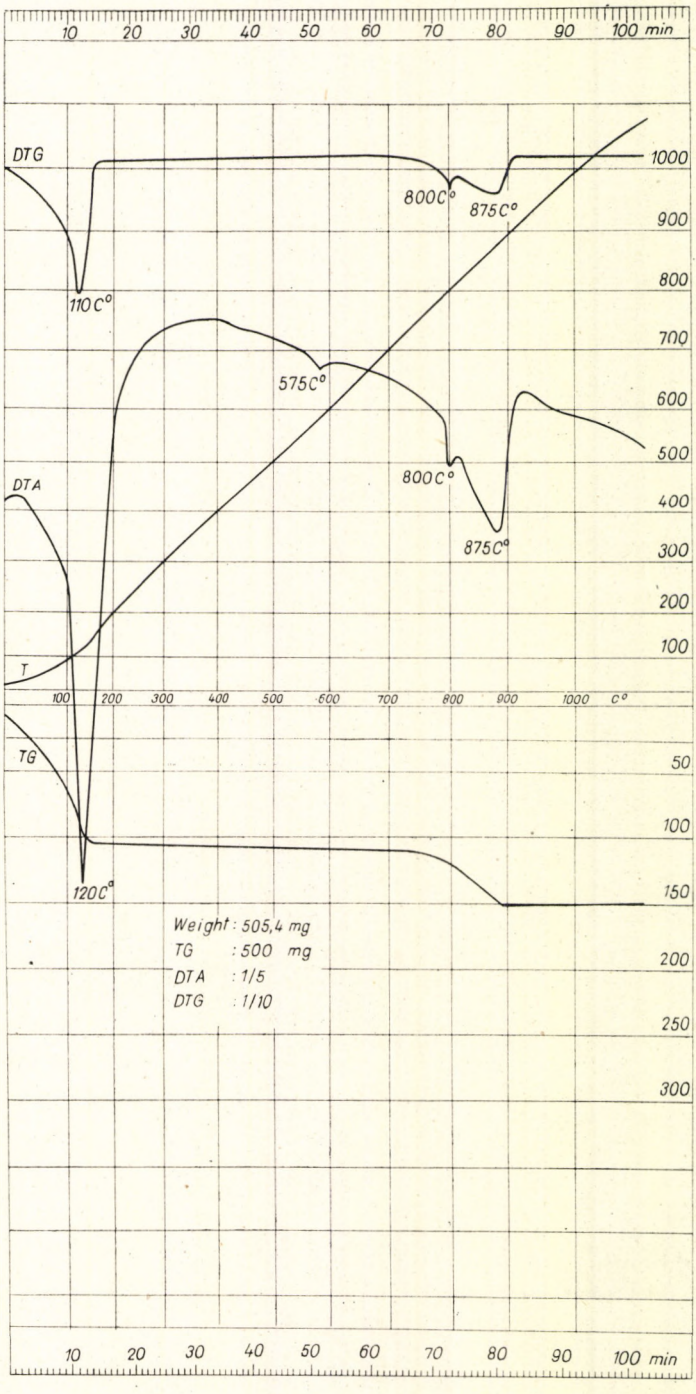

Fig. 3. A derivatogram of the bottom sample from the Bay Kis

TABLE II

Bacterial counts (10^9 cell/g wet weight) and amounts of particulate organic materials of 3—15 μ (10^6/g wet weight) and 15—40 μ (10^5/g wet weight) along the transversal sections examined

Transversal section	Bacterial count	Particulate organic material	
		3—15 μ	15—40 μ
I. (M)	1.14±0.15	19.7±5.9	4.5±2.4
II.	1.17±0.24	22.8±9.5	11.5±14.0
III.	1.14±0.55	15.6±9.4	3.9±2.3
IV.	1.02±0.26	17.5±6.0	3.7±1.1
V. (K)	1.08±0.07	17.2±1.5	4.5±1.4
XIII. (G)	0.69±0.35	10.9±6.0	3.5±2.5
XVIII (A)	1.10±0.20	13.4±5.0	3.0±0.7
XXII.	0.93±0.21	5.9±1.3	1.8±0.2
XXIV. (E)	0.53±0.09	4.8±4.8	2.4±0.3

TABLE III

Bacterial counts (10^9 cell/g wet weight) and amounts of particulate organic materials of 3—15 μ (10^6/g wet weight) and 15—40 μ (10^5/g wet weight) at 7 points of transversal section II

	Bacterial count	Particulate organic material	
		3—15 μ	15—40 μ
1.	0.3	6.7	4.0
2.	1.4	25.9	14.9
3.	1.2	27.4	7.0
4.	1.4	21.9	7.7
5.	0.7	19.7	1.6
6.	1.4	38.2	6.0
7.	1.4	20.0	40.3

to the sandy southern shore quantities of bacteria and particulate organic materials were generally lower than at points near the northern shore.

Discussion

The results show that the organic matter content of the bottom deposit in the open water of Lake Balaton is lower than in other lakes (RYBAK, 1969; HANSEN, 1959; SCHÖNBORN et al., 1965; etc.).

The organic materials were found to occur in uniform distribution over large areas of the lake. As a result of the conditions of current in River Zala the distribution of organic materials in the bottom deposit of the Bay of Keszthely is rather variable (Fig. 4). Our examinations proved the previous results concerning current conditions in the Bay of Keszthely (PÁSZTÓ, 1963; VITUKI, 1966), and also that the sedimentation of organic materials takes place along the depth axis of the lake "proceeding" from the mouth of the River Zala towards Keszthely and Siófok, respectively.

