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THE HORIZONTAL DISTRIBUTION OF ROTIFERA PLANKTON IN LAKE BALATON

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The systematical investigation of the horizontal distribution of zooplankton in the lake began in 1955 (SEBESTYÉN, 1960; 1964; PONYI, 1968). However, only the distribution of Crustacea plankton was concerned by these works.

The necessity of investigating the horizontal distribution of the plankton of the lake arose again in 1965 in connection with the extensive destruction of the fish population. The investigations started that time had first revealed that as far as the Rotifera are concerned, the extended open water is not uniform and even the population dynamics is different at certain areas of the water (ZÁNKAI and KERTÉSZ, 1967; ZÁNKAI and PONYI, 1970).

The aim of our present work was to gather informations about the structural changes of the Rotifera populations on the basis of qualitative samples collected practically at the same time (in 2 days) from 5 segments representing the open water surface of the whole lake in 1966—67. On the basis of the investigations we wanted to answer the question whether the three-fold distribution of the open water shown by the arrangement of Rotifera (See ZÁNKAI and KERTÉSZ, 1967) is a persisting phenomenon or it had only been characteristic for 1965.

Material and methods

Sample takings were carried out monthly from May to November in 1966 and from April to October in 1967. The places of sample taking as well as the methods and the section of the day when it was carried out were the same described earlier (ZÁNKAI and KERTÉSZ, 1967). The exact time and circumstances of collecting samples are summarized in *Tables 1* and *2*. The animals of the 1967 samples were killed by hot (about 80°C) water avoiding thus the shrinkage of numerous species.

The samples have been evaluated by a relative quantitative method (SEBESTYÉN, 1953). The dominant species have been determined on the basis of the relation of species to each other and to the total number of Rotifera individuals counted in the samples. Differences larger than 10% were consid-

TABLE 1

Circumstances of sample takings in 1966

Collecting			Temperature of water °C	Transparency cm	Meteorological notes
place	date	time (hour)			
M_0	1966. V. 17	8.30	19	68	Balmy breeze, cloudy weather
K_0	1966. V. 17	10.30	20	100	Balmy breeze, cloudy weather
G_0	1966. V. 17	17	20	81	Balmy breeze, cloudy weather
A_0	1966. V. 18	11	21	68	Balmy breeze, cloudy weather
E_0	1966. V. 18	16	20	150	Balmy breeze, cloudy weather
M_0	1966. VI. 14	9	23	62	Gloomy weather, smooth water
K_0	1966. VI. 14	12	23.5	76	Gloomy weather, smooth water
G_0	1966. VI. 14	17.30	23	75	Gloomy slight water undulation
A_0	1966. VI. 15	11	22	56	Gloomy slight water undulation
E_0	1966. VI. 15	17.30	22	92	Gloomy weather, choppy water
M_0	1966. VII. 25	8.30	19	55	Gloomy weather, dropping waves
K_0	1966. VII. 25	11	20	50	Gloomy weather, drizzling rain
G_0	1966. VII. 25	16.30	20	62	Gloomy weather, almost smooth water
A_0	1966. VII. 27	10.45	21	44	Sunshine, dead calm
E_0	1966. VII. 27	16	22	60	Sunshine, dead calm
M_0	1966. VIII. 23	7.30	22	50	Rain, still water, algal bloom
K_0	1966. VIII. 23	11	22.2	58	Gloomy weather, algal bloom
G_0	1966. VIII. 23	16.15	23	56	Gloomy weather, algal bloom
A_0	1966. VIII. 24	10.40	22	50	
E_0	1966. VIII. 24	15.30	22	50	
M_0	1966. IX. 21	9.45	17.1	36	Gloomy weather, smooth water, algal bloom
K_0	1966. IX. 21	12	16.8	51	Gloomy weather, small waves
G_0	1966. IX. 21	17	19	84	Cloudless sky, gentle wind
A_0	1966. IX. 22	10.30	18	75	Cloudless sky, gentle wind
E_0	1966. IX. 22	15.45	18	95	Cloudless sky, gentle wind
M_0	1966. X. 18	7.45	16	48	Drizzling rain, choppy water
K_0	1966. X. 18	10	16	26	Drizzling rain, choppy water
G_0	1966. X. 18	16.15	16	87	Weak waves, clearing up
A_0	1966. X. 19	10.10	17	88	Still water, sunshine
E_0	1966. X. 19	15	17	109	Still water, sunshine
M_0	1966. XI. 15	7.10	4	45	Gloomy weather, weak wind
K_0	1966. XI. 15	10.30	6	48	Gloomy weather, rising wind
G_0	1966. XI. 15	16	6	66	Gloomy weather, rising wind
A_0	1966. XI. 16	10.30	6	77	Gloomy weather, rising waves
E_0	1966. XI. 16	14.45	6	105	Drizzling rain, calm

ered valid during the evaluation of the data whereas lower values were taken for errors of the method on the basis of our earlier experiences (ZÁNKAI and KERTÉSZ, 1967).

The values obtained from the evening and day-time samples of the sections "E", "A" and "M" have been averaged when descripting the percentual distribution of the species. The values below 1 % have not been recorded in the tables.

