

INVESTIGATIONS ON PLANKTONIC CRUSTACEA IN LAKE BALATON V. HORIZONTALLY OCCURRING QUANTITATIVE CHANGES IN THE DIFFERENT AREAS OF THE LAKE IN 1965—1966

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A good many publications provided information on the qualitative changes of planktonic Crustacea in the open water and littoral zones of Lake Balaton. The case is different with papers revealing quantitative relationships, for so far only five are known. This is attributable besides laboriousness to methodological difficulties (ELSTER, 1958).

The crustaceans from series of samples taken from the open water in front of the Biological Research Institute, Tihany, have been treated besides other members of plankton in three papers (ENTZ, G. et al., 1937; SEBESTYÉN et al., 1951; SEBESTYÉN, 1953). The other two papers (SEBESTYÉN, 1960; 1964) have furnished the first quantitative data concerning farther areas of the open water of the lake.

The aim of the present study was to compare the quantitative relations of planctonic Crustacea from different areas of Lake Balaton.

Places of examinations, methods of sample taking and treatment

Samples were collected for five months in 1965 (9—10, VI; 1—2, VII; 3—4, VIII; 7—8, IX; 13—14, X;) and for seven months in 1966 (17—18, V; 14—15, VI; 26—27, VII; 23—24, VIII; 21—22, IX; 18—19, X; 15—16, XI;) at 1 and 3 points respectively of each of the five transversal sections of the lake within two days in each month (*Fig. 1*). Detailed description of the transversal sections and the exact places of sample takings are given in earlier publications (SEBESTYÉN, 1960; ZÁNKAI and PONYI, 1970).

Collections were performed by means of a water-column-scooping-filtering apparatus devised by SEBESTYÉN (SEBESTYÉN, 1960). The apparatus was lifted three times from the bottom to the surface, and the filtrate obtained according to the depths of water at the places of sampling (3 m in average) ranged between 86—125 liter. After repeated shaking of the samples aliquots containing at least 1000 specimens were taken from each sample for examination. Depending on the density of individuals, portions of $1/3$ — $1/6$ of samples were put into the counting vessel.

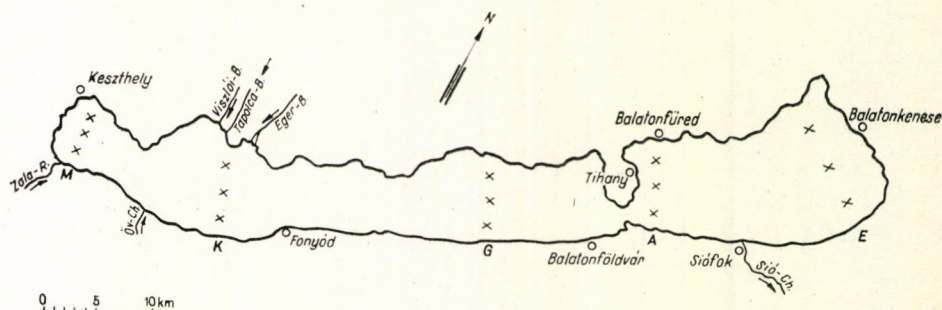


Fig. 1. Sampling places in Lake Balaton

Results

There are marked differences in the total numbers of planktonic Crustacea in the various areas of open water of the lake (Fig. 2). In both years and particularly in 1966 the smallest numbers were obtained in the central areas of the lake. The highest numbers were taken in general in the Bay of Keszthely and its vicinity (Table I).

TABLE I.

Quantitative relations between Cladocera and Copepoda in identical periods (VI—X) of 1965 and 1966 along five transversal sections of Lake Balaton (average values, i/liter)

	M		K		G		A		E	
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966
Cladocera	6.8	8.7	6.6	4.5	4.8	3.5	2.5	2.8	3.7	4.8
Copepoda	9.3	11.4	10.7	7.8	9.5	8.5	9.9	10.3	10.4	11.0
Total	16.1	20.1	17.3	12.3	14.3	12.0	12.4	13.1	14.1	15.8

Averages of both years show that Cladocera were most numerous in the Bay of Keszthely (Table I). In 1965 increase in population density occurred only once (June—July) along each transversal section, and in 1966 on two occasions excepting the two middle sections (G, A) of the lake (Table II). The second increase took place in August—September.

