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COMPARATIVE INVESTIGATIONS ON THE BENTHIC FAUNA AT TWO SEWAGE INFLOWS OF LAKE BALATON

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DADAY (1897) and FRANCÉ (1897) were the first to investigate the Protozoa and Crustacea of the benthic fauna. Later LENZ (1926), ZILAHI-SEBESS (1932) and BERCZIK (1960) reported valuable observations on Chironomida. Quantitative investigations on the benthic animals of Lake Balaton have first been carried out by MOON (1934) and for a long time to come only his data were available however, even these discussed the macrobenthos of only one transversal section. SEBESTYÉN wrote in 1948: "Only informatory data are available on the benthic fauna . . ., however, its intense investigation is absolutely indispensable . . ." (p. 8).

The first quantitative evaluation of Chironomida larvae began by ENTZ in 1950—1952, which, however, continued only later in 1964 and 1965. The results of these investigations give more detailed informations about the quantitative distribution of Chironomida inhabiting the lake.

ENTZ (1954) was the first who reported some informatory quantitative data about the benthic animals being smaller (designated as microbenthos MARE, 1942) than Chironomida (macrobenthos). More intense investigations began in the 1960s, (ENTZ et al. 1963; BIRÓ et al. 1968; PONYI, 1969), especially on Crustacea and Nematoda. These investigations involved mainly the benthos of the open water of Lake Balaton.

There are no data available concerning the composition of the benthic fauna of the areas near the shore, displaying different degrees of eutrophication. From point of view of applied research this problem was apparently very important, thus the investigations were carried out with the financial support of VITUKI (Budapest). The concrete aim of the investigations was to establish the qualitative and quantitative differences of the benthic fauna in the sewage inflow areas at Balatonfüred and Tihany as well as in front of the Biological Research Institute far from the sewage-inflow.

Collecting places and methods

a) *Description of collecting places*

Sample takings were carried out on three different areas of the lake between August and October:

1. Sewage-inflow at Balatonfüred,
2. Sewage-inflow at Tihany,
3. In front of the Biological Research Institute (500 m off shore).

Samples were taken from the following places of sewage inflow of Balatonfüred during August *(Fig. 1A)*:

No. 1. sewage-inflow, 1 m off the reeds.
No. 2. in front of the sewage-inflow, 10 m off the reeds.
Nos. 3—4. 5 m off the reeds.
No. 5. 80 m off the sewage-inflow
(*Nos. 6—10.* samples from the above mentioned stations taken with the Craib-sampler for the study of Nematods).

The samples collected in August at the sewage-inflow of Tihany were taken on the following places *(Fig. 1B)*:

Nos. 11—14. sewage-inflow, 3 m off the reeds
Nos. 12—15. the reed-grass, 15 m off the reeds.
Nos. 13—16. the reed-grass, 30 m off the reeds.
Nos. 17—18. 1 m of the reeds(samples taken with Craib-sampler for study of Nematods).

Samples *Nos. 19–23* were collected in August in front of the Biological Institute as far as 500 m from the shoreline, at one point.

The points of sample takings at the sewage-inflows were reduced to two in September—October and 5 parallel samples were collected at each place.

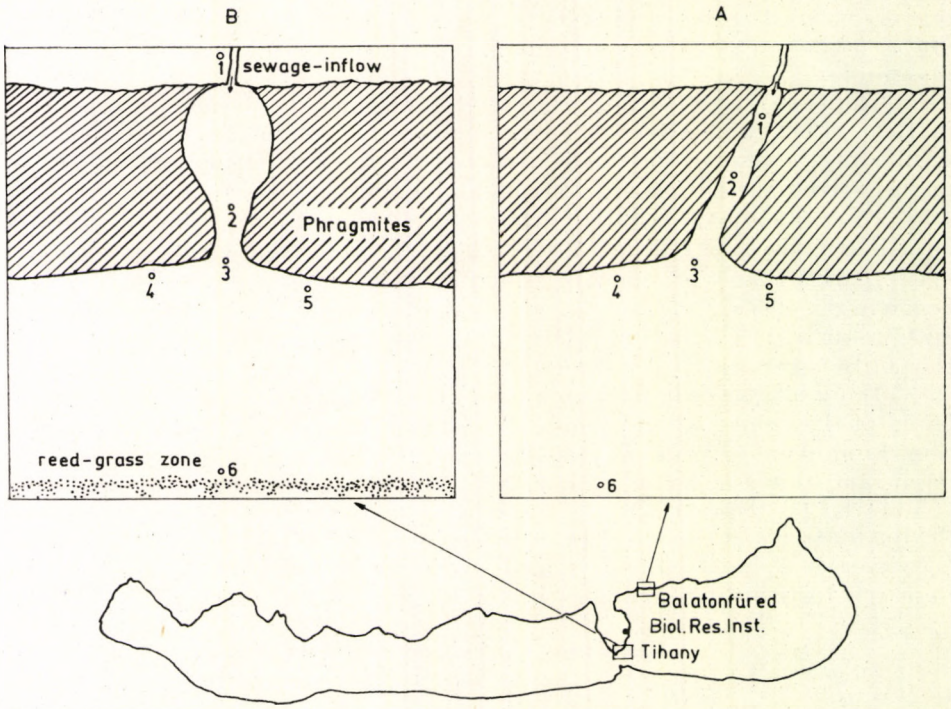

Fig. 1. Collecting sites at the sewage-inflow at Balatonfüred (A) and Tihany (B) in August. Detailed explanation in the text

Samples taken in September at the sewage-inflow of Balatonfüred originated from the following places:

No. 24—28. The skirts of the reeds in front of the sewage-inflow.

No. 29—33. 80 m from the same place.

Samples taken in September at the sewage-inflow of Tihany were taken:

No. 34—38. The skirts of the reeds in front of the sewage-inflow.

No. 39—43. 30 m from the same place.

Samples taken in September in front of the Biological Research Institute (500 m off), are: No. 44—48.

Samples taken in October at the sewage-inflow of Balatonfüred, were:

No. 49—53. The edge of the reeds in front of the sewage-inflow.

No. 54—58. 80 m from the same place.

At the sewage-inflow of Tihany:

No. 64—68. The edge of the reeds.

No. 69—73. 30 m from the same place.

In front of the Biological Research Institute (500 m off): *No. 59—63.*

The three places of sample takings were significantly different considering the detritus content of the benthos and the abundance of the vegetation. The highest amounts of vegetable detritus were found at Balatonfüred while the lowest in front of the Biological Research Institute.

b) *The method used*

For collecting mud samples the EKMAN-BIRGE tool and the modified Craib mud-dredge (PONYI et al. 1967) were used. The first brings 1 dm^2, whereas the second 33 cm^2 area of mud, onto the surface.

The mud-dredger was enclosed by a net (No. 6) under the water in order to avoid the loss of animals from the samples.

The sample has been washed in the framed net and placed in a plastic vessel. After a careful homogenization the samples were screened using nets of 5 and 0.4 mm meshes subsequently, to remove particles less than 0.4 mm (detritus, grains of sand, living beings). The samples were flushed several times as long as living organisms remained on the net of 5 mm mesh. The content of the more dense net was flushed to a conic net then placed in a glass-vessel and conserved by means of ethanol.

A further cleaning was carried out in the laboratories by sedimentation (PONYI et al. 1967).

The material, prepared this way, was placed into small dishes bearing a square network of 1 cm mesh and using a suitable dilution, all animals found in the samples were selected under a stereoscopic microscope. The selection was done step by step, first the larger then the smaller animals were selected.

Notes about the species new to the fauna of Hungary and Lake Balaton

OSTRACODA

Ilyocypris bradyi G. O. SARS

New to the fauna of Lake Balaton. It was observed in 7 samples collected at the inflow of sewage of Tihany. It is a wide-spread species in Europe, North Africa, Central Asia and North America; in Hungary it was first collected in

Fehér Lake (FARKAS, 1958). This species has frequently been found in springs and small waters, thus showing a hardiness to the great fluctuations of temperature.

Isocypris arnoldi DUBOWSKY *(Photo 1)*

Both the genus and species are new to the fauna of Hungary. It rarely occurs even in Europe (ILLIES, 1967; BRONSTEIN, 1947). The ecology of this animal is completely unknown. Several specimens were found at both sewage-inflows.

Cypridopsis newtoni BRADY et ROBERTSON

Until now it has not been known from Lake Balaton. A new *Cypridopsis* species had been described by DADAY (1894) from the lake, called *verrucosa* and described as similar to *C. newtoni*. Since species of DADAY has not been accepted, it may probably be identical with the latter. A considerably large number of it was collected on one occasion at the sewage-inflow of Balatonfüred. It is at home in waters of constant character, however, it occurs also in sodic waters of the Great Hungarian Plain.

Cypridopsis vidua (O. F. MÜLLER)

In spite of its common and wide-spread occurrence it has not been known from Lake Balaton. DADAY (1897) mentioned it from Lake Kis-Balaton, where it generally occurs. It is found of waters of constant character and rich in vegetation. Its population increases twice a year at the beginning and at the end of summer, however, some individuals can be found even in winter. It has been collected in large number at the sewage-inflow of Balatonfüred.