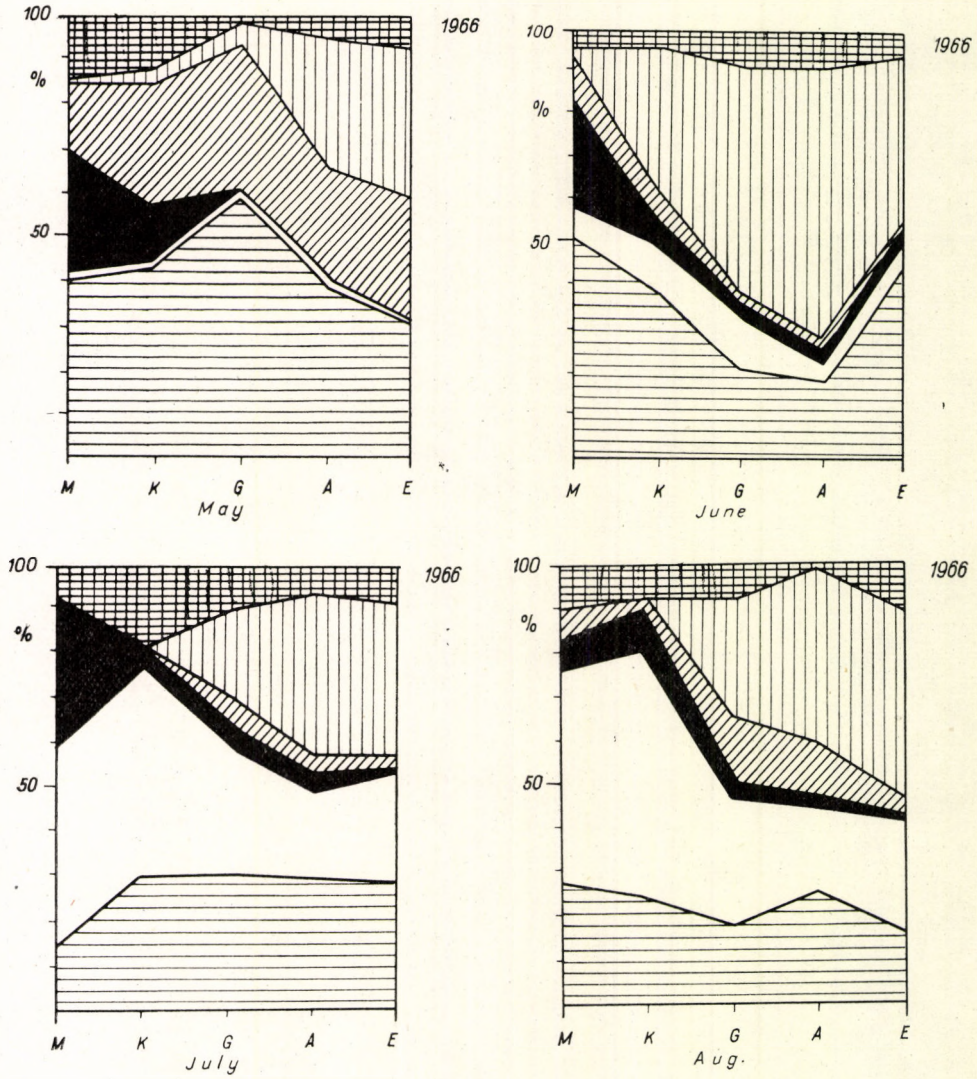
TABLE 2

Circumstances of sample takings in 1967

Collecting			Temperature of water °C	Transparency cm	Meteorological notes
place	date	time (hour)			
M_0	IV. 11	8	12	59	Gloomy weather, calm
K_0	IV. 11	10	12	54	Gloomy weather, calm
G_0	IV. 11	17.30	12.5	68	Gloomy weather, calm
A_0	IV. 12	11.30	12	74	Gloomy weather, weak wind
E_0	IV. 12	16.30	12	94	Gloomy weather, rising wind
M_0	V. 16	8	19	46	Gloomy weather, slight water undulation
K_0	V. 16	10.30	19	53	Gloomy weather rising waves
G_0	V. 16.	17	19	47	Rain, combing waves
A_0	V. 17	11	19	55	Rain, small wind
E_0	V. 18	11	19	46	Sunshine, slight waves
M_0	VI. 20	8	20	100	Gloomy weather, balmy breeze
K_0	VI. 20	10.30	19.5	52	Storm clouds, slight waves
G_0	VI. 20	16.30	20	100	Rain, slight waves
A_0	VI. 26	11	24	150	Sunshine, smooth water
E_0	VI. 26	16	25	—	Sunshine, smooth water
M_0	VII. 18	7.30	23	58	Clear weather, slight waves
K_0	VII. 18	9.30	22	70	Clear weather, rising waves
G_0	VII .19	9.30	23	51	Clear weather, slight waves
A_0	VII. 20	10.30	24	118	Clear weather, dead calm
E_0	VII. 19	16.30	23	59	Clear weather, dead calm
M_0	VIII. 15	8	20	70	Foggy weather, calm
K_0	VIII. 15	10	20	60	Gloomy wether, balmy breeze
G_0	VIII. 15	16	21	52	Gloomy wether, balmy breeze
A_0	VIII. 16	11	21	72	Sunshine, balmy breeze
E_0	VIII. 16	16	21.5	72	Sunshine, balmy breeze
M_0	IX. 19	8	16.5	86	Fog, rippling water
K_0	IX. 19	10	17	77	Gloomy, slight wind
G_0	IX. 19	16	18	78	Gloomy, slight wind
A_0	IX. 20	11	18	98	Gloomy, weak wind
E_0	IX. 20	16	18	155	Clouding, weak wind
M_0	X. 17	7.30	16	100	Sunshine, weak wind
K_0	X. 17	10	16.5	46	Sunshine, choppy water
G_0	X. 17	15.30	18	55	Sunshine, moderate wind
A_0	X. 23	12.30	12	87	Gloomy, weak wind
E_0	X. 23	15.30	14	66	Gloomy, calm

Results

Altogether 102 net samples have been investigated, 50 from 1966, and 52 from 1967. The number of individuals found in 1966 was 35.423 and in 1967 34.245 giving in all 69.668 Rotifera. The Rotifera plankton of open water of the lake was composed by 40 species, varieties and forms.

