A Comparative study on the density of Gastropoda from Lake Ohrid for the period 1963-2016

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Abstract

The changes in the density of the Gastropoda, as well as in other groups from the benthic fauna, have seasonal character and have been considered as natural annual phenomenon closely related with the ecological conditions and the physiological adaptation of the respective organisms. But, how these changes have been reflected in the overall population density over the period of several decades? This was a question we have tried to answer in the research we have conducted in the period 2015-2016 on the profile HBI-Radozda in Lake Ohrid. Thus, by monthly sampling dynamic, on 10 depth sampling points (from 0-50 m) the density changes of Gastropoda have been followed. The results have confirmed the monthly changes whereby 2 maximums in the density of Gastropoda populations have been registered: in April and May-in spring period. The comparisons between the density data obtained in 1963/64, 1998/99, 1999/2000, 2000/2001, 2005/2006 and the most recent ones (2015-2016) have shown a trend of decreasing in the general density of Gastropoda from Lake Ohrid.

Keywords: Gastropoda, Lake Ohrid, changes in the density, decrease.

Introduction

The survival, density and distribution of the benthic communities in the Lake Ohrid are in function of three depth-living habitats: littoral (0-20 m), sublittoral (20-50 m) and profundal (50-289 m). Littoral and sublitoral are the transitional zones where both the distribution (vertical and horizontal) and abundance of Gastropoda reach their highest values. In general, the littoral zone is characterized by the highest biodiversity of the benthic communities due to the great heterogeneity of the habitat, as well as the presence and the role of macrophyte vegetation.

The vertical profile HBZ-s.Radozda, we have selected for our research, has been known as a transect with enhanced bottom heterogeneity whereby the transition from one to another bottom type is clearly visible and enable an opportunity for studying of the inhabiting preferences of the benthic fauna including Gastropoda. Thus the shallowest parts of the profile are covered with sandy bottom, which is deeper changed by sandy-muddy I.e. clear muddy bottom in the deepest littoral. The vegetation distribution coincides with the beginning of the profile but it reaches its maximum density almost at the edge of the littoral zone. The nature of the bottom of the sublittoral is different than in the littoral zone: the zone starts with the shell "belt", continues with some gravel formations which are deeper changed by sandy-muddy and finally muddy bottom. Beside the great heterogeneity, this profile has been given the most attention regarding the research of the benthic fauna in the past, which also makes it ideal for making comparison analysis type "then and now" status of the benthic fauna.

Material and Methods

The material was collected on the profile HBI-Radozda, during the period in 2015-2016. There were 10 investigated depth points (0 m, 1 m, 3 m, 5 m, 10 m, 15 m, 20 m, 30 m, 40 m, 50 m) where from the samples have been taken by monthly dynamic of sampling. The research was made according to the standard limnological methods: (Lind 1985; Wetzel 1975). Samples were taken with 225 cm^2 van Veen grab. The values for the density indicate the average density of the specimens from two consecutive samples on unit surface-m^2.
The benthic material was determined in the laboratory conditions to the level of species according to keys for determination on gastropods: Polinski (1929), Snegarova (1954), Hubendick & Radoman (1959), Hubendick (1964), Radoman (1973, 1983), Krunic & *et al.* (1999).

Results and Discussion

Table 1 represents the gastropod species composition in the profile HBZ-v.Radozda, Lake Ohrid. 22 species have been registered belonging to 6 families, whereby 19 out of 22 are being endemic.

Tab.1. Qualitative composition of Gastropoda species from the profile HBZ-v.Radozda, Lake Ohrid.

