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HORIZONTAL DISTRIBUTION OF ORGANIC CARBON CONTENT IN THE UPPER LAYER OF THE BOTTOM DEPOSIT IN LAKE BALATON

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Informations on the organic matter content of the bottom deposits of Lake Balaton were presented the first time by EMSZT (1911) on the basis of six mud-cores. This study was followed by that of CSAJÁGHY and TOLNAI (1955) publishing data on this topic on the basis of two samples taken in the Kereked Bay. ENTZ et al. (1963) carried out studies on the bottom deposits of the Keszthely Bay.

PONYI et al. (1972) and FRANKÓ and PONYI (1973a; b) provide data of a large number of analyses on organic carbon. The first study concerned examined 64 samples taken at nine transversal sections of Lake Balaton, and the latter one clarified the seasonal fluctuation in the quantity of organic carbon content of bottom deposits at five stations of the Keszthely Bay.

Owing to the current conditions a significant quantity of the sediment and of the particulate organic substances migrate towards the calmest water areas (dead drift spaces) and accumulate there (LIGETI, 1974). Based on previous works on the bottom sediment of the Keszthely Bay it was suggested that the organic matter occurs in spots on the bottom.

The aim of our work was to draw a possibly clear picture on the distribution of the organic matter of bottom deposits on the basis of samples taken from the whole lake.

Localities, dates and methods of collection

Samples were taken with Ekman-Birge bottom sampler from 7 points each of the 24 transversal sections of the lake *(Fig. 1)* in the period of August—September 1971. Detailed description of the sections worked up is given in the study of MÜLLER (1969). Aliquot sampler were taken from the homogenizate of the top 5 cm thick sediment layer and dried at 40—50 °C in an aerated desiccator.

The organic carbon content was determined by the method adapted from WALKLEY and BLACK (1934). The end point of the titration of $K_2Cr_2O_7$ was determined in three parallels with RAVEH's and AVNIMELECH's method (1972) using an automatic titrimeter of the type Radelkis OP-506 connected to Ag/AgCl reference electrode of the type Op-8212 and potentiometric graphit