INSECTA

Limnochironomus ex gr. *nervosus* (STAEG.)

It has been found for the first time in the fauna of Lake Balaton. The 8 mm long larva occurs both in lakes and rivers, mainly among water plants (TSERNOVSKY, 1949; BERCZIK, 1967a).

Limnochironomus ex gr. *tritomus* KIEFF.

New to the fauna of Hungary. The 7 mm long larva lives in the littoral and sublittoral zones, the mud and among the water plants of eutrophic lakes (TSERNOVSKY, 1949).

Cryptochironomus ex gr. *defectus* KIEFF.

New to the fauna of Balaton. The larva is 15 mm long and has a brown colour. It occurs in littoral and sublittoral zones of lakes and rivers. It prefers the sandy bottom (TSERNOVSKY, 1949; BERCZIK, 1967b).

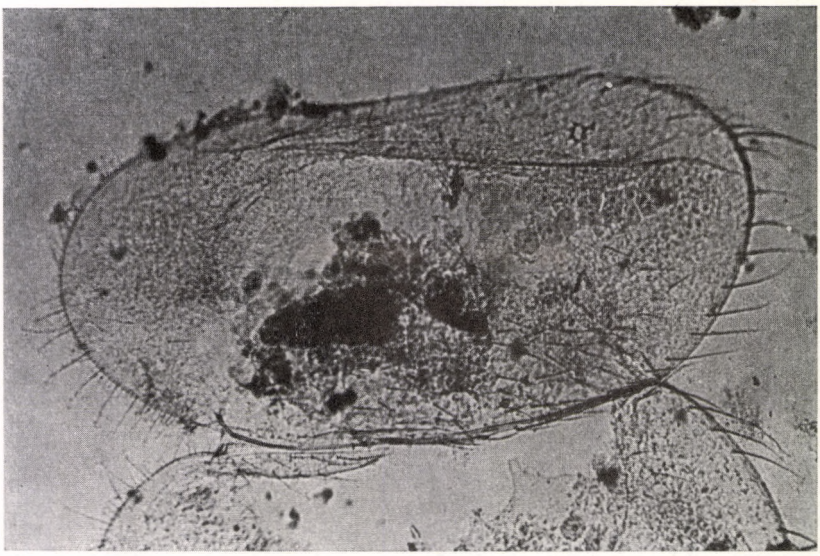

Photo 1. Isocypris arnoldi DUBOWSKY O. Left side of the shell

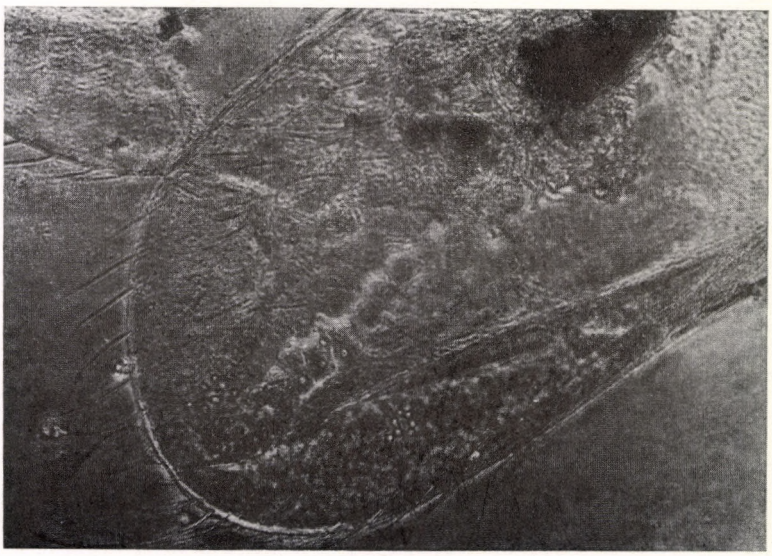

Photo 2. Isocypris arnoldi DUBOWSKY O. Posterior part of the left side, of the shell

The quantitative distribution of zoobenthos of the three collecting sites in different months

PORIFERA

Spongilla carteri ssp. *balatonica* ARNDT.

A single colony was found 80 m away from the reeds at the sewage-inflow of Balatonfüred. It cannot quantitatively be evaluated.

NEMATODA

The three collecting sites stand out in sharp contrast to each other considering the quantitative results of samples taken on the 5th August *(Table I)*. The number of Nematodes was remarkably low at the sewage-inflow of Balatonfüred and its surrounding. Receding from the inflow area, the number of *Tobrilus gracilis* and an other *Tobrilus* species increased to some extent. On the contrary, the inflow area of the sewage of Tihany was rich in Nematodes and also the number of individuals was the highest there: it reached 502, whereas it was 27 at Balatonfüred, and 230 in front of the Biological Research Institute when counting all individuals in the 5 samples of each site.

At the sewage-inflow of Tihany 3—47 *Monhystera paludicola* were found per sample. The frequency of this species was only 3—13 per sample of the other collecting site of Tihany. *Theristus setosus* showed a similar distribution. A considerably number of *Monhystera stagnalis* occurred only at the first collecting place. *Tobrilus longus* and *Tripyla papillata* were of similar distribution, however, their number was lower. Several other species occurred only sporadically, thus their distribution cannot quantitatively be evaluated.

OLIGOCHAETA

Tubifex sp.

It occurred in 3 of 13 samples of August, in 20 of 25 samples of September and in 4 of 25 samples of October *(Tables V, VI* and *VII)*. Its amount is only significant in the samples of September. At the sewage-inflow of Tihany, 30 m off the reeds 6—42 individuals were found per dm^2; at the skirts of the reeds, at the sewage-inflow of Balatonfüred, the same data were 1—18; in the mud of the region in front of the Biological Research Institute it was represented by low number of individuals (1—5/dm^2), nevertheless, it was present in every sample.

ANNELIDA

Piscicola geometra L. and *Glossiphonia* sp.

Quantitatively cannot be evaluated.

CRUSTACEA

Samples of 5th August

Low numbers of benthic Crustacea were observed in this period of the year *(Table II)*. From the Cladocera and Ostracoda only the numbers of

TABLE I

Quantitative distribution of Nematoda at different collecting places, 5th August 1969

Species	Collecting sites	Sewage-inflow area at Balatonfüred					Sewage-inflow area at Tihany					Area in front of the Biol. Res Inst. Tihany, about 500 m from the shore				
	Number of samples	6	7	8	9	10	14	15	16	17	18	19	20	21	22	23
1. *Aphanolaimus aquaticus* DADAY		—	—	—	—	—	—	—	1	—	—	1	1	—	1	—
2. *Ethmolaimus pratensis* de MAN		—	—	—	—	—	1	1	—	—	—	—	—	—	—	—
3. *Eudorylaimus* sp.		—	—	—	—	—	—	1	—	1	1	—	—	—	—	—
4. *Hemicycliophora aquatica* MICOLETZKY		—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
5. *Ironus tenuicaudatus* de MAN		—	—	—	2	—	—	—	1	—	3	—	4	10	9	01
6. *Mermis* sp.		—	—	—	—	—	—	—	3	—	—	—	—	—	—	—
7. *Monhystera paludicola* de MAN		—	1	—	—	—	3	36	47	5	23	13	3	—	3	3
8. *Monhystera stagnalis* BASTIAN		—	—	—	—	—	—	17	26	3	18	—	—	—	—	—
9. *Monhystera macramphis* FILIPJEV		—	—	—	—	—	—	—	—	—	2	—	—	—	—	—
10. *Paraphanolaimus behningi* MICOLETZKY		1	—	—	—	—	—	4	15	1	4	18	6	7	9	5
11. *Paraplectonema pedunculatum* HOFMÄNNER		—	—	—	—	—	—	—	25	24	19	11	4	2	76	3
12. *Plectus tenuis* BASTIAN		—	—	—	—	—	—	1	1	—	—	—	—	—	—	—
13. *Theristus setosus* FILIPJEV		—	—	—	—	—	—	11	39	16	13	2	3	1	4	1
14. *Tobrilus gracilis*		—	—	—	2	10	9	1	8	13	2	2	4	5	7	2
15. *Tobrilus longus* LEIDY		—	—	—	—	—	—	6	10	—	—	—	—	—	—	—
16. *Tobrilus medius* G. SCHNEIDER		1	—	—	—	—	—	—	—	—	6	—	—	—	—	—
17. *Torbilus* sp.		1	—	—	1	7	34	13	27	—	—	—	—	—	—	—
18. *Tripyla papyla papillata* BÜTSCHLI		—	—	—	—	—	1	1	1	2	2	—	—	—	—	—
Total: (33 cm²)		3	2	—	5	17	47	115	181	65	94	47	25	25	109	24

TABLE II

Quantitative distribution of Crustacea at different collecting sites, 5th August, 1969