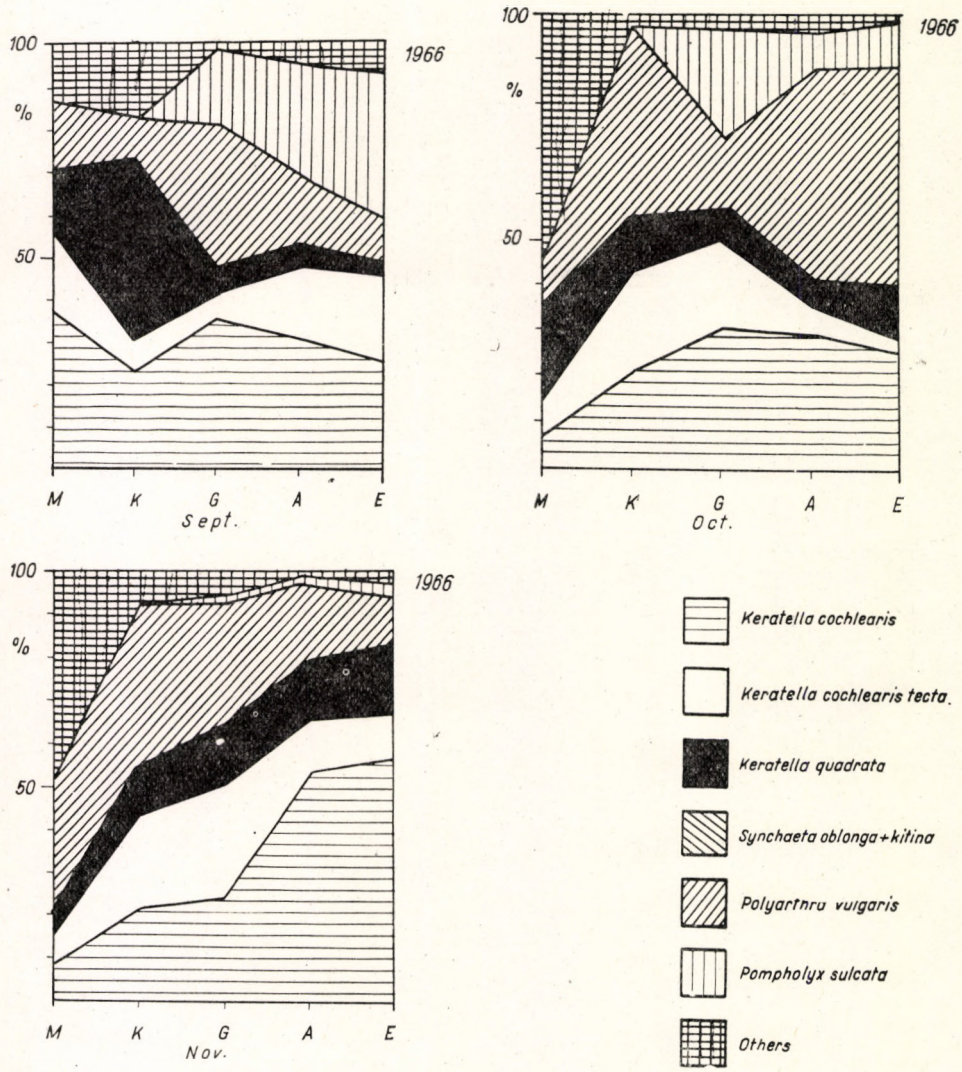


Figs 1—4. The percentage distribution of the dominant species in different sections of the lake (1966). Explanation see p. 289.

1. *Species new to the fauna of Hungary and Lake Balaton*

Encentrum viszniewski WULFERT *(Photo 1)*

One strongly shrunked individual has been found in the sample collected at the Keszthely-Bay in the evening of 8th June, 1966. Only the measurement of its toe (12 μ) could be used from the body sizes, however, using a sodium hypochlorite treatment, its oral organs became visible on the basis of which the identification of the species could be made.

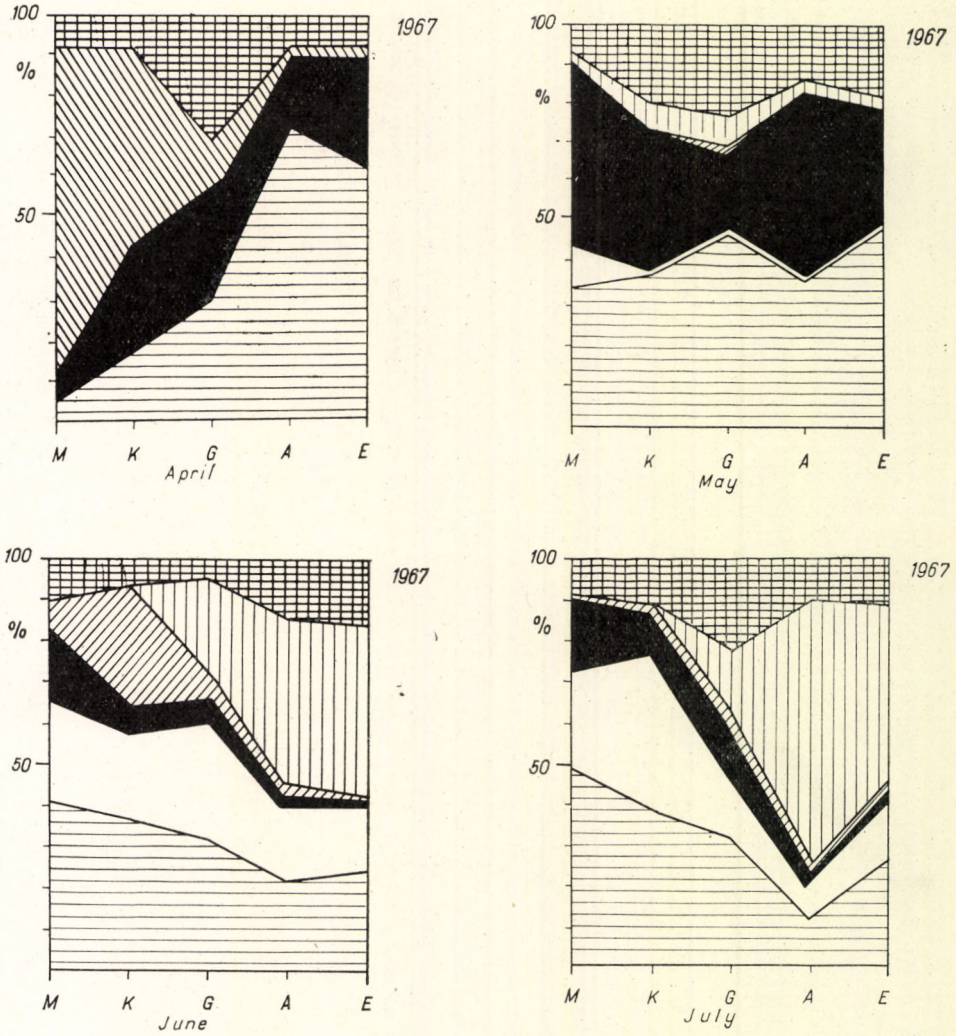


Figs 5—7. The percentage distribution of the dominant species in different sections of the lake (1966)

This animal has first been found by WISZNIEWSKI in the psammon of River Czarna near Warsaw in 1935, and later, in 1939, by WULFERT in the half-dry mud of the river near Dorndorf of Germany. Lake Balaton is the third known locality in the world.

Trichocerca rousseleti (VOIGT)

It has often been observed in the plankton since 1966. The body length is 65—70 μ in shrunken state. The jagged chitin structures on the anterior part