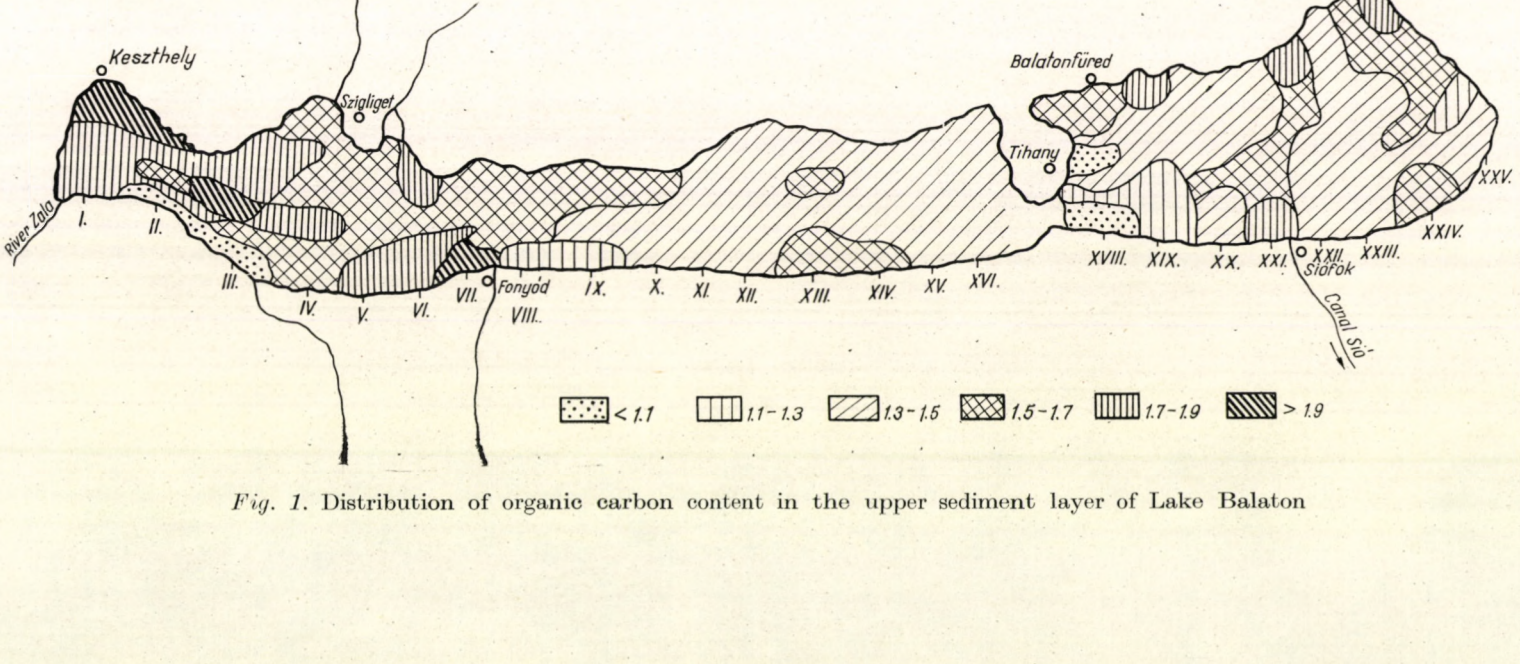

Fig. 1. Distribution of organic carbon content in the upper sediment layer of Lake Balaton

electrode of the type OP-C-7111-D. The determination of organic carbon content (DAVIES, 1974) was not disturbed by the very high $CaCO_3$ content which is characteristic in Lake Balaton (EMSZT, 1911; ENTZ, 1959; FRANKÓ and PONYI, 1973 a; b).

Results and discussion

Compared to other lakes (SCHÖNBORN et al., 1965; HANSEN, 1961; RYBAK, 1969; THOMAS et al., 1973) the results show that the organic carbon content of the open water bottom sediment of Lake Balaton is approximately low. Based on 168 mud-samples analysed *(Fig. 1)* it was found that localities with higher organic carbon content (over 1.9 per cent) are situated in the two south-western basins of the lake. The organic carbon content of these basins (sections I—VII) is distributed in spots. From this point of view the central basin of the lake shows homogenous distribution (sections VII—XVI). The north-eastern basin (sections XVIII—XXV) distribution has a mosaic pattern as well as in the two basins of the south-western region, with the distinction that higher values than 1.9 per cent were absent. On the basis of the average organic carbon content calculated for one section the four basins can well be differentiated from each other *(Fig. 2)*.

The distribution of organic carbon content may be explained by the currents raised by the prevailing winds (MUSZKALAY and STAROSOLSZKY,