No.	Species	Collecting sites	Sewage-inflow area at Balatonfüred					Sewage-inflow area at Tihany			Area in front of the Biol. Res. Inst. Tihany, about 500 m from the shore				
		Number of samples	1	2	3	4	5	11	12	13	19	20	21	22	23
1.	*Diaphanosoma brachyurum* (Lievin)		—	—	—	—	—	—	—	—	7	—	1	—	1
2.	*Daphnia hyalina* var. *galeata* G. O. Sars		1	—	—	—	—	—	—	—	—	—	1	—	—
3.	*D. cucullata* f. *kahlbergensis* Schödler		—	—	—	—	—	—	—	—	9	—	—	—	—
4.	*Iliocryptus sordius* Lievin		1	—	—	—	—	—	—	—	—	—	—	—	—
5.	*Monospilus dispar* G. O. Sars		—	—	1	—	—	—	—	—	1	—	—	—	—
6.	*Leydigia leydigii* (Leydig)		—	—	—	—	—	—	—	—	1	—	—	—	—
7.	*Alona quadrangularis* (O. F. Müller)		—	—	1	—	—	—	—	1	—	—	—	1	1
8.	*Cyclocypris* sp.		—	—	3	—	—	1	—	—	—	—	—	—	—
9.	*Candona* sp.		1	—	—	—	—	—	—	—	—	6	—	1	1
10.	*Darwinula stevensoni* (Brady et Robertson)		—	—	—	—	—	—	—	4	1	5	—	3	—
11.	*Limnocythere inopinata* (Baird)		—	—	—	—	—	—	—	1	—	—	—	—	—
	Ostracoda sp.		—	2	—	—	—	—	—	—	—	—	—	—	—
12.	*Eudiaptomus gracilis* (G. O. Sars)		1	—	—	—	—	—	—	—	4	6	7	4	11
13.	*Eucyclops serrulatus* (Fischer)		—	—	1	—	—	—	—	—	—	—	—	—	—
14.	*Paracyclops fimbriatus* (Fischer)		—	1	—	—	—	—	—	3	15	3	2	9	2
15.	*Cyclops vicinus* Uljanin		—	—	4	2	10	—	4	5	90	68	129	70	92
16.	*Acanthocyclops viridis* (Jurine)		—	—	—	—	—	—	—	—	1	—	—	5	2
17.	*Mesocyclops leuckarti* (Claus)		2	1	—	—	—	—	—	1	2	2	—	4	1
18.	*Ectinosoma abrau* (Kritschagin)		1	1	1	1	—	1	1	3	—	6	—	1	1
19.	*Canthocamptus staphylinus* (Jurine)		—	1	—	—	—	—	—	—	—	—	—	—	—
20.	*Nannopus palustris* Brady		—	—	—	—	—	—	—	—	7	1	1	5	—
21.	*Corophium curvispinum* f. *devium* Wundsch		—	—	—	—	—	—	2	1	—	—	—	—	—
	Total:		7	6	11	3	10	2	7	20	138	97	141	103	112

TABLE II

Quantitative distribution of Crustacea at different

No.	Species	Collecting sites	Sewage-inflow area at Balatonfüred									
			The edge of reeds					About 80 m from the edge of reeds				
		Number of samples	24	25	26	27	28	29	30	31	32	33
1.	*Sida crystallina* (O. F. Müller)		—	—	—	—	—	—	—	—	—	—
2.	*Diaphanosoma brachyurum* (Lievin)		—	—	—	—	—	—	—	—	—	—
3.	*Daphnia hyalina* var. *galeata* G. O. Sars		—	—	—	—	—	—	—	—	—	—
4.	*Daphnia cucullata* G. O. Sars		1	—	3	—	1	—	—	—	—	1
5.	*D. cucullata* f. *kahlbergensis* Schödler		—	1	—	—	—	—	—	—	—	—
6.	*Macrothrix laticornis* (Jurine)		—	—	—	—	—	—	—	—	—	—
7.	*Iliocryptus sordius* Lievin		12	14	7	15	3	4	11	3	23	11
8.	*Monospilus dispar* G. O. Sars		—	—	—	—	—	—	—	—	—	—
9.	*Leydigia acanthocercoides* (Fischer)		4	37	23	40	5	5	11	4	55	5
10.	*Pleuroxus uncinatus* var.*balatonicus* Daday		—	—	—	—	—	—	—	—	13	—
	Pleuroxus sp.		—	—	—	—	—	—	1	—	—	—
11.	*Alona affinis* Leydig		—	—	—	—	1	—	—	—	—	—
12.	*Alona quadrangularis* (O. F. Müller)		—	—	1	—	—	—	—	—	10	—
13.	*Alonella rostrata* (Koch)		—	—	—	—	—	—	—	—	—	—
14.	*Leptodora kindtii* (Focke)		—	—	—	—	—	—	—	—	—	—
15.	*Ilyocypris gibba* (Ramdorh)		—	—	—	—	—	—	—	—	—	—
16.	*Ilyocypris bradyi* G. O. Sars		—	—	—	—	—	—	—	—	—	—
	Ilyocypris sp.		—	—	—	—	—	—	—	—	—	—
17.	*Isocypris arnoldi* (Dubowsky		—	4	3	—	—	—	—	—	—	—
18.	*Cyclocypris ovum* (Jurine)		—	—	—	—	—	—	—	—	2	—
	Cyclocypris sp.		—	7	—	—	—	—	—	—	—	—
19.	*Candona marchica* Hartwig		—	—	—	—	—	—	—	—	—	—
	Candona sp.		—	—	—	—	—	—	—	—	—	—
20.	*Darwinula stevensoni* (Brady et Robertson)		—	1	—	—	—	—	—	—	—	—
21.	*Limnocythere inopinata* (Baird)		—	—	—	—	—	—	—	—	—	—
22.	*Eudiaptomus gracilis* (G. O. Sars)		—	—	—	—	—	—	—	—	—	—
23.	*Macrocyclops albidus* (Jurine)		—	1	—	—	—	—	—	—	—	—
24.	*Eucyclops serrulatus* (Fischer)		—	2	1	4	1	1	3	—	10	—
25.	*Paracyclops fimbriatus* (Fischer)		1	—	—	—	—	—	—	—	—	—
26.	*Cyclops vicinus* Uljanin		1	4	1	7	1	5	3	4	10	6
27.	*Acanthocyclops viridis* (Jurine)		—	—	—	—	—	1	1	—	2	—
28.	*Acanthocyclops vernalis* (Fischer)		—	—	—	—	—	—	—	1	—	—
29.	*A. vernalis* f. *robusta* (G. O. Sars)		—	1	1	—	—	—	1	—	—	—
30.	*Mesocyclops leuckarti* (Claus)		—	—	—	—	—	—	—	—	—	—
	Cyclops sp.		—	—	—	—	—	—	—	—	—	—
31.	*Ectinosoma abrau* (Kritschagin)		—	—	1	—	—	—	—	—	—	—
32.	*Canthocamptus staphylinus* (Jurine)		12	1	—	7	—	9	7	3	5	3
33.	*Limnomysis benedeni* (Czern.)		—	—	—	—	—	—	—	—	—	—
34.	*Dicerogammarus* sp.		—	1	—	9	—	1	—	—	—	—
35.	*Corophium curvispinum* f. *devium* Wundsch		—	22	—	40	1	70	1	—	—	—
	Total		31	96	41	122	13	96	39	15	130	26

collecting sites, on September 2nd and 3rd, 1969

Sewage-inflow area at Tihany										Area in front of the Biol. Res. Inst. Tihany, about 500 m from the shore				
The edge of reeds					About 30 m from the edge of reeds									
34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	2	—	17	33	26	14	11
—	—	1	—	—	—	—	—	—	—	—	—	—	1	—
1	4	3	37	8	4	2	1	20	—	7	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	13	6	4	1
—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
—	1	—	1	—	—	—	—	—	—	3	1	—	1	—
—	1	3	—	1	1	2	1	16	4	—	—	—	—	—
—	—	—	—	—	—	—	—	1	—	12	16	11	19	7
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	2	5	6	14	1	—	5	—	2	—
—	—	—	—	—	1	—	—	—	—	—	2	—	—	—
—	—	2	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
—	—	—	—	3	—	—	—	—	—	—	—	—	—	—
—	—	—	—	2	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
—	—	—	2	3	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	1	—	—	1	4	—	—	—	—	—	—
3	5	1	12	4	2	—	1	8	—	21	13	9	3	5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	4	2	6	6	1	1	—	—	—	—	—	—	—	—
—	2	1	—	—	—	—	—	1	—	—	—	—	—	—
—	1	—	—	—	8	5	4	6	—	61	22	43	19	40
—	—	—	—	—	—	—	—	2	—	—	1	2	—	1
—	—	1	—	—	—	1	—	1	—	—	—	—	—	—
—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	5	1	—	—	2
—	—	—	—	—	—	1	—	—	—	—	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	2	—	—	—	—	—	—	—	—	—	—	—	—	—
—	2	—	—	5	2	—	—	7	—	—	—	—	—	—
—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	1	—	—	—	113	1	2	—	6	1	—
4	23	14	59	35	21	17	15	200	6	128	108	103	65	67

Candona and *Darwinula* showed 5—6/dm² in several samples collected in open water areas in front of the Biological Research Institute in Tihany.