Gastropoda species	
Endemic species	**Cosmopolitan species**
Valvata stenotrema Polinski, 1929	*Theodoxus fluviatilis* (Linnaeus, 1758)
Valvata hirsutecostata Polinski, 1929	*Viviparus viviparus* (Linnaeus, 1758)
Valvata rhabdota Sturanyi, 1894	*Planorbarius corneus* (Linnaeus, 1758)
Ohridohoratia sturanyi (Westerlund, 1902)	
Chilopyrgula sturanyi (Brusina, 1896)	
Stankovicia pavlovici (Polinski, 1929)	
Stankovicia wagneri (Polinski, 1929)	
Trachyohridia filocincta (Polinski, 1929)	
Ochridopyrgula macedonica macedonica (Brusina, 1896)	
Ochridopyrgula macedonica charensis Radoman, 1978	
Ginaia munda munda (Sturanyi, 1894)	
Ginaia munda sublitoralis (Sturanyi, 1894)	
Xestopyrgula dybowskii (Polinski, 1929)	
Micropyrgula stankovici (Polinski, 1929)	
Radix relicta Polinski, 1929	
Gyraulus lychnidicus Hesse, 1928	
Gyraulus trapezoides Polinski, 1929	
Planorbis macedonicus Sturanyi, 1894	
Ancylus tapirulus Polinski, 1929	

The majority of the endemic species, even 15, inhabit the littoral zone of the profile (from 0 to 20 m depth). The littoral habitat of lakes usually supports larger and more diverse populations of benthic invertebrates than do the sublittoral and profundal habitats (Mandaville 2002). The vegetation and substrate heterogeneity of the littoral habitat provide an abundance of microhabitats occupied by a varied fauna.

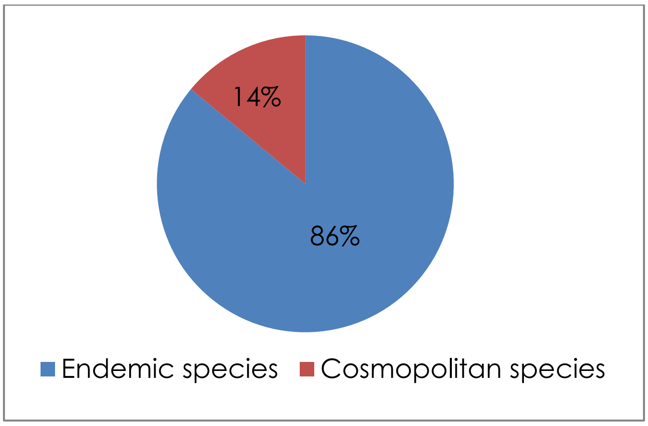

Figure 1. The cosmopolitans/endemics species ratio in the profile HBZ-v.Radozda

The ratio cosmopolitan/endemic, as shown on the Figure 1 is shifted on the side of the endemic species. Thus, even 84 % (19 species) of the registered species are endemic while 16 % or 3 species are cosmopolitan. The highest number, or half of the endemic species belong to the family of Hydrobiidae.

The most diverse family among the 6 ones we have registered was the family of Hydrobiidae. It covers a portion of 50 % (11 species). The second most diverse family is Planorbidae represented by 5 species or covering a portion of 23 % after which is the family of Valvatidae which participates with 13.5 % (3 species). The lowest is the portion of the Viviparidae, Neritidae and Lymnaeidae, whereby each of them are present by one species or cover a portion of 4.5% each.

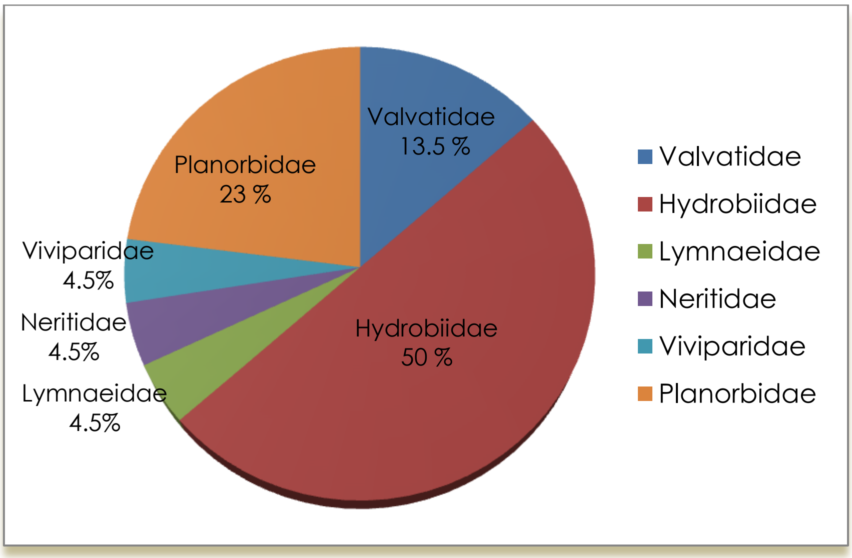

Figure 2. Participation of the families from the class Gastropoda in the profile HBZ-v.Radozda

On Fig.3 are given some of registered endemic Gastropoda species from the profile HBZ-v.Radozda.