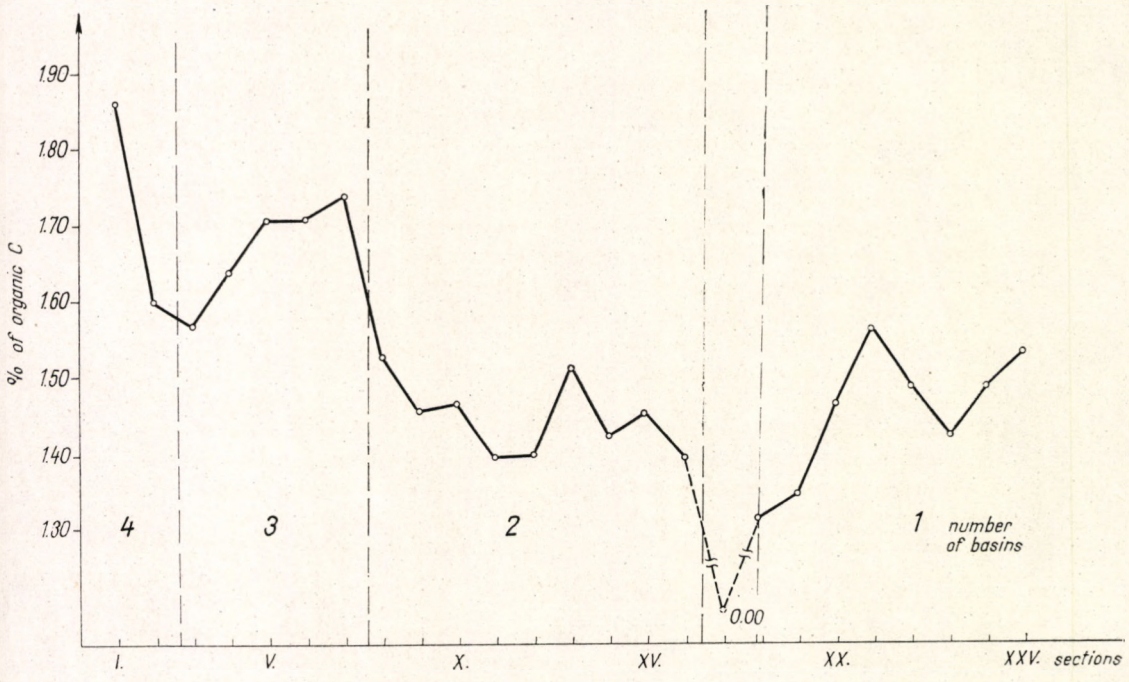

Fig. 2. Variation in the mean organic carbon conent at the sections of the four basins of Lake Balaton

1964; SZESZTAY, 1967; LIGETI, 1974). Since the samples were taken from the top 5 cm thick layer, the map showing the distribution of the organic carbon content based on our investigations, reflects the situation developed in the past 20—30 years (PONYI, 1971).

The open waters under the effects of the most intensive currents (sections II, III, XVIII) have sandy bottoms of low organic carbon content.

Concerning the tributaries, the effect of River Zala on the distribution of organic matter seems to be significant, however, it can be demonstrated only in the Keszthely Bay (PÁSZTÓ, 1963; PONYI et al., 1972; LIGETI, 1974).

In the knowledge of other literary data (OHLE, 1958; 1962; KUSNETZOV, 1968; KAJAK et al., 1970) as the main source of organic carbon content in the bottom deposit the phytoplankton production should be mentioned although there are studies (SEBESTYÉN, 1949; 1964), which underline the role of detritus of macro-vegetation in this aspect. The authors mentioned above have pointed out that not more than 0.8—30.0 per cent of the primary production increases the carbon content of the bottom deposits.

During our investigations carried out monthly in the Keszthely Bay (FRANKÓ and PONYI, 1973a), classified as hyperthrophic (HERODEK and TAMÁS, 1975), the annual increase of organic carbon was found to be about 0.2 per cent. It is suggested that because of its rapid renewal the extremely high alga production (830 gC/m^2/year) (HERODEK and TAMÁS, 1975) remains suspended in the water or can be found only in the uppermost mud layer of some millimetres thickness.

On July 26, 1972 an exploratory study was carried out on the particulate organic matter discharge of River Zala. Water samples of 50—50 litres taken from three points in the mainstream of the river were filtered through a No. 25 net and the filtrates were united. The net became plugged soon and has to be rubbed and patted to filter the total amount of water. It is suggested that organic particles larger than 50 μ in diameters remained in the net.

At the date of the field collection the floating sediment was determined to be 11.68 g/m^3 in River Zala. By using the "dry combustion" method 0.52 g/m^3 organic matter was identified in the sample.