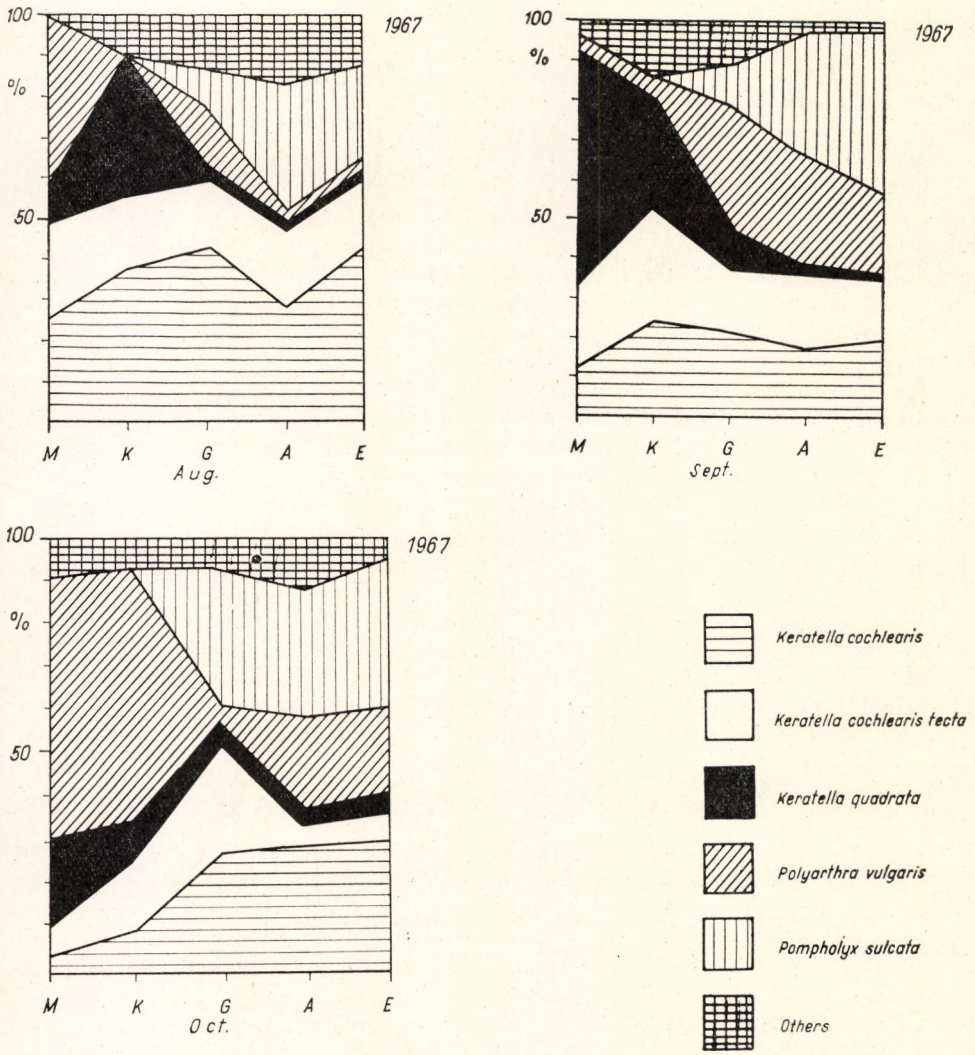


Figs 8—11. The percentage distribution of the dominant species in different sections of the lake (1967). Explanation see p. 291.

of the head as well as the measurements of the toe are characteristic making it easily recognizable. It has not been found in Hungary, so far.

Asplanchna girodi de GUERNE *(Photo 2)*

It was collected manly in the north-eastern basin of the lake between May and October in 1966—67. The outer morphology of the body hardly differs from that of *A. brightwelli*, however, its masticatory organ displays differences of specific level. Lake Balaton is the first locality in our country.



Figs 12—14. The percentage distribution of the dominant species in different sections of the lake (1967)

Brachionus diversicornis (DADAY)

Its body length is 380 μ together with the posterior spines and 160 μ without them. These spines do not diverge and are of unequal length.

Its mass occurrence has been reported mainly in fish-ponds in our country (BIRÓ, 1966/1967; DONÁSZY, 1966). Its further localities: River Tisza (MEGYERI, 1955), lakes of Belly and Kopács along River Drava (WOYNÁROWICH, 1944), lakes of Városliget and Tata (DADAY, 1891) mountain Bükk (ÁBRAHÁM et al. 1956), River Danube (KERTÉSZ, 1962). It is new for Lake Balaton.

2. *Qualitative composition and horizontal distribution of Rotifera plankton in 1966*

The number of Rotifera species is 31, three of them *(Encentrum wiszniewski, Bdelloidea* species, *Lecane ludwigi)* are characteristic inhabitants of littoral waters, psammon and mud surface, while the other two of them *(Trichocerca rattus* and *T. tigris)* are both eu- and tychoplanktonic elements *(Table 3).*

On the basis of their occurrence the species can be classified into four groups:

a) those found in all 5 sections; *b)* those found only in the north-eastern basin or representing a higher percentage there; *c)* those found only in the south-western basin or representing a higher percentage there; *d)* those occurring only in the Keszthely-Bay.

a) Dominant species characteristic for the total open water of Lake Balaton, found in all periods and at all places of collecting: *Keratella cochlearis, K. c. tecta, K. quadrata, Polyarthra vulgaris.* A nearly uniform distribution was shown in all sections by *Kellicottia longispina, Keratella cochlearis macracantha* f. *micracantha, Trichocerca rousseleti* and *T. pusilla.* One can regard the distribution of *Notholca squamula* uniform, however it was absent in the "G" section. *Pompholyx sulcata* and *Brachionus sessilis* occurred in every sections, however, their percentage distribution decreased in the direction from the "E" section of the north-eastern basin towards the Keszthely-Bay.

b) Species found only in the north-eastern basin: *Asplanchna girodi* and a *Collotheca* species (probably *pellagica). Collotheca balatonica* should also be classified here, displaying a nearly uniform distribution in the "E", "A" and "G" sections and an insignificant occurrence in the Szigliget-Bay ("K").

c) Keratella cochlearis macracantha, Asplanchna priodonta, Synchaeta oblonga and *Trichocerca rattus* are restricted to the south-western basin. *Polyarthra major* is more frequent in the "M" section and also occurs in the "K" section. To this group one can classify the *Filina species, Synchaeta kitina, Conochilus unicornis,* however, some individuals of them were observed even in the "A" section.

d) Brachionus angularis, Br. calyciflorus, Keratella quadrata dispersa, Encentrum wiszniewski and *Lecane ludwigi* have been collected only in the Keszthely-Bay. One of the last two species is mud-living, the other prefers the marshy, boggy biotopes being thus known also from Lake Kis-Balaton (VARGA, 1944—45). *Brachionus calyciflorus* has been mentioned as inhabitant of small waters and puddles, and together with the other members of the genus, they are regarded as species indicating the level of eutrophication (PEJLER, 1957).

Comparing the percentage distributions in two ("E" and "A") sections of the north-eastern basin it is clear that they are either completely identical or very similar to each other *(Figs 1—7).* The proportions of the 5 dominant species showed a difference less than 10% in the two sections during the whole period of investigation except in June when 2 species *(Keratella cochlearis* and *Pompholyx sulcata)* differed by 27 and 25%, respectively.

The percentage distribution of *Keratella quadrata* in the "G" section was identical with that of the other two segments ("E" and "A") in every month (difference was between 0—3%). Similar distributions were observed in spring (May and June) and mainly in summer (July and August) as in the "E" and

"A" sections. Other species, *Keratella cochlearis* and *Pompholyx sulcata* showed more than 20% difference in May and June as compared to the proportions found in the "E" and "A" sections, whereas in July and August only the latter species differed significantly. Between September and November completely different relations were found as in the north-eastern basin. Taking into consideration the occurrence of *Pompholyx sulcata* as a mass species as well as the spring and summer percentage distribution of *Keratella quadrata* and other species, the "G" section is nearer to the "E" and "A" sections than the "K" and "M" ones.