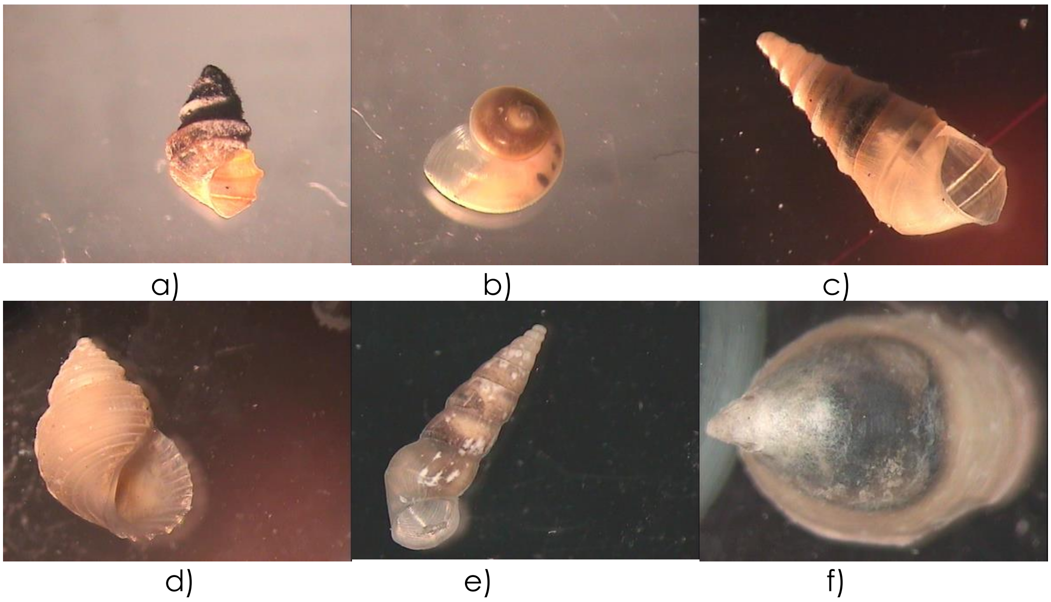

Figure3. Endemic Gastropoda species from the profile HBZ-v.Radozda, Lake Ohrid. (a) *Ochridopyrgula macedonica macedonica*; (b) *Valvata stenotrema*; (c) *Chilopyrgula sturanyi*; (d) *Ginaia munda munda*; (e) *Xestopyrgula dybowskii*; (f) *Ancylus tapirulus.*

Figure 4 depicts the results about Gastropoda density variation in the littoral and sublitoral of Lake Ohrid on the profile HBZ-v. Radozda. It is clear that the density of the snails in the subblitoral is constantly lower than the density in the littoral throughout the whole research period i.e. all seasons.