TABLE II.

Quantitative distribution of Cladocera along five transversal sections of Lake Balaton in 1965, 1966. (average values, in i/liter)

Month	M		K		G		A		E	
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966
V.	—	7.6	—	5.2	—	4.7	—	2.8	—	6.1
VI.	1.2	14.4	2.9	6.4	9.4	3.5	2.1	5.1	2.7	7.1
VII.	21.7	4.0	19.6	2.6	8.0	3.1	5.1	2.5	7.5	2.8
VIII.	4.0	4.6	6.8	2.8	1.7	3.8	2.5	3.3	5.6	8.2
IX.	5.4	14.4	2.5	7.0	3.6	3.2	1.8	2.5	0.4	4.9
X.	1.5	6.1	1.3	3.9	1.5	3.8	0.9	0.6	2.1	1.2
XI.	—	1.1	—	1.5	—	1.7	—	1.7	—	2.3

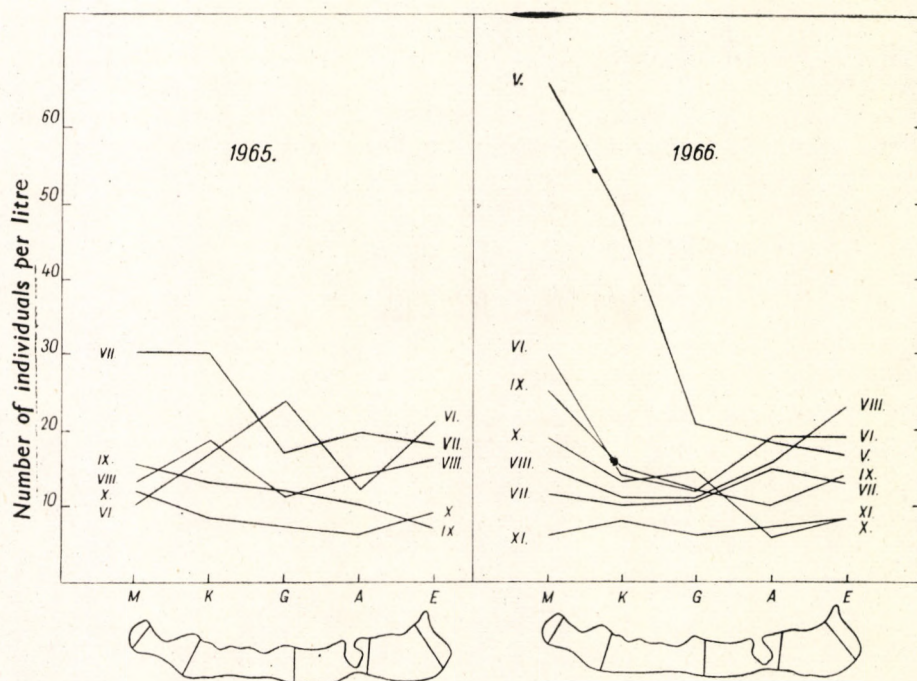


Fig. 2. Quantitative distribution of total planktonic Crustacea in different areas of the lake at nearly identical time points in the various months of years 1965–66

The average data of both years show the distribution in numbers of Copepoda was relatively uniform in the different areas of Lake Balaton (Table I). Maximum numbers were observed in spring (Table III). According to data obtained in winter their number even under the ice cover averaged

TABLE III.

Quantitative distribution of Copepoda in five transversal sections of Lake Balaton in 1965 and 1966 (average values, i/litre)

Month	M		K		G		A		E	
	1965	1966	1965	1966	1965	1966	1965	1966	1965	1966
V.	—	59.2	—	42.9	—	16.1	—	15.6	—	11.2
VI.	9.2	15.6	14.3	7.3	14.2	8.1	9.8	14.3	18.2	12.2
VII.	8.0	7.6	10.1	6.3	9.5	7.5	14.4	12.3	10.6	10.5
VIII.	9.2	10.2	12.0	8.3	9.4	7.6	11.4	12.2	10.4	16.2
IX.	10.1	10.1	10.2	7.7	8.7	8.6	8.3	7.4	6.2	9.1
X.	10.0	13.0	7.1	9.5	5.8	10.8	5.5	5.2	6.4	7.1
XI.	—	5.0	—	6.6	—	4.6	—	5.1	—	5.5

10 i/litre. Marked increase in the number takes place at the end of March, and the beginning of April. Values obtained in spring along sections M and K are many fold over those of the other sections.

