The enchytraeid fauna (Annelida, Oligochaeta) of accumulated debris along the shore of Lake Balaton, and seasonal dynamics of the species

By

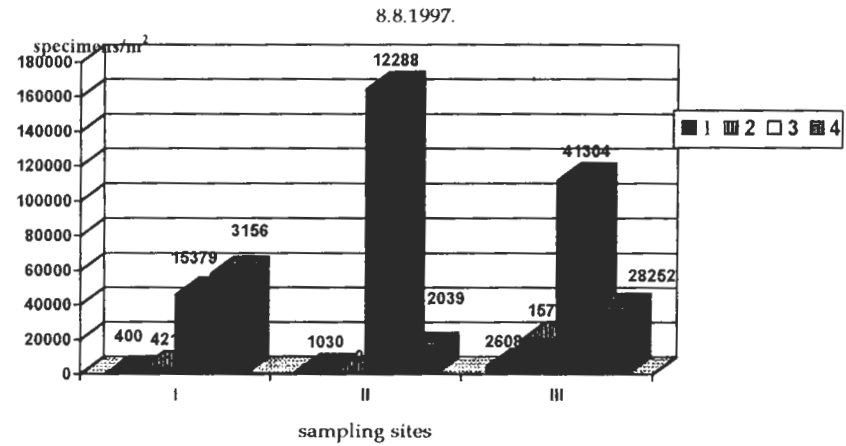
K. DÓZSA-FARKAS*

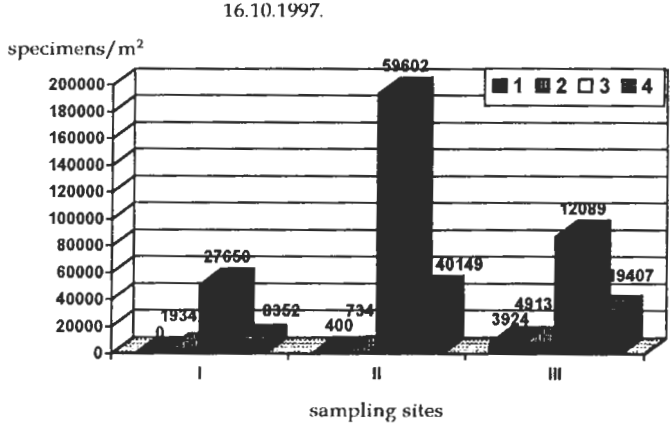
Abstract. The enchytraeid fauna and their seasonal dynamics along the shoreline of the largest shallow lake of Europe, Lake Balaton was investigated. A total number of 19 species belonging to 9 genera were found. Dominant species were *Enchytraeus christenseni, E. buchholzi, Henlea ventriculosa, H. perpusilla* and in the wet habitat *Marionina riparia* and *M. argentea.* Enchytraeids inhabiting dryer, accumulated, thick debris yielded a maximal value of 193500 ±59602 specimen/m² in October 1997 and 217900 ± 10872 specimens/m² in July 1998. In the wet debris the abundance was some hundred or thousand specimens/m². In the nearby soil behind the debris it was lower. However, the number of species was higher in the soil. The abundance of enchytraeids showed a seasonal decline in winter.

Lake Balaton is the largest shallow lake of Europe situated in the Transdanubium (western part of Hungary), at an altitude of 104.8 m above the Adriatic Sea level (Herodek et al., 1988). One part of the primary production is washed ashore (termed debris) along the natural shoreline and is biologically decomposed after a while. The other part decays in the water and increases the eutrophication of the lake. Contiguous natural water fronts disappeared during the last years, many of them were filled up and paved. Thus, development of debris has been hampered noticeably. In other words, organic detritus from the Lake cannot get out to the shore any more, or if any storm throws it out to the stones of the shoreline, it dries out very fast, or the next more powerful wave carries it back to the water again. Only few parts of the shoreline were preserved in natural condition usually bordering some of the beaches.