Two Copepoda species (copepodid stages of *Paracyclops fimbriatus* and *Cyclops vicinus)* were found in larger quantities also in the material collected far from the shoreline (500 m), in front of the Institute. *Ectinosoma abrau* occurred in the majority of samples, however, in very low number. *Nannopus palustris* was found exclusively in this collecting site.

Considering the total number of Crustacea, there is a considerable difference between the collecting places. It reached 2—20/dm² at the sewage-inflows and 97—141/dm² in the open water area in front of the Institute.

Samples of 2nd and 3rd September

Twice as much Crustacea have been found in September than in August *(Table III)*. Attention should be called to the propagation of 4 species of benthic Cladocera. Large number of *Iliocryptus sordidus* was found only at Balatonfüred (80 m off the reeds at the inflow of the sewage). It was observed only randomly on the other two collecting sites. The *Monospilus dispar* was restricted only to the sewage-inflow of Tihany (mainly 30 m from the reeds). The largest number of *Leydigia acanthocercoides* (37, 40, 55 individuals per dm²) was found at Balatonfüred, however a considerable number of it occurred also in the samples collected in front of the Institute. It was practically absent at the sewage-inflow of Tihany. Significant number of *Alona affinis* was found in the two collecting sites of Tihany, only 30 m from the inflow of sewage. *Eucyclops serrulatus* is frequent primarily in the environs of the sewage-inflows. Considerable number of *Canthocamptus staphylinus* was found at Balatonfüred. Juvenile samples of *Corophium* occurred in markedly high number in several samples (40, 70, 113/sample). Ten times more juvenile forms of *Cyclops vicinus* were present in the samples collected in front of the Institute than in the others.

Considering the total number of Crustacea, the relations between the three collecting sites display no sharp differences as compared to those found in the previous month.

Samples of 3rd October

The number of Crustacea in the samples increased again:

Date of collecting	Total number of Crustacea
5th August	657
2nd-3rd September	1.474
3rd October	3.752

The increase may be attributed mainly to the propagation of several benthic Cladocera *(Iliocryptus sordidus, Monospilus dispar)*, Ostracoda *(Cypridopsis vidua)* and Copepoda *(Paracyclops fimbriatus, Canthocamptus staphylinus)*, in spite of the fact that even the planktonic Crustacea are more frequent in that period of year as compared with the earlier months.

The lowest frequency of *Iliocryptus sordidus* was found at Balatonfüred where only 4 samples of all the 10 contained it, however, a value of 46/dm²

also occurred. The largest number of *Monospilus dispar* was found in front of the Biological Research Institute; about half of that number occurred in the inflow area of the sewage-inflow of Tihany (30 m from the reeds); its number was very low at other collecting places *(Table IV)*.

Alona affinis was present at all collecting sites of Tihany except one sample, however, it was totally absent from the samples of Balatonfüred. Relatively large numbers of *Alona quadrangularis* and *Alonella rostrata* could only be collected at the internal edge of reeds situated in the inflow area of the sewage of Tihany. On the other places only a few specimens were found or were completely absent. *Macrothrix laticornis* was frequent only in front of the Institute, at other places only a few individuals occurred.

Cypridopsis newtoni and *vidua* as well as *Cyclocypris ovum* (Ostracoda) were observed almost exclusively at the skirts of the reeds of the sewage-inflow at Balatonfüred. The occurrence of *Darwinula stevensoni* is just the inverse, it is frequent everywhere except the above area, however, it was not collected in large numbers the highest value: 8 (dm^2). *Limnocythere inopinata* is restricted almost completely to the sewage-inflow of Tihany.

Among copepods, *Eucyclops serrulatus* mainly at the two sewage inflows, while *Canthocamptus* and *Macrocyclops* almost exclusively at that of Balatonfüred were observed. *Paracyclops fimbriatus* was found everywhere except the several samples collected at Balatonfüred. It reaches even 21—23/dm^2, at some places.

EPHEMEROPTERA

A *Cloëon* species and *Caenis horaria* L. were found, however, they cannot be evaluated quantitatively.

DIPTERA

Tanypus punctipennis (Meig.)

It occurred in 4 of 13 samples of August, in 15 of 25 samples of September and in 13 of 25 samples of October six pupae were found in September *(Tables V, VI, VII)*.

High number of it occurred (3—16/dm^2) in the samples collected in front of the Institute in September and October. It is remarkable that it was absent in the area of the sewage-inflow of Tihany in August and September, and even in October only a few individuals were present there.

It is more frequent at the sewage-inflow of Balatonfüred (1—11/dm^2) than in the previous place, especially when receding from it (10—56/dm^2).

Procladius sp.

In August, when the number of other organisms is generally low in the samples, this species was found in a very large number, especially in front of the Institute (10—118/dm^2), and in collecting sites being localized farther from the sewage-inflow (1—25/dm^2; *Table V*).

TABLE IV

Quantitative distribution of Crustacea at different

No.	Species	Collecting sites	Sewage-inflow area at Balatonfüred									
			The edge of reeds					About 80 m from the edge of reeds				
		Number of samples	49	50	51	52	53	54	55	56	57	58
1.	*Diaphanosoma brachyurum* (Lievin)		—	—	20	—	—	—	—	—	1	—
2.	*Daphnia hyalina* var. *galeata* G. O. Sars		—	—	—	—	—	—	—	—	—	—
3.	*Daphnia cucullata* G. O. Sars		—	—	5	—	—	—	—	—	—	—
4.	*D. cucullata* f. *kahlbergensis* Schödler		—	—	—	—	—	—	—	—	—	—
5.	*Macrothrix laticornis* (Jurine)		—	—	—	—	—	—	—	—	2	—
6.	*Iliocryptus sordidus* Lievin		—	—	46	—	38	—	—	23	—	2
7.	*Camptocercus rectirostris* Schaedler		—	—	1	—	—	—	—	—	—	—
8.	*Monospilus dispar* G. O. Sars		—	—	—	—	—	—	—	9	—	1
9.	*Leydigia acanthocercoides* (Fischer)		—	—	—	—	1	—	—	1	—	—
10.	*Pleuroxus aduncus* (Jurine)		—	—	—	—	—	—	—	—	—	—
11.	*P. uncinatus* var. *balatonicus* Daday		—	—	—	—	—	—	—	2	—	—
12.	*Alona affinis* Leydig		—	—	—	—	—	—	—	—	—	—
13.	*Alona quadrangularis* O. F. Müller		—	—	—	—	—	—	—	—	—	—
14.	*Alonella rostrata* (Koch)		—	—	—	—	—	—	—	—	—	—
15.	*Ilyocypris bradyi* G. O. Sars		—	—	—	—	—	—	—	—	—	—
16.	*Cypridopsis newtoni* Brady et Robertson		—	21	—	—	—	—	—	—	—	—
17.	*Cypridopsis vidua* O. F. Müller		36	168	53	—	—	—	—	—	—	—
18.	*Cyclocypris ovum* (Jurine)		2	39	15	6	1	—	—	—	—	—
19.	*Candona* sp.		5	4	20	—	—	—	—	1	—	—
20.	*Darwinula stevensoni* (Brady et Robertson		—	—	—	—	—	—	—	—	1	1
21.	*Limnocythere inopinata* (Baird)		—	—	—	—	—	—	—	1	—	—
22.	*Eudiaptomus gracilis* (G. O. Sars)		1	1	42	—	3	—	2	—	4	—
23.	*Macrocyclops aldibus* (Jurine)		5	—	67	—	1	—	—	—	—	—
24.	*Eucyclops serrulatus* (Fischer)		2	3	4	—	21	—	1	1	—	—
25.	*Paracyclops fimbriatus* (Fischer)		—	3	1	—	9	—	1	10	2	9
26.	*Cyclops vicinus* Uljanin		1	1	2	—	4	—	2	2	2	—
27.	*Acanthocyclops viridis* (Jurine)		—	1	—	—	—	—	—	1	—	—
28.	*Acanthocyclops vernalis* (Fischer)		—	—	—	—	1	—	—	—	—	—
29.	*Mesocyclops leuckarti* (Claus)		—	—	10	—	—	—	—	1	2	—
	Cyclops sp.		—	—	40	—	5	—	—	—	1	1
30.	*Ectinosoma abrau* (Kritschagin)		—	—	—	—	—	—	—	—	—	—
31.	*Nitocra hibernica* (Brady)		—	—	—	—	—	—	—	4	—	—
32.	*Canthocamptus staphylinus* (Jurine)		57	25	136	2	16	—	—	1	—	—
33.	*Nannopus palustris* Brady		—	—	—	—	—	—	—	—	1	—
34.	*Limnomysis benedeni* Czern.		—	—	1	—	—	—	—	—	—	—
35.	*Corophium curvispinum* f. *devium* Wundsch		—	—	—	—	—	—	—	1	—	—
	Total		109	266	463	8	100	—	6	58	16	14

