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COMPOSITION OF ZOOTECTON IN THE STONY SHORE OF LAKE BALATON (2003–2005)

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Lake Balaton, a shallow lake, is located in the western part of Hungary. The water surface is 596 km^2 with an average depth of 3.2 m. The dominant ions in the water are Ca, Mg, and HCO_3. The average pH is 8.3. Apart from some publications, the role of the stony shores covering 70–75% of Lake Balaton's littoral zone (the whole shoreline is 193 km) has not yet been studied completely. Ten sampling sites were selected in Lake Balaton's four basins of different water qualities: in Keszthely Basin, in Szigliget Bay, at the Balaton Limnological Research Institute of the HAS in the middle basin, and in Fűzfő Bay.
The changing compositions of zootecton were studied, which was influenced by the weather and water supply. For example, in 2003 the low water level was characteristic for the lake. The taxonomic composition, the situation, and the substrate features given of the littoral zone have an outstanding role in the life of Lake Balaton, because this zone provides food resources and nesting habitats for waterbirds. We also found that the filtering in 2003, in 2004, and in 2005 as well, the predacious zoo-organisms were found in the largest number in the zootecton.

Keywords: Lake Balaton, zootecton, macroinvertebrate, waterbirds

INTRODUCTION

The limnological characters of Lake Balaton are largely determined and affected by the structures of the littoral regions. Periphyton is a complex community of microbes, algae, bacteria, fungi, animals, and inorganic and organic detritus that is fixed to substrata which are basically different and separated from the bottom of waters (WETZEL 1983). It is a community of organisms on underwater solid surfaces like stones or reed stems, which are separated from the bottom of the water and different from the substance of the bottom. Besides fixed organisms, biotecton can contain periodically fixed or movable individuals as well (LAKATOS 1976).

Through fixation of photo energy and uptake of inorganic plant nutrients, autotrophic organisms of *Trapa*-periphyton produce organic matters and oxygen as a derivative. These organic matters are essential source of food for animal organisms of biotechton and other heterotrophic communities (LAKATOS *et al*. 1999).

Natural stony shores can be found on the Zala County side of Lake Balaton as well as on the edge of the Tihany Peninsula. Regarding the living conditions of the sites and their stocking stone heaps and stone buildings which were bulked for the protection of the shore, moles and various structures can be considered as identical with stony shores and treated as natural substrata (SEBESTYÉN 1963).

At present, 10% of the shoreline is shielded by stony shores that were originally created as a temporary solution for the previous problems, and an additional 40% comprises some other types of stone works on the shores of the lake. If we add to the shore parts that are naturally covered by stone, we will see that about 70% of the shoreline contains stony parts, even in Somogy County, where plain, sandy parts generally dominate (LAKATOS *et al.* 2001).

Lake Balaton is the largest shallow lake in Central Europe. Its length is 77.9 km, average width is 7.2 km, surface area is 593 km^3, mean depth is 3.14 m, and catchment area is 5182 km^2 (PADISÁK *et al*. 2006). The dominant ions in the water are Ca, Mg, and HCO_3; the average pH is 8.3.

Before 2003, some dry years led to a negative water balance of Lake Balaton that resulted in a significant decrease of the water level. In 2004–2005, as a consequence of continuously increased water level, formerly exposed surfaces of stones were flooded again. The taxonomic composition, the situation and the substrate features of littoral zone have an outstanding role in life of Lake Balaton, because this zone provides food sources and nesting places for waterbirds.

The aim of this paper is to describe the more important changes in composition of epilithic zootecton from 2003 to 2005 and to reveal the potential food resource for waterbirds in case of Lake Balaton.

MATERIALS AND METHODS

Limnological investigations on the stony shores of the littoral zone were started by our research team in 1994, when mainly methodological problems concerning sampling techniques and sample analyses were in the focus. According to the preliminary results, ten sampling sites were selected in four basins of Lake Balaton which can be characterized by different water qualities. Sampling sites were marked out in Keszthely Basin (K), in Szigliget Bay (Sz), at the Balaton Limnological Research Institute of the Hungarian Academy of Sciences in the middle basin (M), and in Fűzfő Bay (F). Besides revealing the spatial and seasonal differences in the epilithon of the natural stony substrates, zonation and colonization were as also studied at the stony shore in front of the Limnological Research Institute in Tihany.

