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Gyraulus meierbrooki, *G. ioanis*, and *G. shasi* – three new *Gyraulus* spp. from the Skadar Lake Basin, Montenegro (Gastropoda: Planorbidae)

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> Abstract

Our investigations of the malacofauna of Montenegro, which are currently under way, provided new information on the genus *Gyraulus* in this region. The *Gyraulus* species of the Skadar Lake Basin are poorly known, and only species from Central Europe have been mentioned in the literature, which we could not find as yet. Altogether we could observe three new species: *Gyraulus meierbrooki* n. sp., *G. ioanis* n. sp., and *G. shasi* n. sp.

> Kurzfassung

***Gyraulus meierbrooki*, *G. ioanis*, and *G. shasi* – drei neue *Gyraulus*-Arten aus dem Becken des Skutari Sees, Montenegro (Gastropoda: Planorbidae). –** Unsere laufenden Untersuchungen zur Molluskenfauna Montenegros lieferten uns neue Informationen zur Gattung *Gyraulus* in dieser Region. Die *Gyraulus*-Arten des Beckens des Skutari Sees sind nur wenig bekannt, und nur Arten Mitteleuropas wurden bisher in der Literatur erwähnt, die wir bis jetzt nicht gefunden haben. Insgesamt konnten wir drei neue Arten nachweisen: *Gyraulus meierbrooki* n. sp., *G. ioanis* n. sp., and *G. shasi* n. sp.

> Key words

Gyraulus meierbrooki n. sp., *Gyraulus ioanis* n. sp., *Gyraulus shasi* n. sp., Skadar Lake Basin.

Introduction

The *Gyraulus* species of Montenegro are poorly known because only few records were published formerly. While Wohlberedt (1909) as well as Dhora & Welter-Schultes (1996) listed only *Gyraulus albus* (O. F. Müller, 1774) from Montenegro, Jaeckel et al. (1958) recorded also *G. laevis* (Alder, 1838), Jacobi (1981) could not find any *Gyraulus* sp. in the sublacustrine springs in the Skadar Lake, and Meier-Brook (1983) did not consider *Gyraulus* spp. from this region in his outstanding paper. Our investigations in the malacofauna of Montenegro, which are under way, revealed three new *Gyraulus* spp.: *Gyraulus meierbrooki* n. sp., *G. shasi* n. sp, and *G. ioanis* n. sp.

The high degree of species richness (44 gastropod species) and endemism (27 %) in the Skadar Lake has already been pointed out by Glöer & Pešić (in press), and, regarding these results, the authors stated that the Skadar Lake is an ancient lake. So it ment no surprise to find new *Gyraulus* spp. in the Skadar Lake Basin, because the other ancient Balkan Lakes are also populated by endemic *Gyraulus* spp.

Material and methods

The snails were collected with a sieve and were put into 75% ethanol. The dissections and measurements of the genital organs and the shells were carried out using a Zeiss stereo microscope with an eyepiece micrometer; the photographs were made with a Leica R8 digital camera system. All type material is stored in the Zoological Museum of Hamburg (ZMH).

Study Area

The Skadar Lake drainage basin is located between 18° 41' and 19° 47' east and between 42° 58' and 40° 10' north. The Skadar Lake, located in a *karst* terrain in the outer part of the southeastern Dinaric Alps, is the largest of the Balkan lakes and has a surface area which fluctuates seasonally from approximately 370 to 600 km^2.

The water-level of the lake also varies seasonally: from 4.7 to 9.8 m above sea level. The lake is extending in the NW-SE direction, and it is approximately 44 km long. The Bojana River connects the lake with the Adriatic Sea, and the Drim River provides a link with the Ohrid Lake. The exact origin of the lake is unknown, but it probably originated by solvate and tectonic processes during the Pleistocene (STANKOVIĆ 1957).

The southern and southwestern banks of the lake are rocky, barren and steep, there are bays, in which the sublacustrine springs, so called "okos", are usually to be found. On the northern side there is an enormous inundated area, the boundaries of which change as the water levels fluctuate. The climate at the Skadar Lake drainage basin is typically Mediterranean, with a long, hot summer at lower and medium altitudes and a short winter with heavy and abundant rain.