collecting sites, on October 3rd, 1969

Sewage-inflow area at Tihany										Area in front of the Biol. Res. Inst. Tihany, about 500 m from the shore				
The edge of reeds					About 30 m from the edge of reeds									
64	65	66	67	68	69	70	71	72	73	59	60	61	62	63
—	—	—	—	—	5	2	—	—	4	2	1	—	1	12
—	—	—	—	—	2	—	—	—	—	—	—	—	—	—
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	3	—	—	—	—	—
—	—	—	—	—	—	1	—	—	—	12	19	3	5	7
30	6	3	21	—	4	15	2	7	10	26	43	28	5	34
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	1	5	59	5	54	83	11	5	127	121	128	79	179
45	11	5	5	—	2	—	—	—	—	—	—	—	—	—
—	—	—	—	—	2	—	1	1	1	—	4	1	2	3
—	—	—	—	—	—	12	—	—	—	4	9	—	—	—
3	2	1	—	1	1	4	3	3	1	8	7	4	5	9
46	7	4	9	—	1	1	1	—	—	3	—	—	7	3
23	4	1	9	—	—	2	—	—	—	1	—	—	—	—
1	—	1	3	—	—	1	1	—	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	—	—	—	—	—	—	—	—	1	—	—
6	3	8	6	3	—	2	1	1	2	1	3	3	3	4
30	16	7	46	66	—	3	7	1	—	—	—	—	—	—
2	2	16	22	19	8	9	18	1	29	36	79	4	14	55
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
8	4	1	—	1	—	—	—	—	—	2	—	—	—	—
13	4	10	5	7	3	21	26	3	33	4	2	3	3	5
2	7	1	1	10	53	11	31	6	36	3	10	8	—	9
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	9	9	3	7	33	1	4	11	39	10	12	22
10	2	4	2	6	21	24	62	3	7	1	1	5	5	14
—	—	—	—	—	—	1	—	—	—	2	—	—	—	—
—	—	—	—	—	—	1	14	—	—	—	—	—	—	—
1	—	—	1	1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	1	1	—	—	—	—	—	1	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	11	1	1	1	1	1	1	1
221	69	63	144	182	111	172	295	39	136	243	340	198	142	357

TABLE V

Quantitative distribution of the macrobenthos at different collecting sites, on August 5th, 1969

No.	Species	Collecting sites	Sewage-inflow area at Balatonfüred					Sewage-inflow area at Tihany			Area in front of the Biol. Res. Inst. Tihany, about 500 m from the shore				
		Number of samples	1	2	3	4	5	11	12	13	19	20	21	22	23
1.	*Tanypus punctipennis* (MEIG.)		—	—	—	—	1	—	—	—	—	1	1	—	4
2.	*Procladius* sp.		—	—	1	16	—	1	—	25	10	57	118	57	67
3.	*Procladius* sp. puppae		—	—	—	—	—	—	—	—	—	—	—	1	—
4.	*Polypedilum* ex gr. *nubeculosum* (MEIG.)		—	—	—	—	1	—	—	—	—	—	—	—	—
5.	*Polypedilum* ex gr. *convictum* (WALK)		—	—	—	—	—	—	1	—	—	—	—	—	—
6.	*Harnischia* ex gr. *conjugens* KIEFF.		—	—	—	—	—	—	—	1	1	4	5	—	4
7.	*Chironomida* sp.		2	2	—	—	—	—	1	—	—	—	—	2	—
8.	*Piona* sp. I.		—	—	—	—	—	—	—	—	1	2	—	1	2
9.	*Piona* sp. II.		—	—	—	—	—	—	—	—	1	—	—	—	—
10.	*Tubifex* sp.		—	—	—	—	1	—	—	3	2	—	—	—	—
	Total:		2	2	1	16	3	1	2	29	15	64	124	61	77

Its distribution is similar in September, however, its number decreases: 20—43/dm² were found in front of the Institute and it was absent in the regions of the sewage-inflow of Tihany, 1—11/dm² occurred at the skirts of the reeds near the sewage-inflow of Balatonfüred and 80 m from it 10—56/dm² were found.

There was a further decrease in October: in front of the Institute 4—14, 30 m from the reeds of the sewage-inflow of Tihany 1/dm² was found. It was absent near the reeds at the sewage-inflow of Balatonfüred, while 3—4/dm² were found 80 m from it.

Cricotopus ex gr. *sylvestris* (FABR.)

It was found only in samples collected at the edge of the reeds of the sewage-inflow of Tihany.

Polypedilum ex gr. *nubeculosum* (MEIG.)

Only several individuals were secured in the months of August and September at the edge of the reeds and 80 m from it, at the sewage-inflow of Balatonfüred. In October it was present only at the edge of the reeds and 30 m from it, at sewage-inflow of Tihany.

Polypedilum ex gr. *convictum* (WALK.)

A single individual was found 80 m from the reeds of the sewage-inflow of Tihany in August; 1—9/dm² were observed 80 m from the reeds of Balatonfüred; it was absent in front of the Institute.

Polypedilum sp.

It cannot be evaluated.

Harnischia ex gr. *conjugens* KIEFF.

It occurred in 13 of the 45 samples of August, in 16 of the 25 samples of September and in 7 of the 25 samples of October.

In August it was found only in front of the Institute, a single individual was found 15 m from the reeds of the sewage inflow of Tihany. Its amount significantly increased by September, mainly in front of the Institute (2—11/dm^2) and 80 from the reeds of the sewage-inflow of Balatonfüred (1—28/dm^2). We failed to find any on the latter collecting site in August and October.

Harnischia ex gr. *viridula* (L.)

It was found only at the edge of the reeds of the sewage inflow of Balatonfüred in September.

Limnochironomus ex gr. *nervosus* (STAEG.)

It was not present in the samples of August, it appeared at the sewage-inflow and farther off in September, 3—19/dm^2 were found 30 m from the reeds of the sewage-inflow of Tihany in October.

Limnochironomus ex gr. *tritomus* KIEFF.

Its amount was insignificant, 30 m from the reeds of the sewage-inflow of Tihany in October.

Limnochironomus sp.

Quantitatively cannot be evaluated.

Cryptochironomus ex gr. *defectus* KIEFF.

A small number was found mainly in September.

Cryptochironomus holsatus LENZ (?)

Quantitatively cannot be evaluated.

Chironomus ex gr. *plumosus* L.

Several puppae but no larva were found.

Cladotanytarsus ex gr. *mancus* (WALK.)

No specimen were found in August. It was present in 14 of the 25 mud-samples of September and in 13 of those 25 of October. Its occurrence is especially significant in September 30 m from the reeds of the sewage-inflow of Tihany (27—48/dm^2). On the same place its number was very low in October.

TABLE VI

Quantitative distribution of the macrobenthos at

No.	Species	Collecting sites	Sewage-inflow area at Balatonfüred									
			The edge of reeds					About 80 m from the edge of reeds				
		Number of samples	24	25	26	27	28	29	30	31	32	33
1.	*Tanypus punctipennis* (MEIG.)		11	6	2	11	1	38	40	10	56	38
2.	*Tanypus punctipennis* puppae		3	1	—	—	—	—	—	—	1	1
3.	*Procladius* sp.		—	—	—	—	—	7	1	3	15	7
4.	*Procladius* sp. puppae		—	—	—	—	—	—	—	—	1	—
5.	*Cricotopus* ex gr. *sylvestris* (FABR.)		—	—	—	—	—	—	—	—	—	—
6.	*Polypedilum* ex gr. *nubeculosum* (MEIG.)		—	—	—	—	4	—	1	—	—	7
7.	*Polypedilum* ex gr. *convictum* (WALK.)		9	3	—	—	—	—	2	1	—	—
8.	*Polypedilum* sp. puppae		1	—	—	—	—	—	—	—	—	—
9.	*Harnischia* ex gr. *conjugens* KIEFF.		2	2	—	1	7	—	14	—	28	25
10.	*Harnischia* ex gr. *viridula* L.		—	—	1	2	—	—	—	—	—	—
11.	*Harnischia* sp. puppae		—	2	—	—	1	—	2	—	—	—
12.	*Limnochironomus* ex gr. *nervosus* (STAEG.)		—	—	—	3	16	—	—	—	1	1
13.	*Limnochironomus* ex gr. *tritomus* KIEFF.		—	—	—	—	1	—	—	—	—	—
14.	*Limnochironomus* sp.		—	2	—	—	—	—	—	—	—	—
15.	*Cryptochironomus* ex gr. *defectus* KIEFF		1	—	—	1	—	1	1	—	—	—
16.	*Crytochironomus holsatus* LENZ		—	—	—	—	—	—	1	—	—	—
17.	*Chironomus* ex gr. *plumosus* puppae L.		—	1	1	1	1	1	1	1	—	1
18.	*Cladotanytarsus* ex gr. *mancus* (WALK.)		—	2	3	2	—	—	1	—	—	—
19.	*Cladotanytarsus* ex gr. *mancus* puppae		—	—	—	—	—	—	—	—	—	—
20.	*Cladotanytarsus* sp.		—	—	—	—	1	—	—	—	—	—
21.	*Stempellina* ex gr. *bausei* KIEFF.		—	—	—	—	—	—	—	—	—	—
22.	*Chironomida* sp. puppae		—	—	—	—	—	—	—	—	—	—
23.	*Ceratopogonida* larvae		—	1	—	—	—	—	—	—	—	—
24.	*Psychoda* sp. larvae		—	—	—	—	—	—	—	—	—	—
25.	*Cloeon* sp. larvae		—	—	—	—	1	—	—	—	—	—
26.	*Caenis horaria* L. larvae		—	—	—	—	—	—	—	—	—	—
27.	*Oecetis* sp.		—	—	—	—	—	1	—	—	—	—
28.	*Oxyethira sagittifera* RIS.		—	—	—	—	—	—	—	—	—	—
29.	*Ortotrichia tetensii* KOLBE		—	—	2	—	—	1	—	—	—	—
30.	*Ecnomus tenellus* RAMBUR		—	—	—	—	—	—	—	—	—	—
31.	*Corixa* sp.		—	—	—	—	—	—	—	—	2	—
32.	*Piona* sp.		1	—	—	—	—	—	—	—	—	—
33.	*Limnesia maculata* O. F. MÜLLER		1	—	—	—	1	—	—	—	—	—
34.	*Hydracarina* sp.		—	—	—	—	—	—	—	—	—	—
35.	*Tubifex* sp.		1	18	6	14	8	1	—	—	12	3
36.	*Piscicola geometra* L.		—	—	—	1	—	3	—	—	—	—
37.	*Glossiphonia* sp.		—	—	—	—	—	3	—	—	—	—
38.	*Spongilla carteri* spp. *balatonica* ARNDT		—	—	—	—	—	—	1	—	—	—
	Total		30	38	15	35	41	55	64	16	116	83