Epilithon samples were carried to the laboratory, where we measured wet and dry mass, ash content, AFDM, chlorophyll-a content, total nitrogen, and total phosphorus concentrations. Eight important cations (Na, K, Ca, Mg, Fe, Mn, Cu, Cr) were measured with an ICP-AES method (LAKATOS *et al*. 1999).

We fixed the scraped epilithon in 70% alcohol, then washed it through a 300 μm plankton net. During monitoring, the colonisation dynamic of epilithon and competition of macrozootectonic organisms were studied.

The observation of waterbirds took place during the zootecton sampling with the use of a telescope.

RESULTS

Results of zonational examinations

In case of Lake Balaton, the problem of zonation was first examined by ENTZ and SEBESTYÉN (1942). They studied the three upper zones which were distinguished on the basis of mass algae species.

Our examinations were based on the results of previous researches (KOZÁK *et al*. 1998). Instead of the five sampling depths which were used by the aforementioned authors, we selected three sampling depths (0.3, 1.2 and 1.5 m) which are marked with running lines on Figure 1.

Basically, we did not find deviations in the percentage of dry matter and ashes in biotecton which was collected from the three different zones and from the surface of stones. The percentage of chlorophyll decreased from the upper layers to the deepest zones.

We also examined the density of animals on the surface of stones. Our results proved that the composition of organisms is diverse in the three different zones. Besides the numerous *Dikerogammarus* species, *Chironomidae* are the most frequent organisms in the top zone (Z1).

The number of *Chelicorophium curvispinum* individuals is remarkably large in the second zone (Z2) (SARS 1895), but the rate of *Chironomidae* and *Dikerogammarus* species decrease simultaneously. Besides the dominant *Chelicorophium*

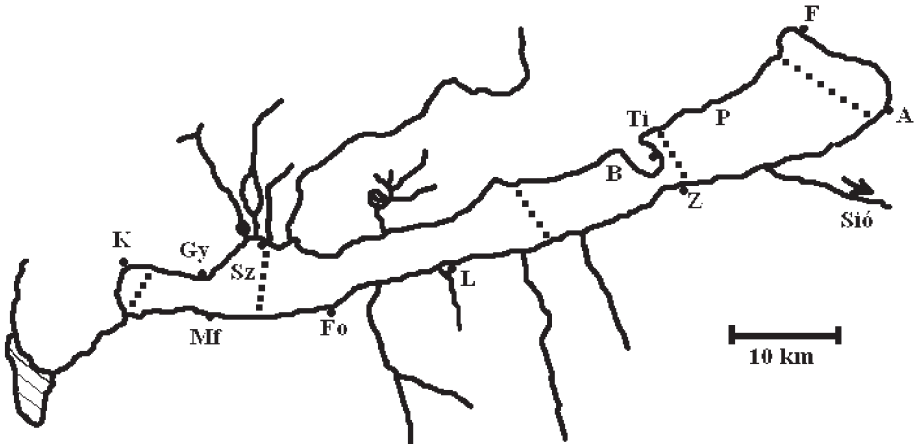

Fig. 1. Sampling sites of zootecton and monitoring areas of waterbirds (A = Balatonaliga, F = Balatonfűzfő, Fo = Fonyód, Gy = Balatongyörök, K = Keszthely, L = Balatonlelle, Mf = Máriafürdő, Sz = Szigliget, Ti = Tihany, Z = Zamárdi)

curvispinum, a large number of *Dreissena polymorpha* (PALLAS, 1771) can be found in the third zone (Z3), as is showed by Figure 2.

Considering the five main groups of macroinvertebrates

In 2004, the number of Chironomidae, Oligochaeta, and *Corophium* individuals was significantly larger than it was in 2003. However, further stony surfaces were flooded in 2005, which led to the decreasing numbers of fixed individuals as a consequence of less food and hiding places. In 2004, Chironomidae and *Dikerogrammarus* species could be found in the largest quantities.

While individuals of *Dreissena polymorpha* (PALLAS, 1771) gathered together in 2003, the number of individuals was smaller on lately flooded substrata in the following years, as it is supported by the decreasing number of individuals in case of planktonic veligera larvae.

It can be proved that water cover of substrate (as a basic physical factor) is the most important factor under these extreme conditions.

However, LILLIE and EVRARD (1994) made the opposite statement, according to which water depth had no significant impact on density of macroinvertebrates in any wetland.

Frequency of species within given taxon

Table 1 contains the list of macroinvertebrates species (taxa).