The objectives of our research were: *1)* to establish the quantity of detritus ashore by the waves on the shore, *2)* to record enchytraeid species inhabiting the debris of different condition, *3)* to determine the dominant elements of the enchytraeid fauna and *4)* to ascertain the seasonal dynamic of these animals.

*Dr. *Klára Dózsa-Farkas,* ELTE Állatrendszertani és Ökológiai Tanszék (Department of Systematic Zoology and Ecology of the Eötvös Loránd University), 1088 Budapest, Puskin u. 3, Hungary.





Figs. 1–2. Abundance of enchytraeids at three sampling sites (I-II-III) and in different types of debris and soil (1-2-3-4). August and October, 1997. (Numbers above bars: SD)

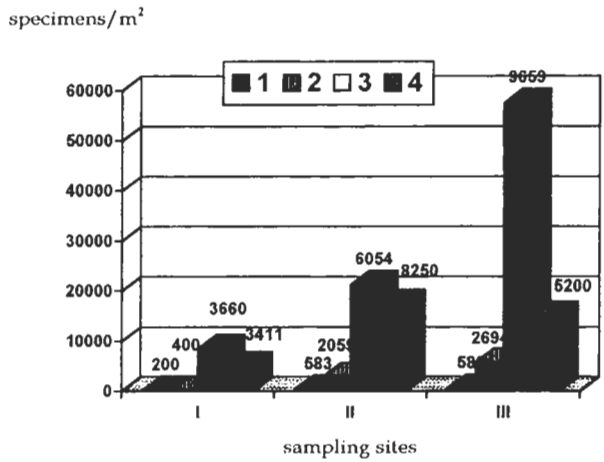


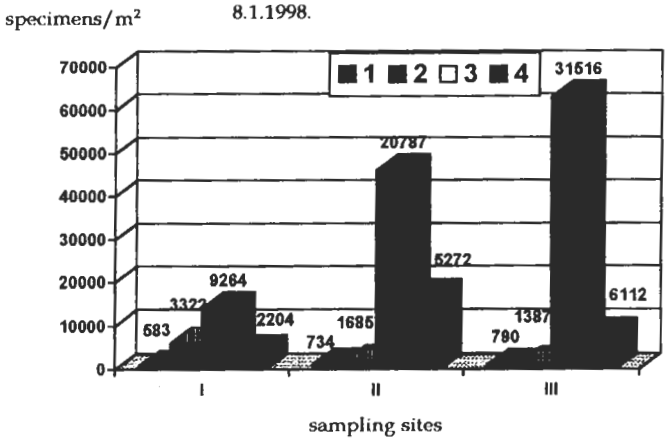
Fig. 3. Abundance of enchytraeids at three sampling sites (I-II-III) and in different types of debris and soil (1-2-3-4). November, 1997. (Numbers above bars: SD)