Šasko Lake (fig 1) is located in the Mediterranean zone of Montenegro in the southeast part of the country, at 10 km distance from the seashore and from the city of Ulcinj. The surface of the lake is 3.5 km^2, and the maximum depth in rainy seasons is about 8 m, the yearly average depth being 3.5 m. The lake belongs to the Skadar Lake water system in Adriatic drainage surface. The water of Šasko Lake is originally from the River Bojana and several springs. Communication with Bojana River is interrupted during summer months (July and August) because the water-level is lowest. The biggest and the most important spring is "Begovo oko" on the southwest part of the lake. Because of the strong variation of the water-level in the lake, the north-eastern shore is not clearly defined. It is slightly inclined and gradually changing from wetland to lake. The south-western lake shore is sharp and rocky and almost vertical.

Fig. 1. Map of the sampling sites and type localities (red numbers) of *Gyraulus* spp. in Montenegro. **1**–**4**: *G. meierbrooki* n. sp. – **1** = Malo Blato; **2** = Karuč; **3** = Tanki Rt; **4** = Virpazar; **5**: *G. ioanis* and *G. shasi*, Šasko Lake.

Results

Altogether we collected in the Skadar Lake basin three *Gyraulus* species, of which were all unknown so far. Because Lake Ohrid is connected to the Skadar Lake by the Drim River, we compared these species with those of Lake Ohrid and Lake Prespa, where six endemic *Gyraulus* spp. are known (MAASSEN 1980): *G. trapezoides* Polinski, 1929, *G. lychnidicus* Hesse, 1928, *G. crenophilus* Hubendick & Radoman, 1959, *G. fontinalis* Hubendick & Radoman, 1959, *G. stankovici* Hadžišče, 1953, and *G. albidus* Radoman, 1953. The morphology as well as the anatomy of these species had been studied thoroughly by HUBENDICK & RADOMAN (1959), and MEIER-BROOK (1983: 67) united these species, except *G. albidus*, to the subgenus *Carinogyraulus*, because they are strikingly distinct from other *Gyraulus* spp. outside this Lakes. Thus we had to compare our *Gyraulus* spp. with *Gyraulus albidus* and the other European species, of course. Other *Gyraulus* spp., that are widely distributed, are the Asian *G. chinensis* (Dunker, 1848) and *G. piscinarum* (Bourguignat, 1852), which we have taken under consideration. In addition to these, from Greece *G. janinensis* (Mousson, 1859) is known to inhabit Lake Pamvotis, possibly an endemic species (FROGLEY & PREECE 2007).

Fig. 2. *Gyraulus albidus*, Ohrid Lake, topotypes. **1**: keeled form, **2**: not keeled form.