Among Copepoda species, *Eudiaptomus gracilis* yielded the highest numbers in yearly average. As regards the development of population the Bay of Keszthely and its vicinity (transversal sections M and K) differed from the other areas of the lake in both years (Figs 3, 4). Marked quantitative differences in the temporal changes of the horizontal distribution were found between the two years.

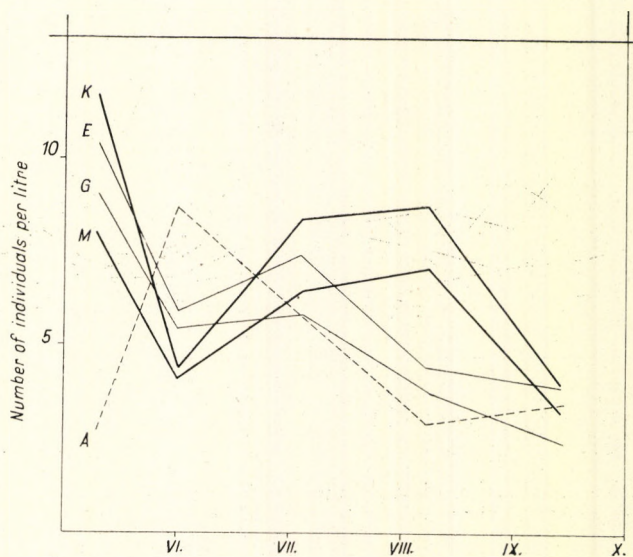


Fig. 3. Quantitative changes of *Eudiaptomus gracilis* in months VI—X, 1965

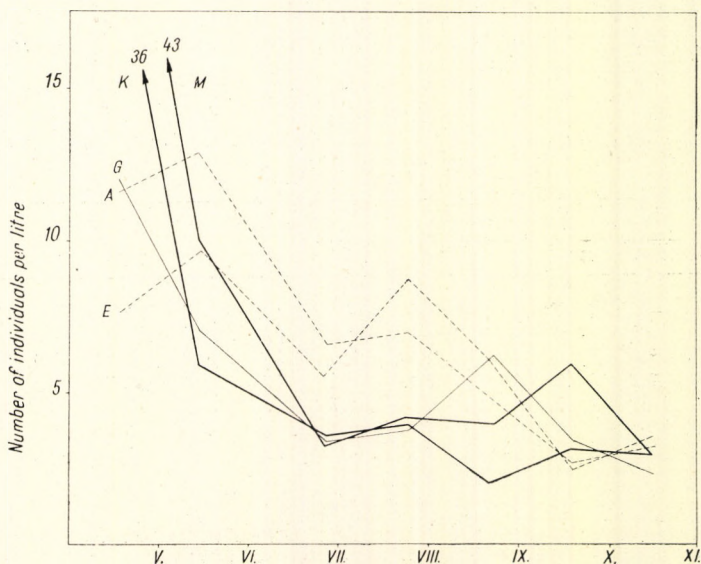


Fig. 4. Quantitative changes of *Eudiaptomus gracilis* in months V—XI, 1966

Discussion

Publications on the horizontal distribution of the number of planktonic Crustacea (SEBESTYÉN, 1960; 1964) offer only general informations about the differences in the number of Crustacea between the different parts of the large area of the shallow Lake Balaton. In earlier investigations "shifts of some weeks, days and hours in the time points of sample takings" occurred owing to lack of a high-speed motor boat and other technical facilities, (SEBESTYÉN, 1960; p. 119) rendering comparison fairly uncertain. In the course of examinations reported in this paper sample takings at points of the five transversal sections representing the lake as a whole were carried out within two days. This implies that the present results are not comparable to earlier data on the horizontal distribution of crustaceans (SEBESTYÉN, 1960).

A most valuable possibility for comparison is offered, however, between present data and those from collections made in identical periods in the area in front of the Biological Research Institute (SEBESTYÉN et al., 1951; SEBESTYÉN, 1953; SEBESTYÉN, 1960) (*Table IV*). It was observed that the number

TABLE IV.