The "K" section between Szigliget and Balatonmária represents a "transitional area" as compared with the "E-A-G" and "M" sections, considering the changes observed in the rotifer fauna. This manifested itself in the fact that *Pompholyx sulcata* being one of the dominant species in the "E-A-G" sections, apart from several cases, did not occur at all in the "K" section. On the other hand, the percentual occurrence of other dominant species (e.g. *Keratella quadrata* and *K. cochlearis tecta)* was identical with those found in "E-A-G" sections during several months *(K. quadrata:* June, July, October, November; *K. c. tecta:* May and June). The relation of the dominant Rotifera to each other, found in the "K" section was influenced in other periods by the conditions observed in the Keszthely-Bay (e.g. the percentual distribution of *K. quadrata* in May, or that of *K. c. tecta* in July and August).

The Rotifera populations of the Keszthely-Bay were not only qualitatively different from that of other sections but also the percentual distribution of the dominant species was different. Occasionally even extreme situations were encountered, i.e. in July only 3 of the 5 dominant species occured in the population. The great percentage of the species classified in the group "all the rest" was represented by Synchaeta in October and November.

3. *Qualitative composition and horizontal distribution of Rotifera plankton in 1967*

32 species, varieties and forms have been found in the 5 sections of Lake Balaton; 25 are euplanktonic and 4 tychoplanktonic species. Three taxa of *Trichocerca* genus have been found *(Trichocerca rattus, T. capucinus* and an unidentified *Trichocerca* species) which according to literary data are frequent both in the littoral zone and open water. The Rotifera plankton was characterized — like 1966 — by the mass occurrence of *Keratella cochlearis, K. c. tecta, K. quadrata,* and *Polyarthra vulgaris.*

Evaluation of the horizontal distribution of the species and the changes of the populations is carried out on the basis of the same grouping accepted earlier. However, different changes were observed in the Rotifera populations, i.e. the mass propagation of *Synchaeta* species, and although these species belonged to the group of those found in all 5 sections, we deemed it advisable to make comments on them in smaller sub-groups.

a) Species occurring nearly uniformly in all 5 sections are the following: *Kellicottia longispina* and *Notholca squamula. Conochilus unicornis* and *Keratella cochlearis macracantha* f. *micracantha* should also be considered of uniform distribution in spite of their absence in the "K" section.

Two *Synchaeta* species were found in all sections. A significant percentage of them was found in the Rotifera plankton of Keszthely-Bay ("M") in April.

TABLE 3

The qualitative and relative quantitative distribution of the Rotifera plankton in 1966

Species	Time of collecting	Places of sample takings															
		M_0				K_0		G_0		A_0				E_0			
		in the evening		in the morning						in the afternoon		in the evening		in the afternoon		in the evening	
		pc.	%	pc.	%	pc.	%	pc.	%	pc.	%	pc.	%	pc.	%	pc.	%
Asplanchna girodi GOSSE	V.									4	0.62	1	0.15				
	VI.									1	0.15						
	IX.									1	0.15	2	0.30	1	0.14	1	0.14
	X.													7	1.08		
Asplanchna priodonta GOSSE	V.	4	0.58	4	0.61	2	0.25	4	0.53								
Bdelloidea sp.	VI.															1	0.15
Brachionus angularis GOSSE	V.	3	0.44	2	0.30												
	VI.	1	0.14														
	VIII.	2	0.28														
	XI.	1	0.14														
Brachionus angularis bidens (PLATE)	X.					1	0.15										
Brachionus calyciflorus PALLAS	V.			1	0.15												
Brachionus sessilis VARGA	VI.					1	0.14										
	VII.			1	0.16	11	1.58	10	1.91	11	1.40	9	1.28	31	4.19	61	9.08
	VIII.					1	0.16	13	1.92	12	1.62	7	1.04	2	0.30	14	2.11
	IX.							1	0.14	1	0.14	3	0.45	25	3.51	8	1.16
	X.	1	0.14											1	0.15		
Collotheca balatonica VARGA	V.									2	0.30						
	VI.					1	0.14	20	3.00	19	2.78	27	4.13	4	0.60	24	3.63
	VII.							13	1.83	28	3.58	17	2.43	3	0.41	7	1.04
	VIII.							3	0.44	5	0.68	4	0.59	1	0.14	2	0.30
	IX.					1	0.15	4	0.57					1	0.14	3	0.44
Collotheca sp.	V.													1	0.15		
	VI.													1	0.15		
	IX.											11	1.65	4	0.56	1	0.14

Conochilus unicornis ROUSSELET	V.	3	0.44	7	1.06	21	2.66			1	0.15						
Encentrum wiszniewski WULFERT	VI.	1	0.14														
Filinia longiseta (EHRBG.)	V.	2	0.29	1	0.14					1	0.15						
	IX.			1	0.15												
	XI.							1	0.15								
Filinia terminalis (PLATE)	V.					1	0.14										
Kellicottia longispina KELLICOTT	V.	22	3.21	37	5.63	42	5.32	7	0.92	29	4.48			8	1.19		
	VI.			23	3.55	21	3.02	31	4.65	26	3.81	28	4.29	21	3.14	9	1.36
	VII.			4	0.62	11	1.58	16	2.25	20	2.55	10	1.43	9	1.22	1	0.15
	VIII.	1	0.14	2	0.30	6	0.95	20	2.96	3	0.40	6	0.89	9	1.33	6	0.91
	IX.			28	4.15	20	2.95	11	1.58	32	4.76	16	2.40	31	4.35	11	1.60
	X.			7	1.01	4	0.58	11	1.61	2	0.29	1	0.14	11	1.70	3	0.44
	XI.	2	0.29	5	0.79	8	1.24	17	2.61	5	0.76			10	1.47		
Keratella cochlearis (GOSSE)	See its percentage distribution in the figures																
Keratella cochlearis macracantha LAUTERBORN	V.	23	3.35	37	5.63	14	1.77										
	VI.	1	0.14														
	XI.	2	0.29	1	0.15			2	0.31								
Keratella cochlearis macracantha f. *micracantha* LAUTERBORN	VI.	2	0.29	3	0.46					3	0.44						
	VII.	3	0.44			3	0.43	3	0.43					1	0.14	1	0.15
	VIII.	6	0.86	1	0.16	1	0.16			1	0.14	1	0.14			2	0.30
	IX.			3	0.44					2	0.30	2	0.30			2	0.29
	X.			1	0.14	5	0.73	1	0.14	1	0.14			1	0.15		
	XI.			4	0.62	1	0.15	5	0.77	5	0.76			5	0.73		
Keratella cochlearis tecta (GOSSE)	See its percentage distribution in the figures																
Keratella quadrata (O. F. MÜLL.)	See its percentage distribution in the figures																
Keratella quadrata dispersa CARLIN	V.			2	0.30												
Lecane ludwigii ECKSTEIN	X.	1	0.14														
Notholca squamula (O. F. MÜLL.)	XI.	2	0.29	1	0.15	2	0.30			1	0.15			1	0.15		