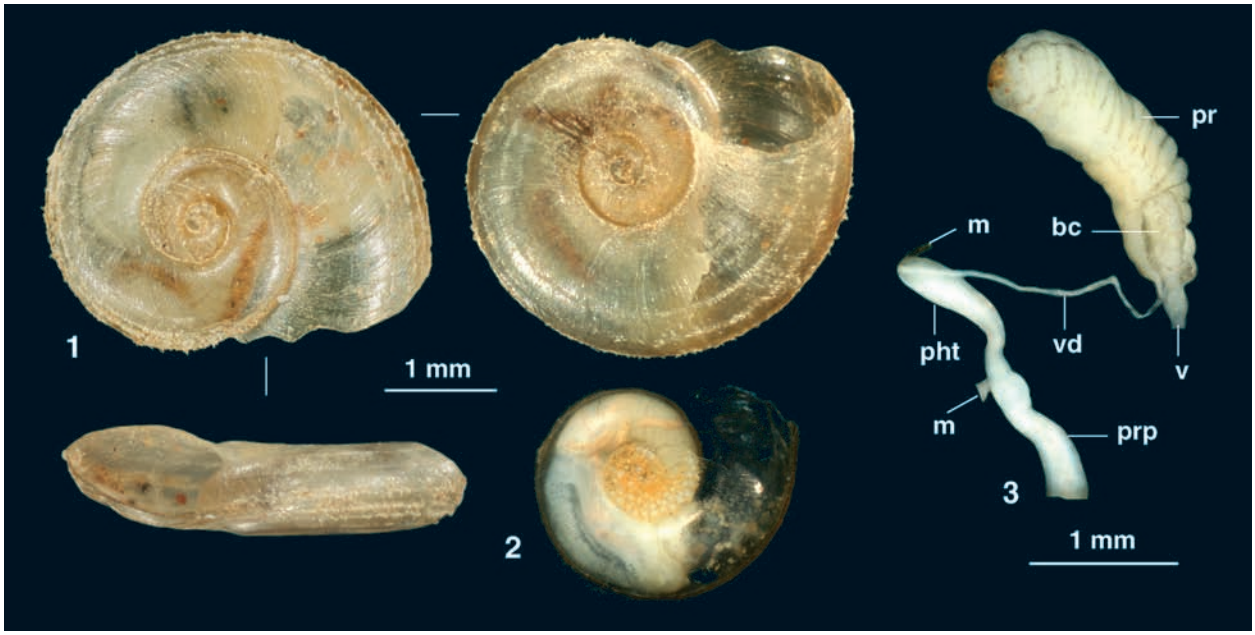

Fig. 3. *Gyraulus meierbrooki* n. sp. – **1**: shell, **2**: shell with spawn on the concave functional under side (leg. Pešić 24.05.2005); **3**: sex tract, bc = bursa copulatrix, m = muscle, pr = prostate gland, pht = phallotheca, prp = praeputium, v = vagina, vd = vas deferens.

Genus *Gyraulus* Charpentier, 1837

Type species: *Planorbis albus* O. F. Müller, 1774

Gyraulus albidus Radoman, 1953

We studied six specimens of the type locality (Ohrid Lake) and found two types of shell. The one type corresponds to the drawing given by Radoman (in Hubendick & Radoman 1959: 241, fig. 35 A), the periphery of which is not angulated (fig. 2.2), and a second type, in which it is angulated (fig. 2.1). The latter form has a yellowish to pale brown coloured shell. The head of these specimens was yellowish.

Gyraulus meierbrooki n. sp.

Material examined: 25 ex. from Karuč (type locality), Malo Blato (1 ex.), Tanki Rt (1 ex.), Virpazar (1 ex.).
Holotype: Shell height 1.0 mm, diameter 3.5 mm, ZMH 51058.
Paratypes: 3 ex. from loc. typ., ZMH 51059, the rest in the collection of P. Glöer.
Locus typicus: Skadar Lake, Karuč, 42°18'19" N, 19°6'3" E.
Habitat: Lives in emergent (*Phragmites communis*) and floating (*Nymphaea alba*, *Nuphar luteum*) vegetation in the littoral zone in Skadar Lake.

Fig. 4. Photos of the localities studied: left: Skadar Lake, sublacustrine spring Karuč, type locality of *Gyraulus meierbrooki* (Photo: V. Pešić); right: Šasko lake (or Lake Šas), type locality of *G. ioanis* and G. *shasi* (Photo: S. Vuksanović).

Etymology: Named after Claus Meier-Brook, the outstanding expert on freshwater molluscs.
Description: The shell is light-corneus, glossy to silky, and transparent with fine growth lines. On both sides there are three to five rows of hairs. The three to three and a half convex whorls increase rapidly in a regular way. The periphery is angled, the upper side is concave. The last whorl is not deflected. The shell is small to medium-sized, 2.7–3.5 mm in diameter and 0.9–1.0 mm in height (fig. 3.1).
Animal: The animal is light grey. The phallotheca is as long as the praeputium, the bursa copulatrix is club elongate, and the prostate gland has 18–20 diverticles (n=3) (fig. 3.3).
Biology: The animals use the concave functional under side of the shells as spawning ground (fig. 3.2).

Gyraulus ioanis n. sp.

Material examined: 22 ex. from loc. typ.
Holotype: Shell height 1.3 mm, diameter 4.7 mm, ZMH 51060.
Paratypes: 3 ex., ZMH 51061, the rest in the collection of P. Glöer.
Locus typicus: Šasko Lake, 41°48’57” N, 19°20’24” E.
Habitat: Lives in emergent (*Phragmites communis*) and floating (*Nymphaea alba*, *Nuphar luteum*) vegetation in the littoral zone together with *G. shasi*.
Etymology: *ioana* (gr.) = ‘Ivona’. The species is named after Ivona Pešić, daughter of one of the authors, in July 2007 one year old.
Description: The shell is light-corneus, glossy to silky, and transparent with fine growth lines. The three to four whorls increase rapidly. The periphery is angled, and both sides are concave. The last whorl is not deflected. The shell is medium-sized, 3.7–4.7 mm in diameter and 1.2–1.3 mm in height (fig. 5.1).
Animal: The animal is light grey with small black spots (fig. 5.2). The phallotheca is as long as the praeputium. The bursa copulatrix is tadpole elongate, the prostate gland bears 14–16 long diverticles (n=3) (fig. 5.3).