A small number of it occurred in 9 samples of the 10 collected in front of the Institute in September and October. Only a few individuals were found at the sewage-inflow.

Stempellina ex gr. *bausei* KIEFF.

Quantitatively cannot be evaluated.

different collecting sites, 2nd and 3rd September 1969

Sewage-inflow area at Tihany										Area in front of the Biol. Res. Inst. Tihany, about 500 m from the shore				
The edge of reeds					About 30 m from the edge of reeds									
34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
—	—	—	—	—	—	—	—	—	—	15	14	9	9	10
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	—	—	36	28	20	23	43
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
—	—	—	5	2	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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1	—	—	—	1	—	—	—	3	—	9	11	2	7	7
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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—	1	—	—	—	—	—	1	—	1	—	—	—	—	—
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—	—	—	—	—	—	1	1	—	1	1	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	48	28	31	27	27	1	1	2	—	1
—	—	—	—	—	—	3	5	3	5	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	2	—	—	—	—
—	—	1	11	1	1	—	—	—	—	—	—	—	2	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	3	—	—	—	—	—	—	—	—	—	—	—
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—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	2	1	—	2
—	—	1	2	—	35	15	42	6	30	2	1	5	3	1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	1	2	22	4	85	47	81	40	71	66	57	40	44	64

Ceratopogonidae sp.

Quantitatively cannot be evaluated.

Psychodidae, Psychoda sp.

Quantitatively cannot be evaluated.

TABLE VII

Quantitative distribution of the macrobenthos at

No.	Species	Collecting sites	Sewage-infolw area at Balatonfüred									
			The edge of reeds					About 80 m from the edge of reeds				
		Number of samples	49	50	51	52	53	54	55	56	57	58
1.	*Tanypus punctipennis* (MEIG.)		—	—	—	—	—	—	11	7	5	2
2.	*Procladius* sp.		—	—	—	—	—	—	4	3	—	—
3.	*Polypedilum* ex gr. *nubeculosum* (MEIG.)		—	—	—	—	—	—	—	—	—	—
4.	*Polypedilum* sp.		—	—	—	—	—	—	—	—	—	—
5.	*Harnischia* ex gr. *conjugens* KIEFF.		—	—	—	—	—	—	—	—	—	—
6.	*Limnochironomus* ex gr. *nervosus* (STAEG)		—	—	—	—	—	—	—	—	—	—
7.	*Limnochironomus* ex gr. *tritomus* KIEFF		—	—	—	—	—	—	—	—	—	—
8.	*Cryptochironomus* ex gr. *defectus* KIEFF		—	—	—	—	—	1	—	—	—	—
9.	*Cladotynatarsus* ex gr. *mancus* (WALK.)		—	—	—	—	—	—	7	—	1	—
10.	*Chironomida* sp. larvae		—	—	—	—	—	—	—	—	—	—
11.	*Chironomida* sp. puppae		—	—	—	—	—	—	—	—	—	—
12.	*Caenis horaria* L.		—	—	—	—	—	—	—	—	—	—
13.	*Ecnomus tenellus* RAMBUR		—	—	—	—	—	—	—	—	—	—
14.	*Corixa* sp.		—	—	—	—	—	—	1	—	—	—
15.	*Piona* sp.		—	—	—	—	—	—	—	—	—	—
16.	*Limnesia maculata* O. F. MÜLLER		—	—	—	—	—	—	—	—	—	—
17.	*Tubifex* sp.		—	—	—	—	—	—	—	—	—	—
	Total		—	—	—	—	—	1	23	10	6	2

TRICHOPTERA

Several species were found in small number, quantitatively cannot be evaluated.

HEMIPTERA

Corixa sp.

Quantitatively cannot be evaluated.

HYDRACARINA

Three species were found in different periods, quantitatively cannot be evaluated.

The uneven distribution of the zoobenthos an d the bottom

The quantitative data unanimously revealed that there were differences between the qualitative and quantitative composition of species of all the three collecting sites *(Tables I—VII)* when investigating 5 parallels of each, which cannot be attributed merely to methodical inadequacy (see for methodical problems: PONYI et al. 1967). The differences may be connected with the uneven distribution of detritus at the bottom of the collecting sites. Especially large differences were observed along the borders of the reeds, decreasing toward the open water. The amounts of the detritus were 44,11, 18,51 and

different collecting sites, 3rd October, 1969

Sewage-inflow area at Tihany										Area in front of the Biol. Res. Inst. Tihany, about 500 m From the shore				
The edge of reeds					About 30 m from the edge of reeds									
64	65	66	67	68	69	70	71	72	73	59	60	61	62	63
2	—	—	1	—	2	—	—	1	—	4	16	8	3	7
—	—	—	—	—	1	—	—	1	—	9	14	5	4	10
2	—	—	—	3	1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
4	—	—	—	—	4	—	—	—	—	—	8	6	2	2
—	1	—	1	1	—	19	4	3	5	—	—	—	—	—
—	—	—	—	—	—	4	2	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	14	1	2	—	1	3	5	4	7	6	3
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
1	—	—	1	3	—	—	—	—	2	—	—	—	—	—
—	—	—	—	—	2	1	1	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	1	—	—	—	1
—	—	—	—	—	—	1	—	—	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
—	—	—	—	—	—	1	1	1	1	—	—	—	—	—
12	1	—	3	21	11	28	8	7	13	20	42	26	17	23

13 ml wet detritus/sample at the border of the reeds at the sewage-inflow of Balatonfüred (2nd September). At the same time 80 m from it, values of 68, 81, 53, 51 and 60 ml wet detritus/sample were recorded, demonstrating a more even distribution of the detritus. Similar situation was found in the region of the sewage-inflow of Tihany, too. The differences in the distribution of detritus are significantly lower in front of the Biological Research Institute (15—25 ml wet detritus/sample).

These facts call our attention to a zonal or mosaic-pattern arrangement of the bottom. It is known that some species closely associate themselves with the bottom and its structure due to factors like oxygen-requirement, pollutions, microcurrents. This association is especially significant in the case of species of restricted motility, being otherwise in need of a certain consistence of the bottom because of their habits, as well as of those being more agile and having a feeding habit based on the detritus.

The knowledge of cenological relations and exact distribution of mud-living animals in the littoral zone can most probably be achieved by applying the principle of the "mosaic-pattern" similarly to the investigation of flowing waters (OLÁH, 1967). Similar detailed investigations could reveal finer structural differences over and above the qualitative and quantitative differences existing between the benthic fauna of the littoral sectors displaying different degrees of eutrophication. These problems should be solved in the future.

Differences between the collecting sites considering the benthic fauna

NEMATODA

The three collecting sites are sharply separated from one another from a quantitative point of view as it was shown by the data of August. The total number of Nematoda was 502 at the sewage-inflow of Tihany, 230 in front of the Institute and 27 at the sewage inflow of Balatonfüred.