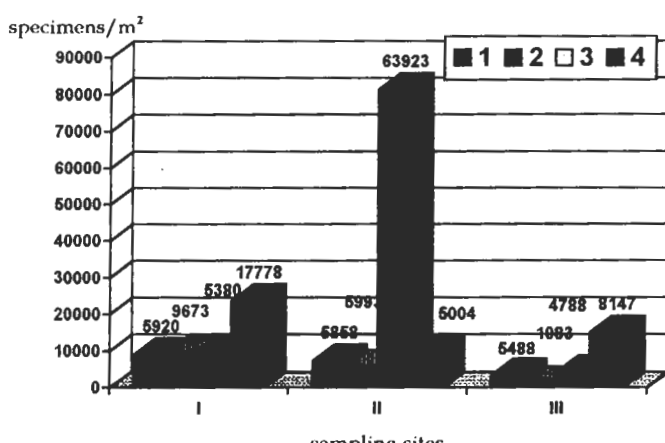
Materials and methods

Our investigations were carried out during the period from August 1997 to November 1998. Samples were taken seven times in approximately every season. The three localities of our research were situated at the southern part of the Lake, where the water was quite shallow: in Balatonszárszó 2 km removed from each other (sampling sites I and II) and near Balatonberény (III). There are holiday homes at the localities I and II, 20 m away from the shore, whereas locality III is free of any houses. All the three sampling sites are situated in the reeds, interrupted by bathing access, where the water ashore large quantities of detritus (rising to max. 50 cm). The samples were taken with the usual enchytraeid sampler (20 cm^2 surface, 5 cm depth) along a 3 m wide water-shore transect of the debris of three different conditions: *1.* detritus-water interface at the waterline, *2.* wet debris deposited at the edge of shore, *3.* drier, thickly accumulated debris and one sample was obtained from the soil behind the debris *(4)*.

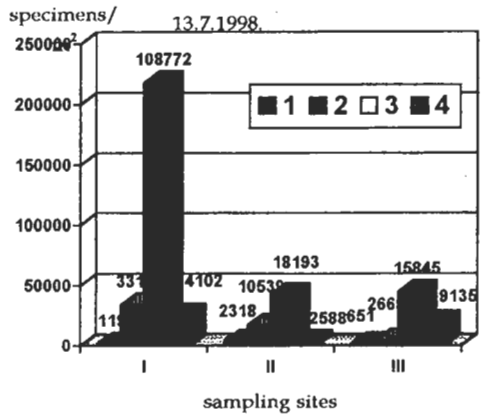
The samples were transported in polyethylene bags to the laboratory, where the worms were extracted by O'Connor's method and identified alive. In addition, we investigated also the aquatic oligochaetes, but they were identified only at family (Tubificidae, Lumbriculidae, Naididae) or class level (Aeolosomatida).

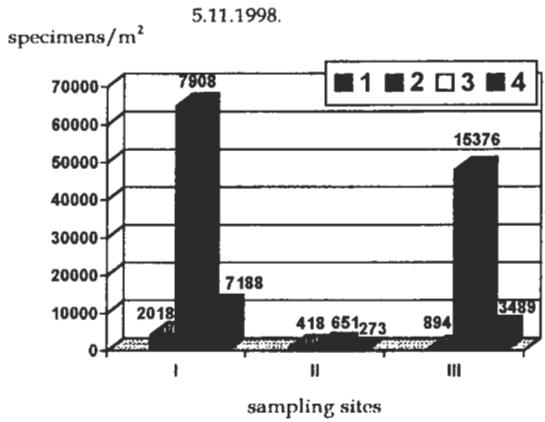
Obtaining quantitative samples was impossible from the debris of macrovegetation put out to the paved shoreline by the waves.





Figs. 4–5. Abundance of enchytraeids at three sampling sites (I-II-III) and in different types of debris and soil (1-2-3-4). January and April, 1998. (Numbers above bars: SD)





Figs. 6-7. Abundance of enchytraeids at three sampling sites (I-II-III) and in different types of debris and soil (1-2-3-4). September and November, 1998. (Numbers above bars: SD)

Results

The 19 recorded enchytraeid species were as follows:

Achaeta pannonica Graefe, 1989
Buchholzia appendiculata (Buchholz, 1862)
Cognettia glandulosa (Michaelsen, 1888)
Cernosvitoviella minor Dózsa-Farkas, 1990
Enchytraeus buchholzi Vejdovsky, 1879
Enchytraeus bulbosus Nielsen & Christensen, 1963
Enchytraeus christenseni Dózsa-Farkas, 1992
Enchytraeus lacteus Nielsen & Christensen, 1961
Fridericia bulbosa (Rosa, 1887)
Fridericia galba (Hoffmeister, 1843)
Fridericia paroniana Issel, 1904
Fridericia sp.
Hemifridericia parva Nielsen & Christensen, 1959
Henlea heleotropha (Steph., 1922)
Henlea nasuta (Eisen, 1878)
Henlea perpusilla Friend, 1911
Henlea ventriculosa (d'Udekem, 1954)
Marionina argentea (Michaelsen, 1889)
Marionina riparia Bretscher, 1899

Comparing with earlier investigation made along the Lake's shore (Dózsa-Farkas, 1995), we found two species new for this area (*Enchytraeus lacteus* and *Fridericia* sp.), however, four formerly unusual species were not present this time.