Table 3 (contined)

Species	Time of collecting	Places of sample takings															
		M_0				K_0		G_0		A_0				E_0			
		in the evening		in the morning						in the afternoon		in the evening		in the afternoon		in the evening	
		pc.	%	pc.	%	pc.	%	pc.	%	pc.	%	pc.	%	pc.	%	pc.	%
Polyarthra major BURCKHARDT	V.	9	1.31	10	1.52	3	0.38										
	VI.	2	0.29														
	VIII.	6	0.28			1	0.16										
	IX.			1	0.15												
	X.	24	3.54	4	0.58												
	XI.	4	0.60	1	0.15	1	0.15										
Polyarthra vulgaris CARLIN	See its percentage distribution in the figures																
Pompholyx sulcata HUDSON	See its percentage distribution in the figures																
Synchaeta kitina ROUSSELET	V.	4	0.58														
	VI.	1	0.14	8	1.24												
	VII.			83	12.88	81	11.70	5	0.70								
	VIII.	36	5.16	35	5.31	31	4.89										
	IX.			80	11.85	27	3.99										
	X.	76	11.20	22	3.19	3	0.43			39	5.63						
	XI.	140	20.95	83	12.97	16	2.48	5	0.77								
Synchaeta oblonga EHRBG.	V.			3	0.46												
	VII.	1	0.14														
	VIII.	38	5.44	3	0.45												
	IX.			2	0.29												
	X.	420	61.94	211	30.62			7	1.02								
	XI.	278	41.61	107	16.71	25	3.87	9	1.38								
Trichocerca pusilla (JENNINGS)	VII.			2	0.31	12	1.73	5	0.70	1	0.13						
	VIII.	4	0.57	1	0.16	2	0.31	17	2.51	1	0.14	3	0.45	22	3.24	8	1.21
	IX.					6	0.89	1	0.14								
Trichocerca rousseleti (VOIGT)	VII.			4	0.62			4	0.56	14	1.79	1	0.15	3	0.41		
	VIII.					4	0.64	1	0.14					2	0.30	1	0.15
	IX.							1	0.14								
Trichocerca rattus (O. F. MÜLL.)	VII.					9	1.30										
	VIII.	2	0.28			2	0.31	2	0.29								
	IX.					5	0.74										
Trichocerca tigris (O. F. MÜLL.)	X.							1	0.14								

The relative amount of these species, however, decreased in direction from "M" toward the north-eastern basin.

Similarly, *Pompholyx sulcata* was found in all sections. Its distribution is opposite as compared to that of the species mentioned above, namely in south-western direction from the "G" section it represents only an insignificant percentage in the Rotifera plankton.

An unusual distribution was shown by *Brachionus diversicornis* found in "M" and "K" and in addition in the "E" section, too. The occurrence of *Cephalodella catellina* was similar to that.

b) *Asplanchna girodi* and *Filinia longiseta* were found only in the north-eastern basin. Into this group we may include a *Collotheca* species *(pellagica?)*, too, found in the "A" section and *Collotheca balatonica* although the latter was also present in the "G" section. Nevertheless, its percentual distribution was 18% in the "E-A" sections whereas in the line of Ságpuszta—Balatonszemes ("G" section) it yielded only 4% of the Rotifera population.

The distribution of several species surpassed the north-eastern basin, they reached the "G" and sometimes even the "K" sections. Consequently, the Rotifera plankton of the "G" section was often more similar to that of north-eastern basin than of two sections of the south-western one. *Filina terminalis* displayed a nearly uniform distribution in the "E-A-G" sections whereas *Brachionus sessilis* reached the line of Szigliget—Balatonmária ("K" section). Its percentage distribution gradually decreased in south-western direction.

c) *Polyarthra major* has been found only in the "M" and "K" sections. The highest percentage of *Brachionus angularis* was also found in these sections, however, it reached the Tihany peninsula ("A" section) in spring months.

Trichocerca species are significant mainly in the middle parts of the lake ("G-K" sections), although *Trichocerca pusilla* can be found even in the sections of the north-eastern basin.

d) The number of species found only in the "M" section *(Table 4)* decreased as compared with that of earlier years. These species are only occasional elements of the plankton since they live in the littoral region, between the submerged plants respectively in psammon of Lake Balaton. The percentage distribution of several dominant species in the sections showed a nearly uniform distribution in certain periods of time *(Figs 8—14)*, i.e. *Keratella quadrata* in May and June; *K. cochlearis tecta* in May, June, August and September; *Pompholyx sulcata* in May; *Polyarthra vulgaris* in July.

The percentage distribution of dominant Rotifera species was similar ir "A" and "E" sections, especially in June and September. The difference was less than 10% in every species. Real differences were observed in the percentage distribution of *Keratella cochlearis* in April and May and of *K. quadrata* in July and August.

The percentage distribution of certain species in the "G" section seems to be resembling to that of the "E-A" sections, e.g. *Keratella quadrata* in August, *Pompholyx sulcata* in October, *Polyarthra vulgaris* in June and September. The evaluation of percentage distributions of all dominant species revealed that one, two or three species showed a difference higher than 10% as compared with both the "A" and "K" sections between April and August and the relations strongly differing from those of the "K" section were observable only in the months of autumn. Comparing with the "E-A" sections in Septem-

TABLE 4

The qualitative and relative quantitative distribution of the Rotifera plankton in 1967