Quantitative changes of total planktonic Crustacea in the waters in front of the Biological Research Institute (transversal section "A")

Time of examination		i/liter average value
year	month	
1936	(V—XI)	25.6
1937	(V—XI)	35.1
1938	(V—XI)	43.5
1947	(V—XI)	46.4
1949	(V—XI)	50.9
1951	(V—XI)	83.2
1955	(VII—VIII)	49.7
1956	(VI)	19.4
1958	(VI)	17.0
1965	(VI—X)	12.4
1966	(V—XI)	12.9

of crustaceans gradually increased from 1936 until 1951, and from this time on their number decreased.

The changes are even more conspicuous when those years are compared from which the monthly changes in numbers from spring till autumn are also available (*Fig. 5*). Whereas in the years of 1930 and 1940 changes values occurred exceeding the latter — those there occurred even values beyond the latter — those in 1965–66 varied between 10–20 i/liter. Algological data from the same water-area (*Table V*) indicate that there was an increase in the number of Cyanophyceae in contradistinction to the decrease of that of planktonic Crustacea.

In transversal section "A" a similar phenomenon was observed regarding Rotatoria, an other large group of zooplankton (*Table VI*. column A). From 1938 a gradual increase in the number of rotifers was registered. From 1950

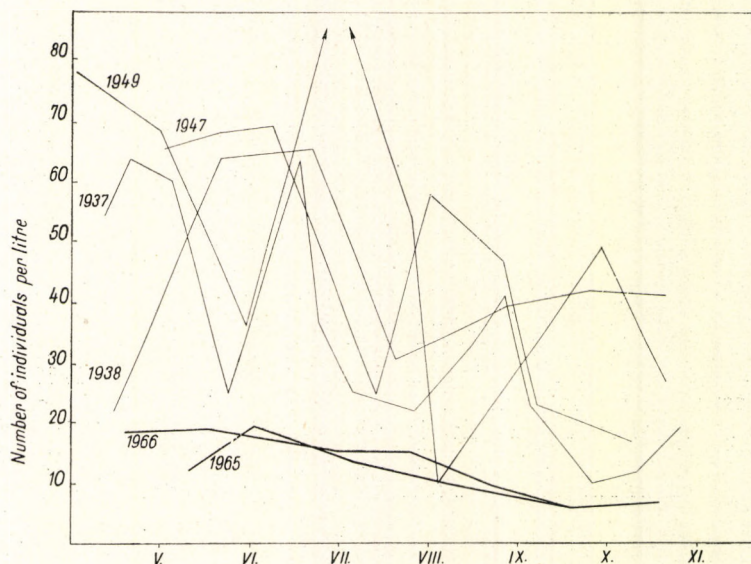


Fig. 5. Quantitative changes of total planktonic Crustacea in the water-area in front of the Biological Research Institute of the Hungarian Academy of Sciences (transversal section "A")

TABLE V.

Quantitative changes of Cyanophyta species in the water-area in front of the Biological Research Institute (transversal section "A") (on the basis of data from TAMÁS 1954, 1967, 1969)

Time of examinations			i/liter average value
year	day	month	
1945	18	VII	5.3
1959	29	VII	5.8
1951	13	VII	18.0
1962	20	VII	16.1
1965	1	VII	53.3

there was no increase excepting some fluctuations, although a further increase was anticipated on the basis of growth rates observed in 1938–1951.

We cannot conclude from these phenomena — owing to lack of sufficient data — on the open water of Lake Balaton as a whole. To do this, further studies are necessary. Nevertheless, the observations called our attention to the fact that in this area (transversal section "A") the zooplankton is rather poorish and shows a decreasing tendency.

The following reasons — even if they are hypothetical may serve explaining the above phenomenon:

- rapid increase in the number of blue-green algae
- increased stocking of fingerlings (consumption of zooplankton)
- various poisonous materials (f.i. detergents, lindane) transported by influent waters.

TABLE VI.

Average changes in total numbers (i/liter) of Rotatoria in Lake Balaton (After SEBESTYÉN et al., 1951; Sebestyén, 1953; ZÁNKAI and PONYI, 1970; 1972)

Date		M	K	G	A	E	Average
year	month						
1938	V—XI	—	—	—	43	—	—
1947	V—XI	—	—	—	111	—	—
1951	V—XI	—	—	—	168	—	—
1965	VI—XI	100	86	110	92	104	98
1966	V—XI	180	170	195	154	152	170
1967	V—X	64	136	170	125	158	130

Evaluation of average quantitative data on planktonic Crustacea show that they occur in greater numbers in the Bay of Keszthely and its vicinity (M+K) than in any other areas of the lake (*Table VII*). This applies particularly to Cladocera for their number per-liter in the M+K area were twice that obtained in other places.