Species composition and seasonal changes were determined in the debris of different decomposition stages. The dominance values yielded in tables 1-5 present the results from October 1997 and all the investigated seasons in 1998. *Buchholzia appendiculata* turned to be an extremely dominant species. Its outstandingly high dominance is probably a consequence of the unusual way of its reproduction: the fragmentation. Enchytraeid species with such a reproduction strategy may effectively colonise new habitats (Dózsa-Farkas, 1996). In thick debris deposits (3) we often estimated its nearly 40 % dominance. In favourable seasons, e.g. July, it even had a dominance of 92 % at site 1 (Szárszó). A considerable number of cosmopolitan species of wet shorelines rich in organic material such as *Enchytraeus christenseni, E. buchholzi, Henlea ventriculosa* and *H. perpusilla* occurred in the debris. Dominant species of the wet samples were *Marionina riparia* and *M. argentea.*

Investigation of the enchytraeids' quantitative distribution (Figs. 1-7) revealed that they play a subordinated role in the wet debris habitat. Mostly some hundred or thousand specimens could be found per m^2 with quite uneven distribution and high standard deviation. Maximal abundance values were found in 1997 at Balatonberény (area III/2 in August: 20,200 ± 15,728 specimens/m^2) and in 1998 at Balatonszárszó (area I/2 in April: 9100 ± 5920 specimens/m^2). Aquatic oligochaete families (Naididae, Lumbriculidae, Tubificidae) were present in similarly low abundance in this environment (400–1100 specimens/m^2). An interesting gradation of Aeolosomatida population was estimated in summer 1998, although the abundance value

was 45,400 ± 46,259 specimens/m² in sampling site I, with quite an uneven distribution. We didn't meet such a mass abundance last year.

The amount of enchytraeids considerably increases in the organic detritus, deposited in thick strata (3). Their abundance generally fluctuates between 10,000 and 100,000 specimens/m², but it reached an outstanding maximum in October 1997 at sampling site II (193,500 ± 59,602 specimens/m²) (Fig. 2), and in July 1998 at sampling site I (217,900 ± 10,872 specimens/m²) (Fig. 6). These facts suggest that enchytraeids play an important role in the decomposition of organic material. In the soil behind the debris, we measured lower abundance values, fluctuating between 5000 and 58,000 specimens/m² in 1997 (Figs. 1–3) and 4000–25,500 specimens/m² in 1998 (Figs. 4–7). In the soil, the total number of enchytraeids was lower, however, the number of species was the highest with 15 ones, in contrast to the 8–11 species in the debris; the latter fact shows that the soil seems to be a different habitat type for them. Moreover, *Achaeta pannonica* and *Enchytraeus bulbosus* occurred exclusively in the soil samples (Tables 1–5). *Fridericia* sp. – resembling *F. ratzeli* (Eisen, 1872) as well as *F. sacculata* Bell, 1936 described from Canada – was also recorded only in the soil samples, but a more detailed description requires further research.

During the winter months, the abundance of enchytraeid population diminished, the only habitat where they thrived was the thicker debris with specimen numbers per m² 63,100 ± 28,189 (site III, 8. January 1998) (Fig. 4), and 64,900 ± 7,908 (site I, 5. November 1998) (Fig. 7), respectively. Significant drop of temperature may serve as an explanation for this decrease. The samples taken on the 5th of November were influenced by an extraordinary phenomenon. The water line of Balaton was unusually high because of the heavy rainfall and inundated a part of the sampling area, therefore it was impossible to take samples from the debris in the water (first habitat). The most remarkable changes due to the uncommon weather occurred at sample site II, which was reflected excellently in our results (Fig. 4).