Species	Time of collecting	Places of sample takings															
		M_0				K_0		G_0		A_0				E_0			
		in the evening		in the morning						in the afternoon		in the evening		in the afternoon		in the evening	
		pc.	%	pc.	%	pc.	%	pc.	%	pc.	%	pc.	%	pc.	%	pc.	%
Brachionus angularis GOSSE	IV.					7	1.13	3	0.47	2	0.31						
	V.	15	2.42	13	2.09	5	0.78	1	0.15	1	0.15						
	VI.			4	0.63												
	IX.			1	0.15												
Branchionus angularis bidens (PLATE)	IV.							1	0.16								
Brachionus diversicornis (DADAY)	IX.			1	0.15	2	0.31							1	0.15	3	0.46
Brachionus sessilis VARGA	VII.					6	0.90	68	10.46	35	5.35	36	5.68	67	10.31	57	8.63
	VIII.			4	0.62	24	3.77	48	7.49	26	3.72	45	6.93	23	3.62	89	13.24
	IX.					1	0.15	11	1.66	7	1.10	6	0.92	11	1.66	2	0.30
Cephalodella catellina (O. F. MÜLL.)	IV.	6	0.94														
	VI.															1	0.15
Cephalodella eva (GOSSE)	IV.	2	0.31														
	X.	1	0.15														
Collotheca balatonica VARGA	VI.							1	0.16	51	7.96	82	12.50	120	18.49	67	10.12
	VII.							26	4.00	27	4.13	11	1.18	14	2.15	5	0.81
	VIII.							26	4.06	106	15.19	39	6.01	12	1.89	45	6.69
	IX.							3	0.46	7	1.10	1	0.14	11	1.70	2	0.31
	X.							1	0.15	12	1.85	12	1.85	14	2.16	1	0.15
Collotheca sp.	VI.											1	0.15				
	X.											3	0.46				
Conochilus unicornis ROUSSELET	IV.	6	0.96	4	0.64			9	1.42	4	0.61	4	0.65	21	3.40	1	0.15
	V.							2	0.31	1	0.15						
Encentrum mustela (MILNE)	X.					1	0.15										
Filinia longisete (EHRBG.)	V.													1	0.15		
	IX.											1	0.14			1	0.15

Filinia terminalis (PLATE)	IV.							4	0.63	3	0.46	3	0.49	3	0.48		
Kellicottia longispina (KELLICOTT)	IV.	1	0.16			30	4.85	151	23.85	36	5.50	30	4.86	54	8.74	10	1.47
	V.	16	2.58	18	2.89	124	19.31	137	21.01	76	11.53			106	16.16		
	VI.	10	1.57	9	1.39	13	1.96	17	2.68	15	2.34	12	1.83	6	0.92	3	0.45
	VII.			6	0.99	17	2.56	21	3.23	6	0.92	4	0.62	4	0.61	1	0.15
	VIII.			1	0.15	22	3.65	1	0.15	1	0.14					1	0.14
	IX.			15	2.28	83	12.79	56	8.64	7	1.10	4	0.71	11	1.70	5	0.78
	X.	39	6.00			48	7.37	45	6.93	67	10.33	28	4.31	68	10 47	19	2.93
	XI.									13	1.98			21	3.21		
Keratella cochlearis GOSSE	See its percentage distribution in the figures																
Keratella cochlearis macracantha f. *micracantha* LAUTERBORN	IV.	1	0.16														
	V.	2	0.32							2	0.30						
	VI.			1	0.15			1	0.16	2	0.31	1	0.15	2	0.31	2	0.30
	VII.			12	1.98											1	0.15
	VIII.			2	0.31					1	0.14	2	0.31	1	0.16		
	IX.											2	0.31				
	X.							2	0.31	1	0.15	1	0.15	1	0.15	1	0.15
	XI.									1	0.15			2	0.13		
Keratella cochlearis tecta (GOSSE)	See its percentage distribution in the figures																
Keratella quadrata (O. F. MÜLL.)	See its percentage distribution in thr figures																
Notholca squamula (O. F. MÜLL.)	IV.	4	0.63	2	0.32	5	0.81	13	1.89			8	1.30			2	0.29
	X.											7	1.08			2	0.31
	XI.									3	0.46			6	0.92		
Polyarthra major BURCKHARDT	VI.	2	0.31			2	0.30										
	IX.			1	0.15												
	X.	16	2.46														
Polyarthra vulgaris CARLIN	See its percentage distribution in the figures																
Pompholyx complanata GOSSE	VI.							2	0.32					5	0.77	1	0.15
	VII.															1	0.15

Table 4 (continued)

Species	Time of collecting	Places of sample takings															
		M_0				K_0		G_0		A_0				E_0			
		in the evening		in the morning						in the afternoon		in the evening		in the afternoon		in the evening	
		pc.	%	pc.	%	pc.	%	pc.	%	pc.	%	pc.	%	pc.	%	pc.	%
Pompholyx sulcata HUDSON		See its percentage distribution in the figures															
Synchaeta kitina ROUSSELET	IV.	28	4.39	35	5.69	44	7.19	15	2.37	5	0.76	2	0.32	3	0.48		
	VI.			18	2.80												
	VII.					5	0.75										
Synchaeta oblonga EHRBG.	IV.	581	91.21	445	72.24	259	41.80	63	9.95	10	1.53	4	0.65	10	1.62	8	1.17
	V.			1	0.16												
	VI.	4	0.63	86	13.37	27	4.07										
	VII.			36	5.95	40	6.02	3	0.45								
	VIII.	1	0.15	10	1.54	1	0.16										
	IX.			9	1.37							1	0.14				
	X.	3	0.46			1	0.15										
	XI.									10	1.54			1	0.15		
Testudinella mucronata (GOSSE)	V.							2	0.31								
	VII.							1	0.15								
Trichocerca capucina (WIERZEJSKI & ZACHARIAS)	VI.													1	0.15		
Trichocerca pusilla (JENNINGS)	VII.							18	2.76							1	0.15
	VIII.					20	2.60	2	0.31	1	0.14			1	0.16	4	0.59
	IX.													5	0.77		
Trichocerca rattus(O. F. MÜLL.)	VIII.			1	0.15			4	0.62								
	IX.					1	0.15										
Trichocerca sp.	VII.							1	0.15								
Trichocerca stylata (GOSSE)	VIII.					1	0.16										

ber, the percentage distributions apart from one species were identical, while 4 species showed differences as compared with the relations of the "K" section at the same time. The "G" section should qualitatively be considered, because of the presence of *Pompholyx sulcata*, bearing resemblance to the "E-A" sections.

The percentage distribution of mass species of the "K" section either differs to a certain extent from the relations found in all other sections, e.g. *Polyarthra vulgaris* in June and August, *Keratella quadrata* in August, or it is identical with the situation found in the Keszthely-Bay, e.g. *Polyarthra vulgaris* in September and October. However, the relations of the Keszthely-Bay are most frequently repeated to a less extent, e.g. *Keratella quadrata* in June and September, *Synchaeta oblonga* in April.

Discussion

The number of common species gives general information about the qualitative composition of the biocenoses and the measure of their differences or even similarities (HILLBRICHT-ILKOWSKA, 1964). Mathematical indexes have been elaborated for characterizing the qualitative comparisons of different biocenoses (SØRENSEN, 1948; WILLIAMS, 1964). The equation of SØRENSEN has later been modified by MARCZEWSKI—STEINHAUS (1959) and used for comparisons of Rotifera populations of fish-ponds by HILLBRICHT-ILKOWSKA (1965). The equation of SØRENSEN was first used by GREEN (1967) in horizontal investigations of Rotifera populations collected from different areas of the water-system of White Nile.