On the basis of the relative amount of detritus *(Table VIII)* the open water area in front of the Institute can be considered as of lowest degree of eutrophi-

TABLE VIII

Detritus content of the samples on the basis of 5 parallels (ml)

Collecting sites / Date of collecting		VIII. 5.	IX. 2—3.	X. 3.	Mean
Sewage-inflow area at Balatonfüred	The edge of reeds	20**	27	40	
	About 80 m from the edge of reeds	6*	63	70	37
Sewage-inflow area at Tihany	The edge of reeds	8*	73	12	
	About 30 m from the edge of reeds	6**	5	15	20
Area in front of Biol. Res .Inst. Tihany, about 500 m from theshore		7	21	8	12

* = Datum calculated on the basis of one sample
** = Data calculated on the basis of 2 samples

cation. Comparing the number of species (7) and individuals (230) found here with those of other collecting sites, the following numbers can be compared.

	Total number of		No. of different	
	species	indiv.	species	indiv.
Sewage-inflow of Tihany	17	502	10	313
Sewage-inflow of Balatonfüred	7	27	3	16

The data show that more than 50% of the individuals collected at the sewage-inflow belong to the species being absent in the "control" area. Consequently, the degrees of eutrophication may be different on the three collecting sites.

The data obtained from samples of the inflow area of the sewage-inflow of Tihany indicate that there is a connection between the number of Nematoda and the condition (degree of mineralization) of detritus. Namely, one can suppose anaerobic decomposition processes considering the black, putrid mud smelling of hydrogen sulphide, collected here. Such phenomenon was not observed in the region of the sewage-inflow of Balatonfüred and the number of Nematoda was also very low.

The total number of organisms in the samples collected in the months of August—October differed at the collecting sites.

In front of the Institute the highest number of animals was found in August (341/5 samples), somewhat decreased by September (271/5 samples) and the lowest value was found in October (126/5 samples) *(Tables V.—VII)*.

The number of organisms was practically the same at the sewage-inflow of Tihany during the three months:

53/3 samples in August,
31/5 samples in September,
39/5 samples in October.

In the samples taken 30 m from the sewage-inflow values of 324/3 samples of September and 57/5 samples of October were found.

At the sewage-inflow of Balatonfüred the following numbers were observed:

21/5 samples in August,

159/5 samples in September, and these animals were not found at all in October. 80 m from the inflow area 334/5 samples and 42/5 samples occurred in September and October, respectively.

The above data reveal that the maximal occurrence of these animals was observed in September *(Table VI)*. The relatively high values of August in front of the Institute and their gradual decrease by October, were caused by the changes of number of *Procladius* sp.

Considering the total number of organisms collected at the different sites during the three months, the following values were obtained:

In front of the Institute	738
30 m from the sewage-inflow of Tihany	381
80 m from the sewage-inflow of Balatonfüred (except in August)	376
At the sewage-inflow of Tihany	104
At the sewage-inflow of Balatonfüred	180

The majority of the species of mass-occurrence, e.g. *Procladius* sp. and *Tanypus punctipennis* seem to be found in front of the Institute, poorest in organic detritus. These species either are absent in the immediate vicinity of the sewage-inflow or only occur in a very low number. Receding from the inflow regions, their number increases *(Tables V—VII)*. This pattern of occurrence indicates that these species do not endure high detritus content. This is evidenced also by the absence of these two species in the mud containing hydrogen sulphide, collected at the sewage-inflow of Tihany during September and October.

Similar distribution is characteristic also for *Harnischia* ex gr. *conjugens*, however, it is not so easy to evaluate because of its low number.

The distribution of *Limnochironomus* ex gr. *nervosus* was just the opposite compared to that of the above species. It was absent in front of the Institute during all the three months, whereas it occurred both at 30 m from the sewage-inflow of Tihany and in the immediate vicinity of that of Balatonfüred *(Tables VI—VII)*.

An extremely high number of *Cladotanytarsus* ex gr. *mancus* was observed 30 m from the sewage-inflow of Tihany in September while at the same time

it was only of scattered occurrence at other collecting sites. In October even the above site contained a small number of it, thus one cannot be sure on the basis of our data about its distribution.

One faces similar difficulties when analysing the distribution of *Tubifex* sp. and the relative detritus content of the mud. The majority of species of genus Tubifex is well-known "indicator" of high detritus content. Nevertheless, on the basis of their number found in the samples, one cannot differentiate between the collecting sites.

Trichoptera and Ephemeroptera species were of scattered occurrence found only in areas near the shoreline.

In the inflow of sewage-inflow small number of *Ceratopogonida* and *Psychoda* larvae were observed. Their high detritus-requirement is connected with their feeding habit.

CRUSTACEA

The Crustacea fauna of the collecting sites differed from each other during all the three months.

In spite of the low number of individuals observed in August, it can be established that the number of Cladocera, Ostracoda and Copepoda is higher in front of the Institute than at the other two collecting sites *(Table IX)*. The difference is especially conspicuous when considering the total number of Crustacean individuals. The regions of the two sewage-inflows do not differ sharply from each other. Significant difference was observed only in the number of Cladocera species, however, this loses its significance when considering the extremely low number of individuals of almost all Crustacean species observed in August. This "pauperization" of August in Curstacean species of the benthos had also been observed earlier. (Ponyi, 1966; 1969). Taking into consideration the literary data (Cole, 1955; Gurvic, 1961; Smyly, 1961; Staňczykowska and Przytocka-Jusiak, 1968), the decrease of meiobenthic popula-

TABLE IX

Qualitative and quantitative distribution of Crustacea found in the mud according to the main groups. Averages of 5 samples of each, 5th August, 1969

Collecting sites	Cladocera		Ostracoda		Copepoda		Malacostraca		Total	
	Number of species	Total number of individuals	Number of species	Total number of individuals	Number of species	Total number of individuals	Number of species	Total number of individuals	Number of species	Total number of individuals
Sewage-inflow area at Balatonfüred	4	4	2	6	7	27	—	—	13	37
Sewage-inflow area az Tihany*	1	1	3	6	5	19	1	3	10	29
Area in front of the Biol. Res. Inst. Tihany about 500 m from the shore	6	23	2	17	7	551	—	—	15	591
								Total number of individuals		657

* = average of 3 samples

tion (MARE, 1942; MCINTYRE, 1964) seems to take place regularly in summer in certain lakes. According to the investigations published hitherto, the decrease may be caused partly by the propagation of the carnivorous members of macrobenthos and partly by an oxygen-shortage in the mud-layer (MCINTYRE, 1964; KAJAK et al. 1968; STAŃCZYKOWSKA and PRZYTOCKA-JUSIAK, 1968). There are, however, data reporting a relatively high pesticide content of planktonic Crustacea of Lake Balaton in summer months, decreasing only in September (PONYI et al. 1968). Thus, it can be assumed that different pollutions also contribute to the quantitative decrease of benthic Crustacea.

The number of Crustacean individuals significantly increased in September compared to August, especially that of Cladocera *(Table X)*. The characteristic mud-living and detritophag species *(Iliocryptus sordius, Leydigia*

TABLE X

Qualitative and quantitative distribution of Crustacea found in the mud according to the main groups. Each datum is an average of 5 samples, 2nd and 3rd of September, 1969

Collecting sites	Cladocera		Ostracoda		Copepoda		Malacostraca		Total	
	Number of species	Total number of individuals	Number of species	Total number of individuals	Number of species	Total number of individuals	Number of species	Total number of individuals	Number of species	Total number of individuals
Sewage-inflow at Balatonfüred	5	168	3	15	7	47	2	73	17	303
Sewage-inflow at Balatonfüred, 80 m off reeds	6	157	1	2	6	75	2	72	15	306
Sewage-inflow at Tihany	6	64	4	12	6	50	3	9	19	135
Sewage-inflow at Tihany, 30 m off reeds	9	86	3	7	7	43	2	123	21	259
In front of Biol. Res. Inst., 500 m off the shore	9	213	—	—	4	249	1	9	14	471
Total number of individuals:										1474

acanthocercoides) propagated at the collecting site of Balatonfüred, while in front of the Institute mainly the number of juvenile *Diaphanosoma* increased markedly *(Table III)*. The number of Ostracoda somewhat increased at the sewage inflows whereas it was reduced to zero in front of the Institute. The number of Copepoda individuals increased only in the latter region caused by the copepodid stages of *Cyclops vicinus*. Their number was about the same at the other two places. The number of *Malacostraca* considerably increased at the sewage-inflows it was, however, insignificant at other places. The number of species observed at the collecting sites is nearly identical except that of the Ostracoda. The pauperism in Ostracoda in the water area 80 m from the inflow of the sewage-inflow of Balatonfüred is conspicuous.