In stormy, rainy weather the macrophyte-vegetation washed ashore in the paved shoreline contained roughly the same dominant enchytraeid species as the debris in the natural shorelines. However, in summer the sunlight dried up or the waves washed back the vegetation quickly, thus the enchytraeid fauna's qualitative composition was strongly affected by the latter facts.

Discussion

A remarkable number of enchytraeids was observed in the debris found on the shores of Balaton, thus these worms must have an important role in the decomposition of organic material. This theory was supported by a previous experiment on food consumption, where one *Helena nasuta* specimen consumed daily 156 ± 15 µg leaf of rotting reed, while *H. ventriculosa* consumed 33 ±12 µg/day/specimen (own data, yet unpublished). The results of the quantitative study revealed that in this habitat type species of largest dominance are *Buchholzia appendiculata, Enchytraeus christenseni, E. buchholzi, Henlea ventriculosa* and *Henlea perpusilla*. Dominant species in the moist debris were *Marionina riparia* and *Marionina argentea*. Furthermore, we concluded that the debris's fauna differs from that of the soil, since in the latter more *Fridericia* species occurred among the

dominant *Enchytraeus* species. Putting out the organic material on the shore (according to our still unpublished observations, its amount could reach 87 to 230 kg detritus/month in a 100 m stretch of the shore) and its decomposition outside of the water demonstrate the Lake's self-cleaning ability. The artificial stone barriers, breakwaters prevent this process, thus, decaying organic material remains in the water increasing eutrophication. Its consequences are clearly visible: the stones along the artificial shoreline (near the Balatonberény sampling site) are densely covered with an alga, *Cladophora* sp. in summer.

Acknowledgements. The investigation was made in the frame of the Balaton Program supported by the Prime Minister's Office of Hungary.

REFERENCES

1. DÓZSA-FARKAS, K. (1995): Enchytraeid fauna of the shore of lake Balaton. - In: Mishra, P. C. & al.: Advances in ecology and environmental sciences. Ashish Publ. House, New Delhi, :117-131.
2. DÓZSA-FARKAS, K. (1996): Theorie zur Vermehrungsstrategie einiger Enchytraeiden-Arten (Oligochaeta). (Reproduction strategies in some enchytraeid species). - Newsletters on Enchytraeidae, 5: 25-33.
3. HERODEK, S. & al. (1988): Lake Balaton, research and management. - Budapest, pp. 110.

Table 1. Dominance values (%) of enchytraeid species in the different types of debris in the three sampling sites (16 November, 1997) (1. detritus in the water, 2. wet debris, 3. drier debris, 4. soil)

Species	1	2	3	4	1	2	3	4	1	2	3	4
Achaeta pannonica												
Buchholzia appendiculata		+	21	+		20	90	61		+	21	+
Cognettia glandulosa						+						
Cernosvitoviella minor									+	+	+	
Enchytraeus buchholzi		11	14	+			+	17		+	10	10
Enchytraeus bulbosus												
Enchytraeus christenseni		+	14	+	20		+	+	20	30	8	13
Enchytraeus lacteus												
Enchytraeus sp. juvenil												
Fridericia bulbosa												+
Fridericia galba					+							+
Fridericia paroniana												
Fridericia sp.												
Fridericia sp. juvenil												
Hemifridericia parva		+					+					
Henlea heleotropha			+	+			+	+		+	+	+
Henlea nasuta			+				+	+			+	+
Henlea perpusilla		+	10	+			+	12	10	15	29	41
Henlea ventriculosa		27	28	+		53	+		+	16	15	19
Marionina argentea		+	10	+			+	+	+	+	+	+
Marionina riparia		30	+	61	20				57	24	17	+

Table 2. Dominance values (%) of enchytraeid species in the different types of debris in the three sampling sites (8. 1. 1998.) (1. detritus in the water, 2. wet debris, 3. drioer debris, 4. soil)