The wave action also accounts for the heterogeneous distribution of deposited particulate organic materials and bacteria acting on them, and only

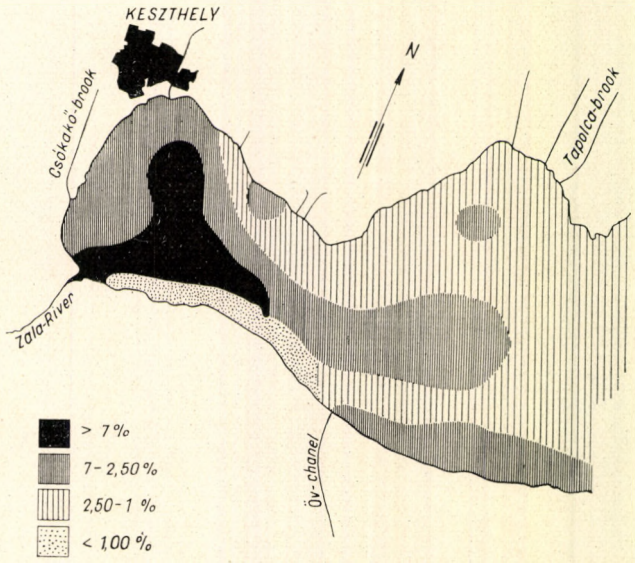

Fig. 4. Organic matter content in different areas of the bottom in the Bay of Keszthely

the average data indicate that there is a positive relationship between the quantitative occurrence of organic materials and bacteria.

The horizontal distribution of HCl-soluble substances in the bottom deposit nearly conforms to the results of MÜLLER (1969). In opposition to the observations of PÁSZTÓ (1963) namely, the values for the carbonate content of the bottom deposit are lower in the Bay of Keszthely than in a great part of the south-west basin. At present bottoms with highest carbonate content occur in the area between the Bay of Szigliget and Balatonszemes-Ságpuszta *(Table I)*.

The C/N ratio is often used for characterizing the bottom deposits of various waters and for classifying lakes (HANSEN, 1959; 1961; KUZNETSOV, 1970). On the basis of the C/N ratio Lake Balaton may be ranged among eutrophic lakes (SOROKIN, 1958; SCHÖNBORN et al., 1965). The higher C/N ratio *(Fig. 5)* in the Bay of Keszthely is probably due to the presence of humic materials transported into the lake by River Zala.

Summary

1. The upper layer of the bottom deposit in the open water of Lake Balaton is poor in organic materials. The values obtained were 3—4% except for the Bay of Keszthely where values of 8—9% were registered. Noteworthy quantitative differences in the organic matter content between the different points of the individual transversal sections were found only in the Bay of Keszthely.

2. Values of Kjeldahl-N content in the different areas of bottom are nearly identical (0,3—0,5%).

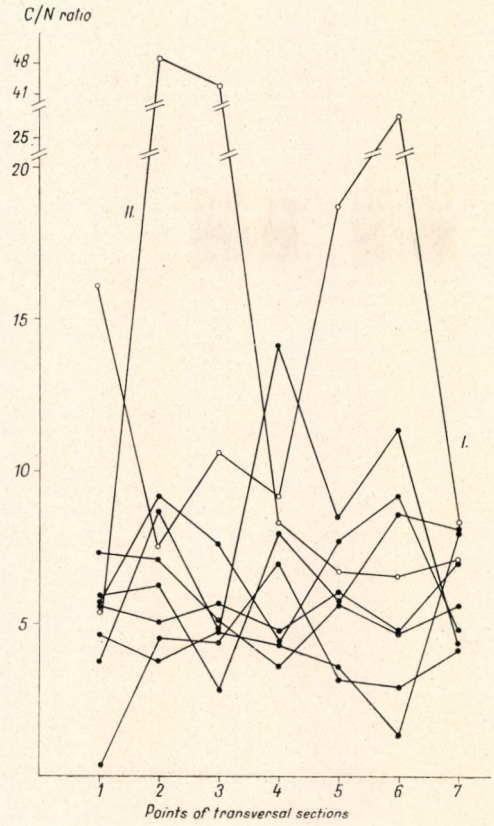

Fig. 5. Changes in C/N ratio along the transversal sections investigated

3. Amounts of HCl-soluble materials in the Bay of Keszthely and its neighbourhood are 46—51% and in the other areas of the lake over 60%, and proceeding from the southern shore northward the amounts increase in most of the transversal sections.

4. Average bacterial counts and the amounts of the 3—5 μ fractions of particulate organic materials in the bottom are generally higher in the Bay of Keszthely and its neighbourhood than in other areas of the lake. The quantitative distribution of bacteria and particulate organic materials along the transversal sections is heterogeneous.

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SZERVESANYAG ÉS BAKTÉRIUMOK MEGOSZLÁSA A BALATON NYÍLTVIZÉNEK FELSŐ ÜLEDÉKRÉTEGÉBEN

Ponyi Jenő, Oláh János és *Frankó András*

Összefoglalás

1. A Balaton nyíltvizének felső iszaprétege szervesanyagban szegény, a Keszthelyi-öböl kivételével (8—9%) 3—4%-os értékeket találtunk. A keresztszelvényeken belül a szervesanyag mennyiségi eltérései csak a Keszthelyi-öbölben jelentősek.

2. A különböző iszapterületek Kjeldahl-N tartalma közel azonos (0,3—0,5%).

3. A HCl-ban oldható anyagok mennyisége a Keszthelyi-öböl és környékén 46—51% a tó egyéb területein 60 % felett van és a déli parttól észak felé haladva a szelvények, többségében emelkedik.

4. A baktériumszám átlagos értékei és a formált szervesanyag 3—15 μ nagyságú frakciója a Keszthelyi-öböl és környéke iszapjában általában magasabbak, mint a tó egyéb területein. A keresztszelvényeken a baktériumok és a formált szervesanyag mennyiségi megoszlása heterogén.