Gyraulus shasi n. sp.

Material examined: 4 ex. from loc. typ.
Holotype: Shell height 1.3 mm, diameter 5.5 mm, ZMH 51062.
Paratypes: 1 ex., ZMH 51063, the rest in the collection of P. Glöer.
Locus typicus: Šasko Lake, 41°48’57” N, 19°20’24” E.
Habitat: Lives in emergent (*Phragmites communis*) and floating (*Nymphaea alba*, *Nuphar luteum*) vegetation in the littoral zone together with *G. ioanis*.
Etymology: Named after Šas lake (Šasko lake), where this species lives.
Description: The shell is corneus, silky, and not transparent, with fine growth lines. The four to four and three quater convex whorls increase regularly with a deep suture. The periphery is slightly angled, the underside is concave. The last whorl is not deflected. The shell is medium sized, 5.0–5.5 mm in diameter and 1.3 mm in height (fig. 6.1).
Animal: The animal is grey, the mantle covered with an irregularly dark pattern (fig. 6.4). The bursa copulatrix is tadpole elongate with a broad bursa duct (fig. 6.2). The delicate prostate gland has 8 scattered long diverticles (fig. 6.3). The phallotheca is as long as the praeputium.

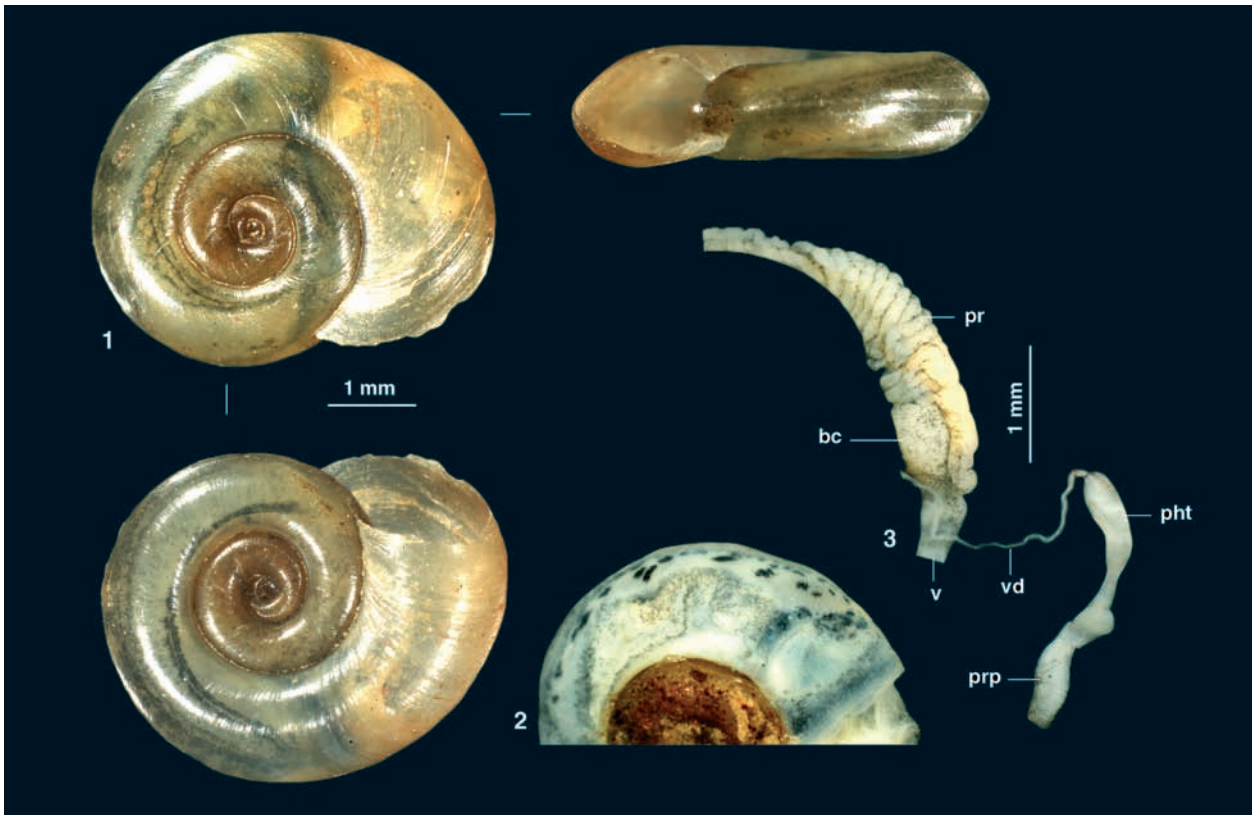

Fig. 5. *Gyraulus ioanis* n. sp. – **1**: shell, **2**: mantle pigmentation, **3**: sex tract, bc = bursa copulatrix, m = muscle, pr = prostate gland, pht = phallotheca, prp = praeputium, v = vagina, vd = vas deferens.

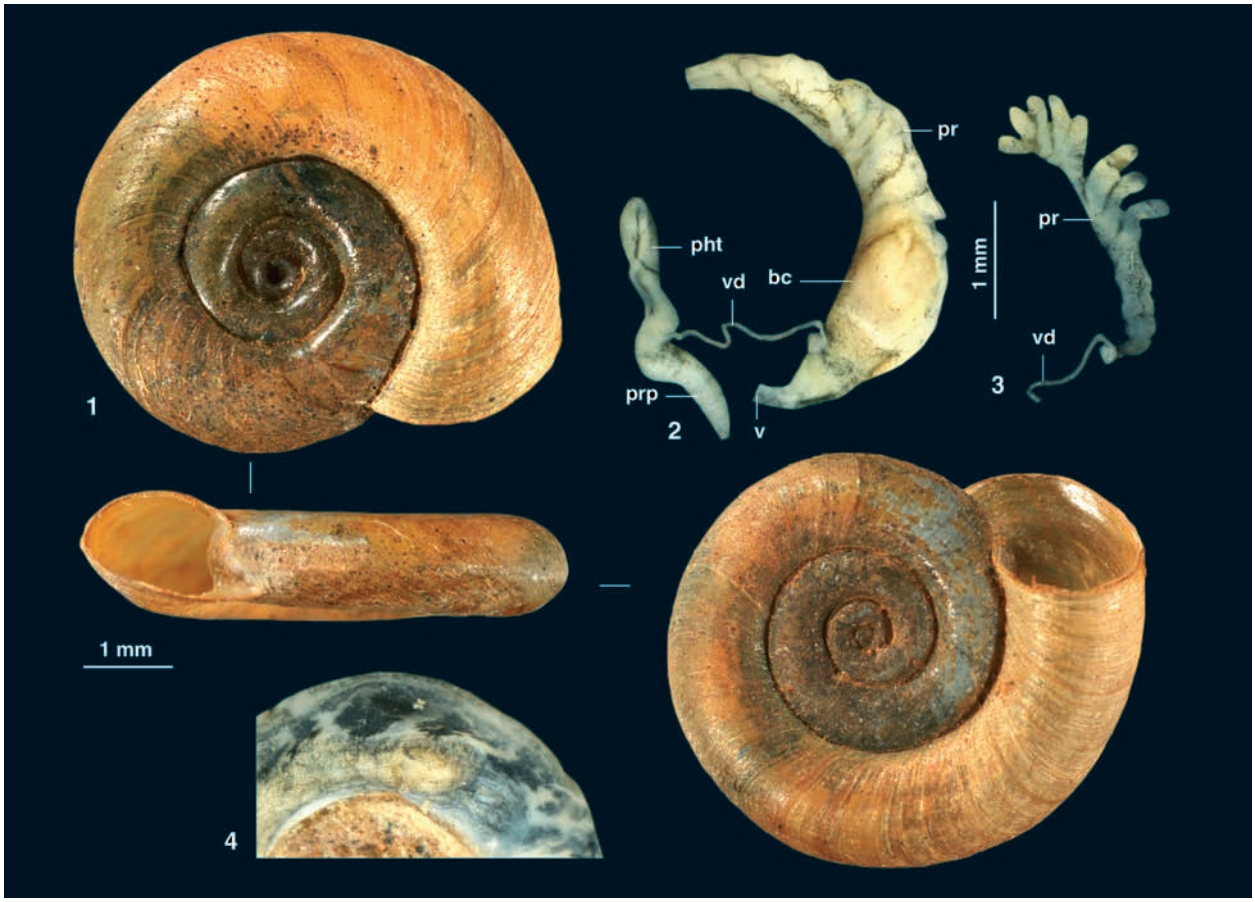

Fig. 6. *Gyraulus shasi* n. sp. – **1**: shell, **2**: sex tract, **3**: prostate gland, **4**: mantle pigmentation, bc = bursa copulatrix, m = muscle, pr = prostate gland, pht = phallotheca, prp = praeputium, v = vagina, vd = vas deferens.