Species	1	2	3	4	1	2	3	4	1	2	3	4
Achaeta pannonica												
Buchholzia appendiculata		13	49	12			47	26			58	12
Cognettia glandulosa												
Cernosvitoviella minor	+	+			+	+				+		
Enchytraeus buchholzi		+	22	19	27	+	+	13	20	14	+	+
Enchytraeus bulbosus				+				+				+
Enchytraeus christenseni	+	23	+	17	27	26	+	11	30	29	+	20
Enchytraeus lacteus				+								
Enchytraeus sp. juvenil		+				+	+	+	10		+	+
Fridericia bulbosa				+			+	+			+	+
Fridericia galba			+	+			+	+				+
Fridericia paroniana				+				+				+
Fridericia sp.				+				+				+
Fridericia sp. juvenil			+	+			+	+			+	+
Hemifridericia parva			+				+	+				+
Henlea heleotropha			+				+				+	+
Henlea nasuta			+				+	+			+	+
Henlea perpusilla		+	+	+		10	15	18			+	+
Henlea ventriculosa		43	+	+		15	20	+		+	22	+
Marionina argentea		+	+	14	18	21	+	+	20	+	+	10
Marionina riparia	67	+			+	10	+		20	21		

Table 3. Dominance values (%) of enchytraeid species in the different types of debris in the three sampling sites (1.4.1998.)(1. detritus in the water, 2. wet debris, 3. drier debris, 4. soil)

Species	1	2	3	4	1	2	3	4	1	2	3	4
Achaeta pannonica				+				+				+
Buchholzia appendiculata		+	16	24		20	71	39		+	+	25
Cognettia glandulosa												
Cernosvitoviella minor	+	+	+		+	+				+		+
Enchytraeus buchholzi	+	14	18	14	+	10	+	+	+		+	+
Enchytraeus bulbosus				+				+				+
Enchytraeus christenseni	21	28	25	10	23	25	+	+	31	36	27	21
Enchytraeus lacteus				+								
Enchytraeus sp. juvenil	+			10	27	15	+	+				+
Fridericia bulbosa				+			+					+
Fridericia galba			+	+			+	+				+
Fridericia paroniana				+			+					+
Fridericia sp.				+				+				+
Fridericia sp. juvenil			+	+			+	+				+
Hemifridericia parva			+	+			+	+				+
Henlea heleotropha			+				+	+				+
Henlea nasuta				+				15			+	+
Henlea perpusilla	+	+	11	+	+	+	+	11			27	+
Henlea ventriculosa	+	21	13	+	+	+	+	+	11	14	25	+
Marionina argentea	16	17	+	+	10	+	+	+		29	+	+
Marionina riparia	29	+			21	+	+		54	+		

Table 4. Dominance values (%) of enchytraeid species in the different types of debris in the three sampling sites (13. 7. 1998.) (1. detritus in the water, 2. wet debris, 3. drier debris, 4. soil)

Species	1	2	3	4	1	2	3	4	1	2	3	4
Achaeta pannonica				+								+
Buchholzia appendiculata		38	92	+		+	46	27	+	10	28	4
Cognettia glandulosa						+	+					
Cernosvitoviella minor	+	+				+	+		15	+	+	
Enchytraeus buchholzi		+	+	16		13	+	45	23	+	+	+
Enchytraeus bulbosus				69							+	1
Enchytraeus christenseni	12	+	+	+	51	37	+	12		25	15	2
Enchytraeus lacteus				+								
Enchytraeus sp. juvenil												
Fridericia bulbosa				+								+
Fridericia galba												
Fridericia paroniana				+								+
Fridericia sp.				+							+	+
Fridericia sp. juvenil				+								+
Hemifridericia parva			+									
Henlea heleotropha		+	+	+								
Henlea nasuta		+	+	+								+
Henlea perpusilla		+	+			+	+	+		+	+	+
Henlea ventriculosa		12	20	+	26	13	+		15	17	30	+
Marionina argentea	+	26			14	18	26	+	31	+	10	+
Marionina riparia	62	+			+	+	+		+	25		