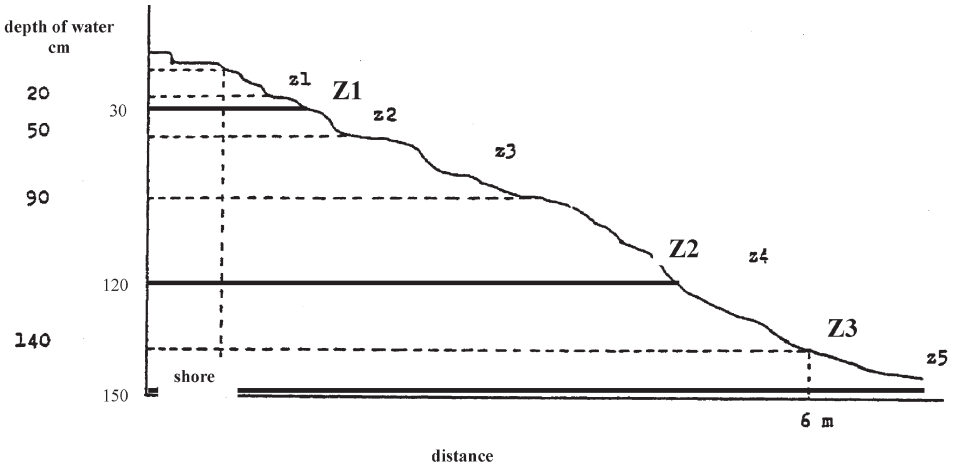

Fig. 2. Profile of the stony shore (1996, 2004)

Table 1. List of identified species (taxa) from the epilithic zootecton during the study period. + = presence of a given species, ++ = more than 100 ind./m^2; +++ = more than 1000 ind./m^2

Taxa		2003	2004	2005
Porifera	*Spongilla lacustris* (L.)	+	+	
Cnidaria	*Hydra* sp.			
Platyhelmintes, Turbellaria	*Dugesia lugubris* (O. SCHM.)	+		
Nematoda		+	++	
Oligochaeta		+++	+++	+++
	Stylaria lacustris L.	+		
Hirudinoidea	*Glossiphonia heteroclita* (L.)	+		
	Glossiphonia complanata (L.)	+		+
	Piscicola geometra (L.)	+	+	
	Theromyzon tessolatum (O. F. MÜLLER)			+
	Erpobdella sp.	+		+
	Hirudinea, juv	+		
Gastropoda	*Bithynia tentaculata* L.	+	+	++
	Radix ovata Drp.			+
	Potamopyrgus jenkinsi SMITH	+		+
	Gastropoda, juv.	+	+	+
	Lymnaea sp.	+		
	Planorbiidae	+		
Lamellibranchiata	*Dreissena polymorpha* PALLAS	+++	+++	+++
Bryozoa	*Fredericella sultana* (BLBCH.)	+		
Cladocera	*Sida crystallina* (O. F. MÜLLER)	+		+
	Chydoridae	+		
Ostracoda	*Potamocypris* sp.	+++	+	
	Cypridopsis vidua (O. F. MÜLLER)	+		
Harpacticoida		+	++	
Mysidae	*Limnomysis benedeni* CZERN.		+	+
Isopoda	*Asellus aquaticus* L.	+		
	Jaera istri (VEUILLE)	+	+	
Amphipoda	*Corophium curvispinum* SARS.	+++	+++	+++
	Dikerogammarus sp.	+++	+++	+++
Ephemeroptera	*Caenis* sp.	+		
Odonata	Zygoptera	+		
Heteroptera	*Micronecta* sp.	+		
Coleoptera	*Laccobius* sp.	+		
Diptera	Chironomidae	+++	+++	+++
Trichoptera	*Ecnomus tenellus* RAMB.	+	+	
Acari	Hydracarina		+	+