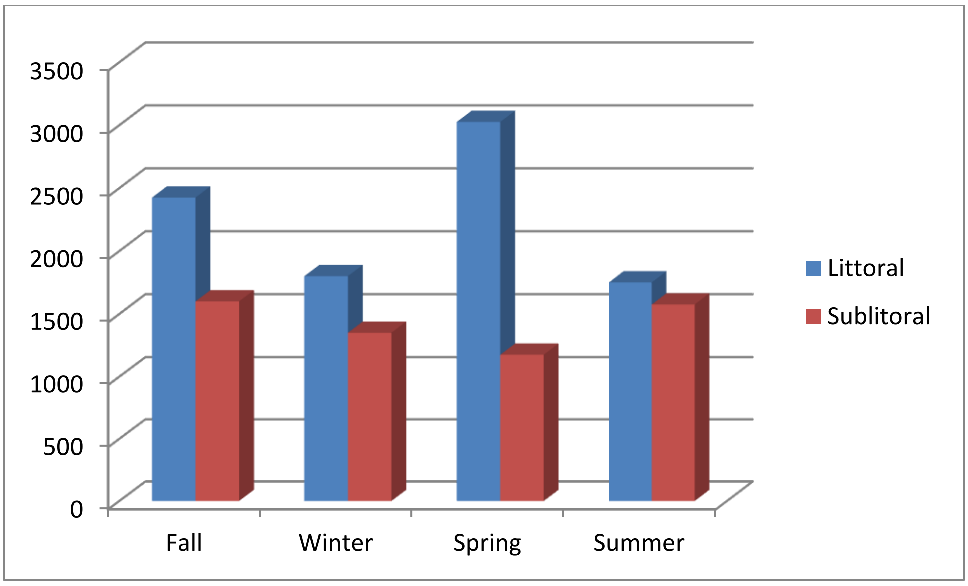

Figure 4. Seasonal dynamic in the density on Gastropoda on the profile HBZ-Radozda, Lake Ohrid.

The Figure 4 also presents the detailed fluctuation in the density of Gastropoda species in both zones in different seasons of the year (in the period from 2015/16). Thus, in the littoral the density on seasonal level is highest in spring (from March to May)- 3025 ind·m^{-2} or so call spring maximum. During the summer the density drops but it increases again in the fall season not reaching the maximum registered during the spring. The density in the littoral, after the second maximum in the fall drops again during the winter. Unlike the littoral, in the sublittoral, the maximum in the density has been recorded in Fall, then in summer, while the densities in winter and springs are lower. According to Stankovic (1959) and Trajanovski (2005) the density of the benthic communities are closely related with the general processes occurring in the surrounding environment. Precisely the highest densities are related with the spring green algae "bloom" in the littoral zone especially on the stones and other hard substrates which are primary feeding source for the snails. Freshwater snails actually "graze" a variety of surfaces, on firm substrates, such as rocks, woody debris, root mats, and submerged plants (Johnson 2003). Thus, in the littoral, the highest density of Gastropoda is in correlation with the highest availability of food during the spring season. In the sublittoral, the maximum in the density has been recorded during the fall season. This could be as result of depleting of the feeding resource in the littoral i.e. many of the species move deeper for food which results in fall maximum. But due to the fact that not all species are physiologically adapted on different depths as well as the food availability is restricted (less algae, more competition with other benthic invertebrates) the fall maximum in the sublittoral reaches only half of the one recorded in the littoral during the spring season.