The investigated 5 sections of Lake Balaton often differed from each other in the composition of species, however, also many similarities were found considering the occurrence of the species. For expressing the differences and similarities of the qualitative composition of Rotifera populations found in the sections, the equation of MARCZEWSKI-STEINHAUS seemed to be most adequate:

$$S = \frac{w}{a + b - w} 100$$

where w is the number of common species in the two compared biocenoses, a and b are the total numbers of species occurring separately in the two associations. The larger is the value of S the more expressed is the qualitative similarity. In our investigations a is the number of species found in one section, while b is the same in the other section.

The values of the index are generally high indicating a considerable number of common species in all sections *(Table 5)*. The differences between the single sections are mainly due to the species restricted to certain regions and the planktonic guests. The highest degree of similarity exists between the two sections of the north-eastern basin and the "G" and "K" sections of the south-western one. The composition of Rotifera population was mostly different from that of other sections in the Keszthely-Bay whereas the "K" section was most of all similar to the latter. The lowest degree of qualitative similarity was between the "M" and "E" and the "M" and "A" sections. The

TABLE 5
The values of MARCZEWSKI—STEINHAUS *index in 1966*

	M	K	G	A	E
M	—	66.6	61.5	51 8	40.0
K	66.6	—	69.5	58.3	54.1
G	61.5	69.5	—	61.9	50.0
A	51.8	58.3	61.9	—	77.7
E	40.0	54.1	50.0	77.7	—

TABLE 6
The values of MARCZEWSKI—SREINHAUS *index in 1967*

	M	K	G	A	E
M	—	63.6	53.8	54.1	53.8
K	63.6	—	52.0	50.0	48.1
G	53.8	52.0	—	66.6	61.5
A	54.1	50.0	66.6	—	73.9
E	53.8	48.1	61.5	73.9	—

composition of Rotifera plankton was different in the two basins on the basis of the index.

The values obtained in 1967 are partly identical with those of the previous year (high value of the index of "E" and "A" sections), partly differ from those, i.e. the similarity is of lower degree between the "K" and "G" sections.

Comparing the indexes of two years, one can see that the similarity of Rotifera fauna was always of high degree in the Keszthely-Bay ("M") and the "K" section. Again an almost identical composition of Rotifera fauna was found in the "E" and "A" sections. The "G" section of the south-western basin can sometimes be assumed to belong to the north-eastern basin (1967) while at other times to the "K" section (1966).

The evaluation of the MARCZEWSKI—STEINHAUS index allows to draw three conclusions:

1) The similarities ("E" and "A" sections) and differences (e.g. "M" and "E" sections) established on the basis of different percentage distributions of the dominant species in different sections are supported by the values of the index.

2) Rotifera population of the north-eastern basin was much richer in common species in 1966 and 1967 than in the previous year (ZÁNKAI and KERTÉSZ, 1967), however, this is valid even for the "K" and "M" sections.

3) There was a higher degree of similarity in the percentual composition of the Rotifera population collected from different places of the lake in 1967 than in 1966.

The occurrence of planktonic guests displayed a high variability, the majority of them was found in the Keszthely-Bay. The appearance of tychoplanktonic elements may be explained by several reasons:

a) the effect of wind,

b) the eutrophication of the Keszthely-Bay indicated also by the Rotifera species occurring there.

Summary

1. The Rotifera plankton of the open water of the lake was composed by 40 species, varieties and forms during two years (1966—67). Three of them *(Encentrum wiszniewszki* WULFERT, *Trichocerca rousseleti* (VOIGT) and *Asplanchna girodi* de GUERNE) are new to the fauna of Hungary whereas *Brachionus diversicornis* (DADAY) is new for that of Lake Balaton.

2. Qualitative investigations have proved that 5 species *(Keratella cochlearis, K. c. tecta, K. quadrata, Polyarthra vulgaris, Pompholyx sulcata)* can be considered as the main elements of the Rotifera plankton of the open water in Lake Balaton.

3. On the basis of their horizontal distribution, the species have been classified into 4 groups: *a* = those found in the open water of the whole lake, being of nearly uniform in distribution; *b* = those found only in the north-eastern basin and showing a higher percentage there, respectively; *c* = those found only in the south-western basin and showing a higher percentage there, respectively; *d* = those living in the Keszthely-Bay.

4. On the basis of percentage distribution of the dominant species as well as of MARCZEWSKI—STEINHAUS index, three areas can be distinguished in the open water of Lake Balaton:

a) North-eastern basin ("E-A" sections),
b) Keszthely-Bay and Szigliget-Bay ("M-K" sections),
c) "G" section of the south-western basin can sometimes be assumed to belong to the north-eastern part while at other times to the "K" section.

5. The richest region in species was the Keszthely-Bay and its surrounding. Taxa found here are characteristic mainly for the strongly eutrophic waters.

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A BALATON KEREKESFÉREG PLANKTONJÁNAK HORIZONTÁLIS ELTERJEDÉSE

P.-Zánkai Nóra és *Ponyi Jenő*

Összefoglalás

1. A 2 év vizsgálatai során a tó nyílt vízének kerekesféreg planktonját 40 faj, változat és forma alkotta. Ezek közül Magyarország faunájára az *Encentrum wiszniewszki Trichocerca rousseleti* és az *Asplanchna girodi*, a Balaton faunájára a *Brachionus diversicornis* új.

2. A minőségi vizsgálatok bebizonyították, hogy a Balaton nyílt vízében 5 faj *(Keratella cochlearis, K. c. tecta, K. quadrata, Polyarthra vulgaris, Pompholyx sulcata)* tekinthető a Rotatória plankton fő alkotóelemeinek.

3. A fajokat horizontális elterjedésük alapján 4 csoportba soroltuk: *a* = az egész tó nyílt vízében megtalált közel egyenes elterjedésű fajok, *b* = csak az északkeleti medencében, ill. ott magasabb %-kal szereplők, *c* = csak a délnyugati medencében, ill. ott magasabb %-kal szereplők, *d* = a Keszthelyi öböl lakói.

4. A Balaton nyílt vízét, a domináns fajok %-os megoszlása, valamint a MARCZEWSKI—STEINHAUS index alkalmazása alapján 3 területre különítettük el:

a) északkeleti medence („E — A" szelvény),
b) Keszthelyi és Szigligeti öböl („M — K" szelvény),
c) a délnyugati medence „G" szelvényét némelykor az északkeleti részhez, máskor a „K" szelvényhez tartozónak lehet tekinteni.

5. A fajokban leggazdagabb terület a Keszthelyi öböl és környéke volt. Itt olyan taxonok találhatók, melyek többsége az erősen eutróf jellegű vizekre jellemző.

Photo 1. Encentrum wiszniewszki, after clearing

Photo 2. Masticatory organ of *Asplanchna girodi*