The total number of individuals was high in October compared to the previous months. The distribution of the main Crustacean groups was also

TABLE XI

Qualitative and quantitative distribution of Crustacea found in the mud according to the main groups. Each datum represents an average 5 samples, 3rd October, 1969

Collecting sites	Cladocera		Ostracoda		Copepoda		Malacostraca		Total	
	Number of species	Total number of individuals	Number of species	Total number of individuals	Number of species	Total number of individuals	Number of species	Total number of individuals	Number of species	Total number of individuals
Sewage-inflow at Balatonfüred	5	111	4	370	9	464	1	1	19	946
Sewage-inflow at Balatonfüred, 80 m off reeds	6	41	3	4	9	48	1	1	19	94
Sewage-inflow at Tihany	6	302	4	197	6	180	—	—	16	679
Sewage-inflow at Tihany, 30 m off reeds	13	250	3	20	7	471	1	12	24	753
In front of Biol. Res. Inst., Tihany 500 m off the shore	9	902	3	16	8	362	—	—	20	1290
Total number of individuals:										3752

markedly changed *(Table XI)*. The number of mud-living Cladocera significantly increased *(Table IV)* in front of the Institute and at the sewage-inflow of Tihany, however, it decreased at Balatonfüred. The most significant changes were observed in the case of Ostracoda representing the greatest differences between the collecting sites. Large amount of *Cypridopsis* species feeding on definitely suspended organic materials occurred at the edge of reeds of the inflow areas of the sewage-inflowes at Tihany and Balatonfüred; it was practically absent at other places. The amount of Copepoda was uniformly high except at one collecting site. Only the number of Cladocera species was different at the collecting places.

Summarizing the quantitative and qualitative distribution of Crustacean species found during the whole period of investigations (August—October), different Crustacean populations characterize the three collecting sites *(Tables XII)*. While the definitely detritophag Ostracoda species found of voluminous plant fragments occurred at the collecting site of Balatonfüred *(Table VIII)*, considerable amounts of *Monospilus dispar* live in the benthic areas farther from the shoreline, covered only with thin layer of detritus (SEBESTYÉN, 1965).

One of the Harpacticida *(Canthocamptus)* lives only in regions covered by a thick layer of detritus, while another *(Nannopus)* prefers the mud surface poor in detritus (PONYI, 1969).

On the basis of qualitative and quantitative distribution of Crustacea the three collecting sites seem to represent different degrees of eutrophication, characterized by different Crustacean populations. Further investigations can reveal whether these differences are permanent or exist only in the period investigated.

TABLE XII

Qualitative and quantitative differences of Crustacea populations observed at the sites of investigations (summarized data of months August—October, 1969. Numbers = individuals present in all samples)

No.	Species	Collecting sites	Sewage-inflow at Balatonfüred		Sewage-inflow at Tihany		Tihany
			The edge of reeds	About 80 m from the edge of reeds	The edge of reeds	About 30 m from the edge of reeds	In front of the Biol. Res. Inst. Tihany, about 500 m from the shore
1.	*Macrothrix laticornis* (JURINE)		—	2	—	2	46
2.	*Monospilus dispar* G. O. SARS		—	10	71	182	635
3.	*Pleuroxus uncinatus* var. *balatonicus* DADAY		—	15	—	12	14
4.	*Alona affinis* LEYDIG		1	—	7	40	40
5.	*Alona quadrangularis* (O. F. MÜLLER)		2	10	67	4	17
6.	*Alonella rostrata* (KOCH)		—	—	39	3	1
7.	*Cyclocypris ovum* (JURINE)		73	2	1	—	—
8.	*Darwinula stevensoni* (BRADY et ROBERTSON)		1	2	30	6	23
9.	*Isocypris arnoldi* DUBOWSKY		7	—	2	—	—
10.	*Cypridopsis newtoni* (BRADY et ROBERTSON)		21	—	—	—	—
11.	*Cypridopsis vidua* (O. F. MÜLLER)		257	—	—	—	1
12.	*Limnocythere inopinata* (BAIRD)		—	1	167	16	—
13.	*Macrocyclops albidus* (JURINE)		74	—	—	—	1
14.	*Eucyclops serrulatus* (FISCHER)		39	16	32	2	2
15.	*Cyclops vicinus* ULJANIN cop. stad.		30	44	27	164	664
16.	*Canthocamptus staphylinus* (JURINE)		257	28	5	—	—
17.	*Nannopus palustris* BRADY		—	1	—	2	16

Summary

1. Investigating the zoobenthos between August—October 1969, 92 taxa were found in the following distribution: 1 Porifera, 18 Nematoda, 1 Oligochaeta, 2 Annelida, 42 Crustacea, 2 Ephemeroptera, 16 Chironomida, 1 Ceratopogonida, 1 Psychodida, 4 Trichoptera, 1 Hemiptera, 3 Hydracarina.

Isocypris arnoldi DUBOWSKY, *Limnochironomus* ex gr. *tritonus* KIEFF., *Cryptochironomus* ex gr. *defectus* KIEFF. is new to the fauna of Hungary.

Species new to the fauna of Lake Balaton: *Ilyocypris bradyi* G. O. SARS, *Cypridopsis newtoni* BRADY et ROBERTSON, *Cypridopsis vidua* (O. F. MÜLLER), *Limnochironomus* ex gr. *nervosus* (STAEG.), *Glyptotendipes* ex gr. *anomalus* KIEFF., *Cladotanytarsus* ex gr. *mancus* (WALK.).

2. The Zoobenthos of the three collecting sites (inflow areas of the sewage-inflow at Tihany and Balatonfüred and the area in front of the Biological Research Institute) showed considerable quantitative differences as far as Nematoda, Crustacea and Insecta are concerned.

The total number of individuals was the lowest in August. The decrease of populations of the different groups of animals in summer months was shown in the previous investigations. The reasons of this phenomenon are not exactly

known in Lake Balaton, however, one can suppose that it is caused by the oxygen-shortage and the carnivorous members of the macrobenthos.

Variable quantitative relations were observed in groups of animals collected at different sites in different months. More detailed analyses are needed to reveal the reasons of this phenomenon.

3. The summarized data obtained during the total period of investigations unanimously show definite quantitative and qualitative differences in the composition of species found at the three collecting sites. These differences may be connected with the quantitative distribution of the detritus and the propagation of detritophag organisms. The phenomenon was especially striking in the case of Crustacea being heterogeneous from point of view of feeding.

4. The degree of eutrophication seems to be different on the three collecting sites when considering the investigations on the zoobenthos.

On the basis of the detritophag benthic fauna, the most advanced level of eutrophication was present at Balatonfüred, followed by the inflow area of the sewage-inflow of Tihany, whereas the lowest degree was observed in front of the Biological Research Institute.

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A BALATON FENÉKFAUNÁJÁNAK ÖSSZEHASONLÍTÓ VIZSGÁLATA KÉT SZENNYVÍZBEFOLYÓ KÖRNYÉKÉN

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Összefoglalás

1. Az 1969 augusztus—októberi zoobentosz vizsgálatok során 92 taxont találtunk, melyeknek megoszlása a főbb állatcsoportokban a következő: Porifera 1, Nematoda 18, Oligochaeta 1, Annelida 2, Crustacea 42, Ephemeroptera 2, Chironomidae 16, Ceratopogonidae 1, Psychodidae 1, Trichoptera 4, Hemiptera 1, Hydracarina 3 faj.

Magyarország faunájára új fajok: *Isocypris arnoldi* Dubowsky, *Limnochironomus* ex. gr. *tritonus* Kieff.

Balaton faunájára új fajok: *Ilyocypris bradyi* G. O. Sars, *Cypridopsis newtoni* Brady et Robertson, *Cyptidopsis vidua* (O'. F. Müller), *Limnochironomus* ex. gr. *nervosus* (Staeg.), *Cryptochironomus* ex gr. *defectus* Kieff., *Cladotanytarsus* ex gr. *mancus* (Walk.).

2. A három gyűjtőhely (balatonfüredi — 2. gy. pont —, tihanyi szennyvízbefolyó — 2. gy. pont. — és a Biol. Kut. Int. előtti vízterület — 1. gy. pont —) zoobentosza jelentős mennyiségi különbségeket mutat, a Nematoda, Crustacea és Insecta állatcsoportokat illetően.

A három hónap közül az össz egyedszámot tekintve az augusztusi a legszegényebb. A nyári népesség lecsökkenést a korábbi vizsgálatok alapján, a különböző szervezet-

csoportokra vonatkozóan már kimutattuk. Ennek oka balatoni vonatkozásban pontosan nem ismert, feltételezhető azonban, hogy ezt a jelenséget a mezobentoszra vonatkozóan az oxigén lecsökkenése mellett a ragadozó mikrobentosz tagok idézhetik elő.

A mennyiségi viszonyok különböző hónapokban és gyűjtőhelyeken állatcsoportonként változnak. Ennek okát csak részletesebb analízisek tárhatják fel.

3. Az egész vizsgálati periódus együttes adatai azonban egyértelműen mutatják, hogy a három gyűjtőhely között a fajok mennyiségi, minőségi összetételében határozott eltérések vannak. Ezek a különbségek kapcsolatba hozhatók a formált tápanyag (detritusz) mennyiségi megoszlásával és a detrituszt fogyasztó szervezetek elterjedésével.

A jelenség különösen a táplálkozásbiológiailag heterogén Crustaceáknál a legszembetűnőbb.

4. A zoobentosz-vizsgálatok alapján úgy tűnik, hogy a három gyűjtési terület eutrofizálódás mértéke eltérő. A formált táplálékra épülő fenékfaunák alapján az eutrofizálódás legelőrehaladottabb állapotában a balatonfüredi terület után a tihanyi szennyvízbeömlés és környéke van, ezt követi a Biol. Kut. Int. előtti víztérség.