TABLE VII.

Average quantitative distribution of more important planktonic groups in two areas of different water quality of Lake Balaton

	M+K	G+A+E	Time of observation	
Bacteria (10 ⁵ cells/ml)	4.7	3.5	V—XI,	1966—70
Alga (10 ⁵ i/liter)	4.9	1.4	V—XI,	1965—67
Rotatoria (i/liter)	122	140	V—X,	1965—67
Crustacea (i/liter)	19	13	V—XI,	1965—66
Total-P (mg · m ⁻³)	86.6	51.5	IV—XII, I—II,	1969 1970

Note: Figures for bacteria, algae and total-P were computed from data published by J. OLÁH (1971), GIZELLA TAMÁS (1967, 1969) and VITUKI, 1972 respectively.

There seems to be a relation between the number of filtering Crustacea and concentration of foodstuffs (bacteria, algae). It is, however, remarkable that to an about three fold increase in the number of algae — for which assumably total-P is responsible (VITUKI, 1972) — planktonic Crustacea responded “only” by one and a half times as great increase. River Zala seems to account for the considerable amount of nutrients (54 %) entering Lake Balaton (VITUKI, 1972) and it is therefore easily understood that some members of the food chain built on bacteria, algae and organic detritus reproduce best in this area.

Summary

1. There are quantitative differences in the distribution of the total planktonic Crustacea in the open water of Lake Balaton. Greatest numbers were obtained in the area containing highest amounts of organic materials (the Bay of Keszthely and its vicinity where numbers were estimated at 16–20 i/liter in average).

2. The number of Cladocera in areas containing higher amounts of particulate foods (transversal sections M + K) was twice those (6 i/liter) of other areas. Increase in their population occurred once in 1965, and in 1966 — excepting the two middle transversal sections (G + A) of the lake — on two occasions.

3. Average distribution in the number of Copepoda was the same in the different areas of the lake in the identical periods of the two years (10 i/liter in general). Maximum numbers were observed in spring (May). Spring maxima in the Bay of Keszthely and its vicinity (M + K) were several times those of the other transversal sections.

4. There was difference in the population dynamism of *Eudiaptomus gracilis* (G. O. SARS) between the Bay of Keszthely, its vicinity (M + K) and other areas (G + A + E) of the lake.

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CRUSTACEA-PLANKTON VIZSGÁLATOK A BALATONON V.
HORIZONTÁLISAN FELLÉPŐ MENNYISÉGI ELTÉRÉSEK A TÓ
KÜLÖNBÖZŐ TERÜLETEIN, AZ 1965—1966. ÉVBEN

Ponyi Jenő és P.-Záncsi Nóra

Összefoglalás

1. A teljes Crustacea-plankton a Balaton nagy kiterjedésű nyíltvizében mennyiségi szempontból különböző. A legmagasabb egyedszámot a tápanyagokban leggazdagabb tóterületen (Keszthelyi-öböl és környéke) találtuk, ahol az egyedszám átlagosan 16—20 e/liter volt.

2. A Cladocera egyedszáma, a formált táplálékban gazdagabb területeken ($M + K$ szelvény) kétszer akkora (6 e/liter), mint egyebütt. Népségük 1965-ben egyszer, 1966-ban — a tó két középső szelvényétől ($G + A$) eltekintve — kétszer emelkedett.

3. A Copepodák átlagos egyedszám eloszlása a két év azonos időszakában a tó különböző területein azonos volt (általában 10 e/liter). Egyedszám maximumok tavasszal (május) figyelhetők meg. A Keszthelyi-öböl és környéki ($M + K$) tavaszi maximum értékei többszörösen felülmúlták a többi szelvényét.

4. Az *Eudiaptomus gracilis* (G. O. Sars) népség dinamizmusa eltérő a Keszthelyi-öböl és környéke ($M + K$), valamint a tó egyéb területei ($G + A + E$) között.