Differential diagnosis

Gyraulus species can be distinguished by the morphology of the shells as well as by the prostate gland, a very important feature to separate *Gyraulus* species from each other (MEIER-BROOK 1983: 15). Some species have a characteristic mantle pigmentation, e.g. the widespread Asian *Gyraulus chinenesis* (BERAN & GLÖER 2006: fig. 2).

All three newly described species have an angled periphery which can be found in Central Europe only in *Gyraulus acronicus* (A. Férussac, 1807), if we do not take the very small *G. riparius* (Westerlund, 1865) and *G. crista* (Linnaeus, 1759) into consideration. The prostate gland of *G. acronicus*, however, has 20–40 regularly arranged diverticles. *G. meierbrooki* and *G. ioanis* have nearly 20 prostate diverticles but in contrast to *G. acronicus* their shell surfaces are glossy. Only the shell of *G. shasi* looks a little similar to *G. acronicus* but has only 8 scattered diverticles. The widespread *G. piscinarum* has no angled periphery and is well defined by the deep umbilicus at the functional under side, so it is distinct from the species from the Skadar Lake Basin. The shell of *G. janinensis* from Lake Pamvotis is very flat, and by this closely related to *G. albidus* (FROGLEY & PREECE 2007). None of the new species discussed here are similar to *G. janinensis*.

Fine growth lines and fine spiral striae form a reticulate surface sculpture in *G. albidus*, similar to *G. albus*, but this sculpture is only weakly developed. The shell surfaces of the new *Gyraulus* spp. have no spiral striae so they are distinct from *G. albidus*.

The mantle pigmentation of the new species under discussion differs from the characteristic mantle pigmentation of *G. chinenes*. Only *G. ioanis* looks a little similar, but the prostate gland of *G. chinensis* bears 11–15 short diverticles versus 14–16 long diverticles in *G. ioanis*.

Discussion

In *Gyraulus meierbrooki* n. sp. we found egg masses on the umbilicated functional underside of the shells. This unusual reproductive strategy could also be observed in other species like *Planorbis presbensis* by ALBRECHT (2006) and *Pseudobithynia westerlundi* by GLÖER & PEŠIĆ (2006). This strategy possibly hinders passive dispersal by vectors. On the other hand, this reproductive strategy was found in *Radix auricularia*, too (ALBRECHT 2006), a widespread species in the Balkans.

The animals of *G. albidus*, the shells of which are not angulated, are white and infected by cercariae. The shells show no fringes at the shell surface while the others' do. Because of the infection we could not compare the prostate gland of the infected specimens, but we believe that all specimens studied are conspecific. Thus we have to state that the parasite hinders the production of "hairs" at the shell surface because this possibly protects the snail against predators, and with these "hairs" the snail is unsuitable to act as intermediate host.

The *Gyraulus* species *G. albus* and *G. laevis*, mentioned formerly from Montenegro, could not be found by us so far. However, among more than hundred samples from different water bodies in Montenegro, the new *Gyraulus* species described here could only be found in the Skadar Lake Basin so that these species are possibly endemic to this Basin.

Usually the endemicity (calculated as: percentage of endemic caenogastropds/percentage of endemic pulmonates) in caenogastropods is in ancient lakes 1.5–10 times greater than that among pulmonates (BOSS 1978: 405). In the Skadar Lake Basin this factor is 1.8, because we found until now 46 species of which 14 are endemic, 19.6 % Caenogastropoda and 10.9 % Pulmonata. This is equal to the Ohrid Lake, but the total number of species is higher in the latter one and depends on longevity and niche width of a lake. In addition every ancient lake is inhabited by endemic *Gyraulus* spp. (BOSS 1978), of which those in old ancient lakes like Lake Ohrid are often characterised by ornamented shell sculpture (*Carinogyraulus*) as compared with ubiquitous (GORTHNER 1992).

Interesting is the occurrence of two possibly endemic *Gyraulus* species which live syntopically in Šasko Lake. Maybe this is an example of sympatric speciation, possibly in a saltational way.

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