Since the average water output of River Zala is 250—300 million m^3/year (PACHNER, 1972) not less than 131—157 tonnes of particulate organic matter are yearly carried into Lake Balaton by the river. Supposed an uniform spreading of this matter in the Keszthely Bay (surface of 38 km^2/each m^2 would share 3—4 g of it. In practice, however, this value may be several times higher, since the above calculation disregarded the fact that the increase of water output may lead to an increase of 10—20 per cent of the organic matter and that the quantity of particulate organic matter of smaller than 50 μ size may be more than it was measured to be. Despite these facts, the quantity of particulate organic matter carried by River Zala cannot be said to be significant. It becomes obvious when comparing it to the quantity of dissolved organic carbon of the river (FELFÖLDY et al., 1970) found to be as great as 2,215 tons a year in average.

Regarding the rapid water renewal in the Keszthely Bay (14 months; SZESZTAY, 1967) it is seen that each m^2 of the bay shares in an average 60 g dissolved organic carbon a year.

Owing to methodological differences the present data on organic carbon cannot be compared to those obtained previously (FRANKÓ and PONYI, 1973a).

However, the data of "dry combustion" *(Table I)* were to be compared and it was found that in the Keszthely Bay the quantity of organic matter increased to 3-fold during the past 70 years with lower increase at other places. As a whole, the organic matter content of the sediment of the lake is low. It may be attributed to the wave action drifting a part of the organic matter ashore (drifts) and to the currents raised by wind carrying the organic matter towards the wind-protected north shore, the site of reed stands. At this latter area even organic matter content of 40 per cent was found (ENTZ et al., 1963).

TABLE I

Organic matter content of the upper sediment layer of Lake Balaton in different years (at a depth of 3 m, measured by "dry combustion")

	EMSZT 1911 %	ENTZ et al. 1963 %	FRANKÓ and PONYI 1973 %
Keszthely	2.13	3.20	7.95
Akali—Szemes	3.21	—	3.15
Tihany, north shore	1.25	—	2.93

Summary

Having the organic carbon content of 168 mud-samples taken at 24 transversal sections in Lake Balaton analysed with WALKLEY's and BLACK's method, the authors conclude as follows:

1. Compared to other European lakes the organic carbon content of the top 5 cm thick sediment layer of the lake (varying between 0.27 and 2.33 per cent) is very low.

2. In the two basins of the south-western region with most of the waters inflowing here, the organic carbon content is relatively higher (over 1.9 per cent).

3. Apart from the central basin the organic carbon is distributed in spots. This phenomenon is due to the typical hydrodynamic conditions of the lake and partly to the effedt of River Zala (Keszthely Bay).

4. The mean organic carbon content of the sections decreases from the south-west end of the lake (section I) to the beginning of the north-east basin (section XVIII) with a slow increase from here. Probably, owing to the currents the mean organic carbon content decreases between the basins.

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A SZERVESSZÉN HORIZONTÁLIS ELOSZLÁSA A BALATON FELSŐ ISZAPRÉTEGÉBEN

Frankó András és *Ponyi Jenő*

Összefoglalás

A Balaton 24 keresztszelvényből származó 168 iszapminta szervesszén analízisét WALKLEY és BLACK módszerével végezték el a szerzők, melynek alapján a következő megállapításokat tették:

1. A tó felső 5 cm-es iszaprétegének szerves C tartalma más európai tavakhoz viszonyítva igen alacsony és 0,27—2,33% között változik.

2. A tó DNy-i részén fekvő két medencében, ahová a vízbefolyások döntő többsége torkollik, viszonylag magasabbak a szerves C értékek (1,9% felett).

3. A középső medencétől eltekintve a szerves C foltszerűen oszlik el, melyet a tó sajátságos hidrodinamikai viszonyai (ÉK-i medence), és részben a Zala-folyó hatása (Keszthelyi-öböl) magyaráz.

4. A vizsgált keresztszelvények szerves C tartalmának átlagértékei a tó DNy-i végétől (I. szelvény) csökkenő tendenciát mutatnak az ÉK-i medence kezdetéig (XVIII. szelvény), majd újra valamelyest megemelkednek. A medencék között, feltehetően az áramlások miatt, az átlag szervesszén értékek lecsökkennek.