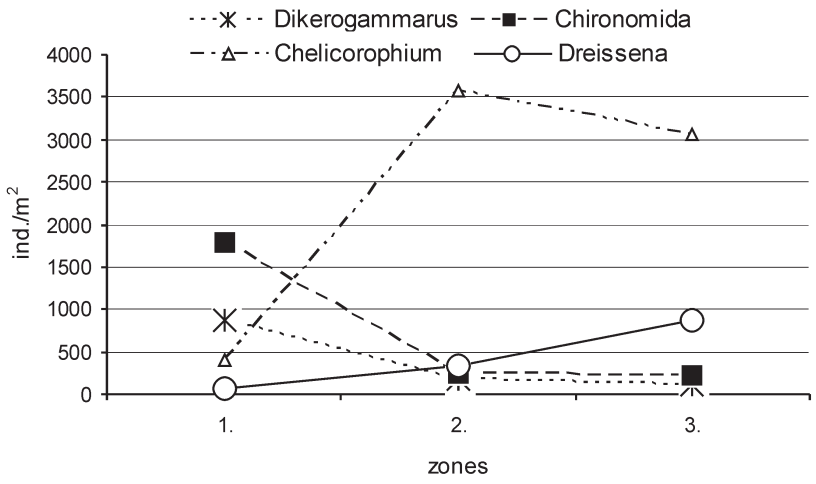

Fig. 3. Results of zonational examinations

On the stony shore of Lake Balaton, 29 taxons were found in 2003, while the number of taxons was 16 in 2004 and 20 in 2005. The summing up of species concerns 39 taxons, among which 36 taxons were found in summer and 24 in autumn.

Functional feeding groups

The examined organisms were divided into functional feeding groups (FFG) (on the basis of MOOG 2002).

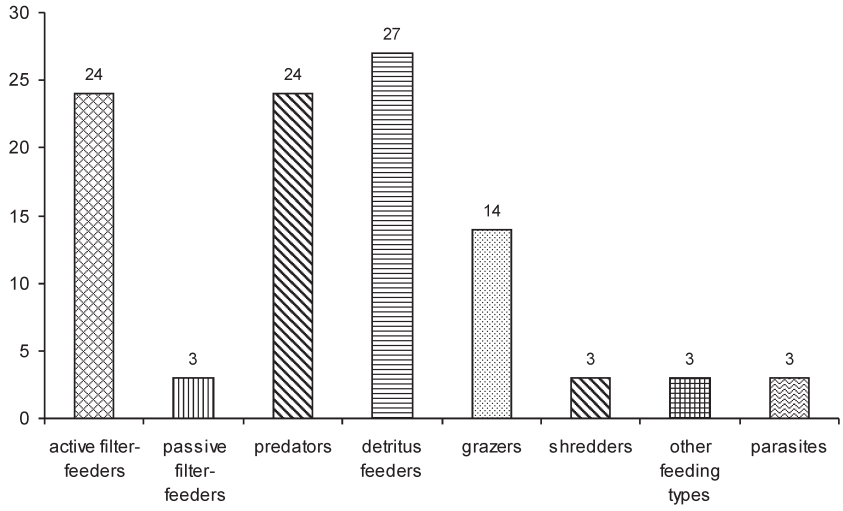

Fig. 4. Summing of functional feeding groups of epilithic zootecton

As it is shown by the summarized results, detritivorous organisms (mostly Oligochaeta) reached the largest percentage, while the percentage of carnivorous and active filtrating organisms was equally 24 per cent.

According to the summarized summer and autumn results, feeding groups showed similar frequencies, except the group of parasites which could be found only in summer (Fig. 3).

In all three years of the examinations, we could distinguish 7 feeding groups: active filtrating organisms, passive filtrating organisms, carnivores, detritivores, scraping organisms, crushing organisms, parasites, and others. Passive filtrating organisms appeared in 2003–2004, but they were followed by parasites in 2005.

In 2004, detritivores could be found in large quantities (37%).

The number of carnivores was one third of all feeding groups in 2003 and in 2005, but it decreased significantly in 2004 (7%) (Fig. 4).

DISCUSSION

Based on our results the composition of epilithic zootecton in Lake Balaton from 2003 to 2005, emphasizing the importance of water cover of stony substrate.

According to the data of zonational examinations, a definite difference can be established between the zones which are in different depths. As an evidence of this difference, the percentage of animal organisms changes simultaneously with