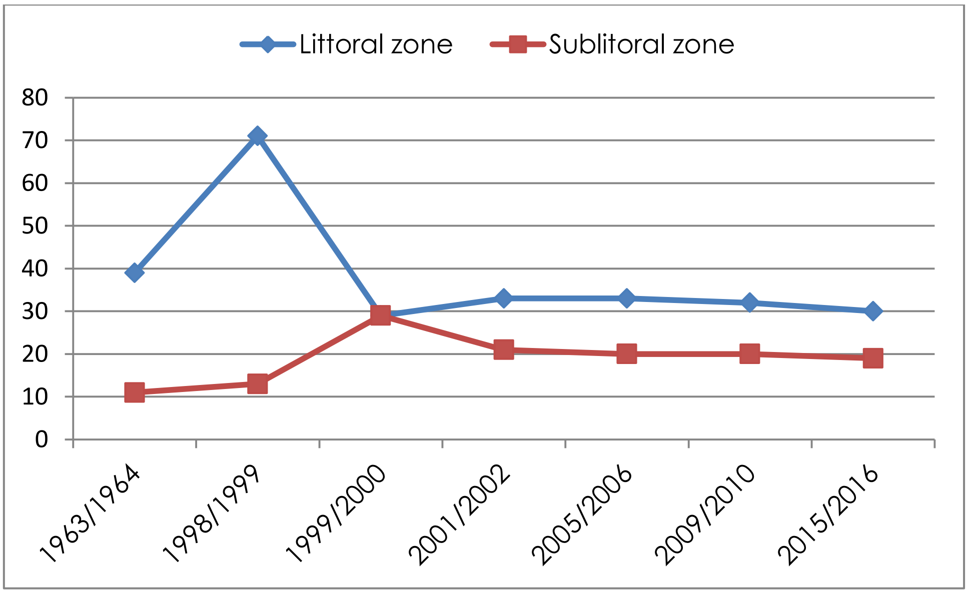

Figure 5. Variation in the density by depth zone and period of investigation on Gastropoda in the profile HBZ-v.Radozda, Lake Ohrid.

Figure 5, shows the variation in the density by depth zone in the profile HBZ-v.Radozda from Lake Ohrid, for the period 1963-2016. Thus, with an exemption in 1999 when 71 ind/m^2 has been recorded, with small variation the density of the gastropods stays within the boundaries from 39 ind/m^2 (1963/1964) to 30 ind/m^2 (2015/2016) which represents slight general decreasing in the density of the gastropod fauna in the littoral zone of profile HBZ-v. Radozda.

Gastropods density in the sublitoral zone on the profile HBZ-v.Radozda was as follows: in 1963/1964 there have been recorded 11 ind·m^{-2} (Sapkarev & Tocko 1972); 1998/1999 -13 ind·m^{-2}; 1999/2000- 29 ind·m^{-2} (Trajanovski *et al.* 2005). In the period 2001/2002 density was 21 ind·m^{-2}, during 2005/2006 and 2009/2010 density was 20 ind·m^{-2} (Budzakoska-Gjoreska 2005, 2012). In the recent investigations on the profile (2015/16) the density of gastropods faunaon different habitats in the littoral zone there have been recorded 19 ind·m^{-2} which could be observed as a trend of increasing in the density of Gastropoda in this depth zone.

The littoral of the lakes generally has a larger and more diverse population of benthic invertebrates than the sublitoral and profundal zones (from the USA Environmental Proction Agency 1998). This fact as well as the one that the littoral zones represents the most vulnerable ones due to their direct exposure to the anthropogenic pressure could be part of the explanation for the slight decreasing trend in the density of Gastropoda from the littoral zone from the profile HBZ-v. Radozda. The living settlement in the littoral zone differs from the settlements of the other zones in the lake bottom not only by the richness of taxes, but also by the diversity of the qualitative composition in the different parts of the zone. This settlement is covered by organic food producers - grown plants, next to the consumers - the living organisms that live and are maintained for the account of the plant. Vegetation and the different substrate of the littoral habitat act on the density of microhabitats with different fauna from one side, but from the other side they influence increased competition which decrease the food and space availability.

According to authors (Sitnikova & Shimaraev 2001) the survival of the organisms depends on the foods available and the successful reproduction of them. The processes of vertical movements and sedimentation of the bottom are active near the littoral. The differences in the intensity of the feeding sources at the bottom may be one of the important reasons for distributing the species of the bottom of the lake.

According to Mackie (2001) gastropods are good trophic indicators because most prevail in the littoral and sublittoral zones. In these zones oxygen concentrations, nutrient levels, pH, alkalinity, light penetration, water currents and other chemical and physical factors vary hourly, daily, and seasonally, as well as with depth and distance from shore.

In relation to oxygen, the authors (Hutchinson 1993, Kellog 1994, Mackie 2001) agree that the pulmonary gastropods are more tolerant than the prosobranchs of the lack of oxygen, since they can be lifted to the surface and receive the oxygen.

The most of the groups of macrozoobenthos, including gastropods, are distinguished by two generations a year, which, in essence, explain the two annual maximums (Barnes 1980). In our research this is the spring and fall maximum. Regarding the trend of increasing of the density in the sublittoral, it could be explained by consideration of the general conditions in this zone: the living conditions are more stable, anthropogenic pressure is attenuated by the littoral, the habitat diversity is still present which at the end could result in increased in the density of particular gastropod species accommodated to this type of conditions.

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