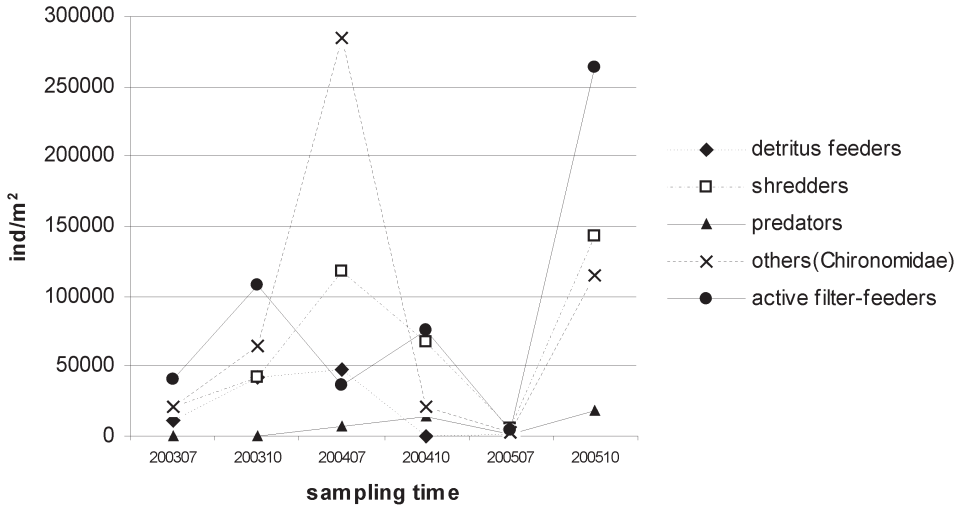

Fig. 5. Seasonal frequency of the five main macroinvertebrate taxon

water-depth, and the chlorophyll-a content decreases simultaneously with the diminishing quantity of light. The former statement can be explained by saying that mainly mobile species are able to stock themselves on the surface of stones which are flooded by water repeatedly.

A large number of water birds appeared in shallow water, since epilithic zootecton of the exposed stones served as food basis for them. Therefore this state of the stony shore is favourable in an ornithological respect.

This favourable establishment contrasts with Padisák's observations, although she is right in another aspect:

"Some areas of the lake bed were exposed and served as resting places for waterfowls, where the guano further repelled swimmers" (PADISÁK *et al*. 2006).

In 2004, water birds became more frequent in the area, which led to the decline of the invertebrate *Corophium* and *Dreissena polymorpha* (PALLAS, 1771) species, since they are common food of waterfowls. In connection with Lake Balaton, the previous establishment was supported by PONYI (1994) as well:

"Food spectra of different bird species indicated that molluscs represented one of the most important food bases of ducks and coots in the autumn-, winter- and spring-period besides crustaceans and larvae of aquatic insects."

We were planning to find relations between planktonic chlorophyll-a content and frequency of Oligochaeta species, but close correlation was not experienced (Fig. 5).

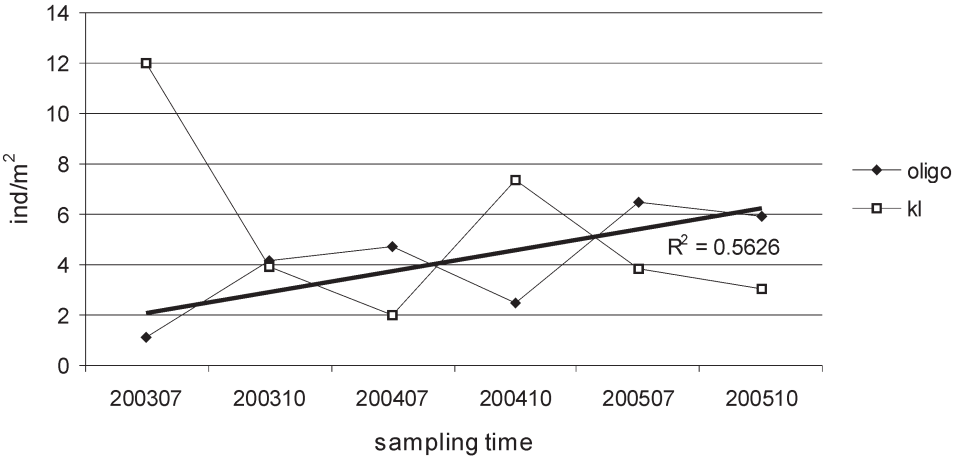

Fig. 6. Correlation between planctonic chlorophyll-a content and number of individuals of epilithic Oligochaeta

More mobile macroinvertebrates responded quicker to changing water cover, but it cannot be said of zebra mussel (*Dreissena polymorpha* (PALLAS, 1771)), which has planktonic larvae and sessile adult individuals.

Besides the biomonitoring role of the actual research, our results, which are based on the examination of epilithic zootechton on the stony shore of Lake Balaton, are important in terms of food bases for aquatic birds as well.

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