NAT. CROAT. | VOL. 6 | No 1 | 91–111 | ZAGREB | March 31, 1997

ISSN 1330-0520
UDK 56:594.3:551.761.2(497.5:1-14)

NEW PLIOPLEISTOCENE GASTROPODS FROM LIKA, CROATIA

ZLATA JURIŠIĆ-POLŠAK*, KREŠIMIR SAKAČ* & MARIJA POJE**

*Geological-palaeontological Department of Croatian Natural History Museum,
**Institute of Palaeontology and Quaternary Geology of the Croatian Academy of Sciences and Arts

Jurišić-Polšak, Z., Sakač, K. & Poje, M.: New Pliopleistocene Gastropods from Lika, Croatia, Nat. Croat., Vol. 6, No 1., 91–111, 1997, Zagreb

The freshwater sediments near Srb in Lika, Central Croatia, contain well preserved sample of molluscs, plant remains and other fossils of lacustrine shallow water environment. Two new gastropod species: *Odontohydrobia croatica* n. sp. and *Limnidia likana* n. sp., together with other determined taxa indicate the Pliopleistocene age of these sediments.

Key words: Gastropoda, new species, Pliopleistocene, Lika, Croatia

Jurišić-Polšak, Z., Sakač, K. & Poje, M.: Novi pliopleistocenski gastropodi iz Like, Hrvatska, Nat. Croat., Vol. 6, No 1., 91–111, 1997, Zagreb

Slatkovodni sedimenti nađeni blizu Srba u Lici, središnja Hrvatska, sadrže dobro očuvane primjerke mekušaca, biljne ostatke i druge fosile plitkovodnog jezerskog okoliša. Dvije nove gastropodne vrste *Odontohydrobia croatica* i *Limnidia likana*, zajedno s drugim određenim vrstama ukazuju na pliopleistocensku starost tih sedimenata.

Ključne riječi: Gastropoda, nove vrste, pliopleistocen, Lika, Hrvatska

INTRODUCTION

During the investigation of Permian evaporites and their associated rocks (ŠUŠNJARA & al., 1992) in the border region between Croatia and Bosnia we were able to identify some peculiar sediments with freshwater flora and fauna near Srb, in Lika (Fig. 1). The outcrops of these sediments are rather limited in extension. A little more to the north, along the upper stream of the river Una, near Orešac, Kulen-Vakuf and Martin Brod there is a discontinued Middle Miocene zone (ŠUŠNJAR & BUKOVAC, 1979). We can be certain that the fauna near Srb is essentially

Hrvatski prirodoslovni muzej, Demetrova 1, Zagreb, Croatia

Fig. 1. Investigated area.

different from that found in Middle Miocene sediments and that sediments near Srb contain some taxa not hitherto found in Croatia.

Besides freshwater gastropods of Tertiary provenance the fauna at Srb also includes gastropods which would indicate Pleistocene age as well. The sediments yielded some plant remains, gyrogonites and *Characeae* thalli are found there. This palaeontological association should be enlarged by an earlier discovery of a mastodon molar (GORJANOVIĆ-KRAMBERGER, 1912).

South of Srb, in northern Dalmatia, there are faunistically two similar sites. The first is Strmica which has been identified, following its vertebrates, as Lower Pleistocene basin. The second area with Neogene and Pleistocene molluscs is Kninsko Polje. In the Pleistocene there MALEZ & al. (1969) have reported Pleistocene vertebrates.

SITE GEOLOGY

The area around Srb is composed of Permian, Triassic and Jurassic sediments as well as, following this study, of sediments which are Pliocene-Pleistocene in age. There are some Quaternary covers there also (Fig. 2).

The wider vicinity of Srb is composed of Permian sediments. They consist of evaporites and clastites. Evaporites are represented by gypsum and anhydrite, while there are two kinds of clastites. The first kind are well-bedded pelites, siltites, and sandstones. They form a base of Upper Tertiary sediments. The other kind of clastites are represented by unbedded carbonatic porous breccias, i. e. Rauchwacke, which, beside Permian, are at least partially, pre-Neogene and Quaternary in age as well. The isotopic composition of sulphur and the sample analysed demonstrate that South Croatian evaporites, including these evaporites along the upper flow of the Una river, are Permian in age (ŠIFTAR, 1982; 1986). Upper Permian age of clastites in these region is also confirmed on the base of a rich and well preserved pali-

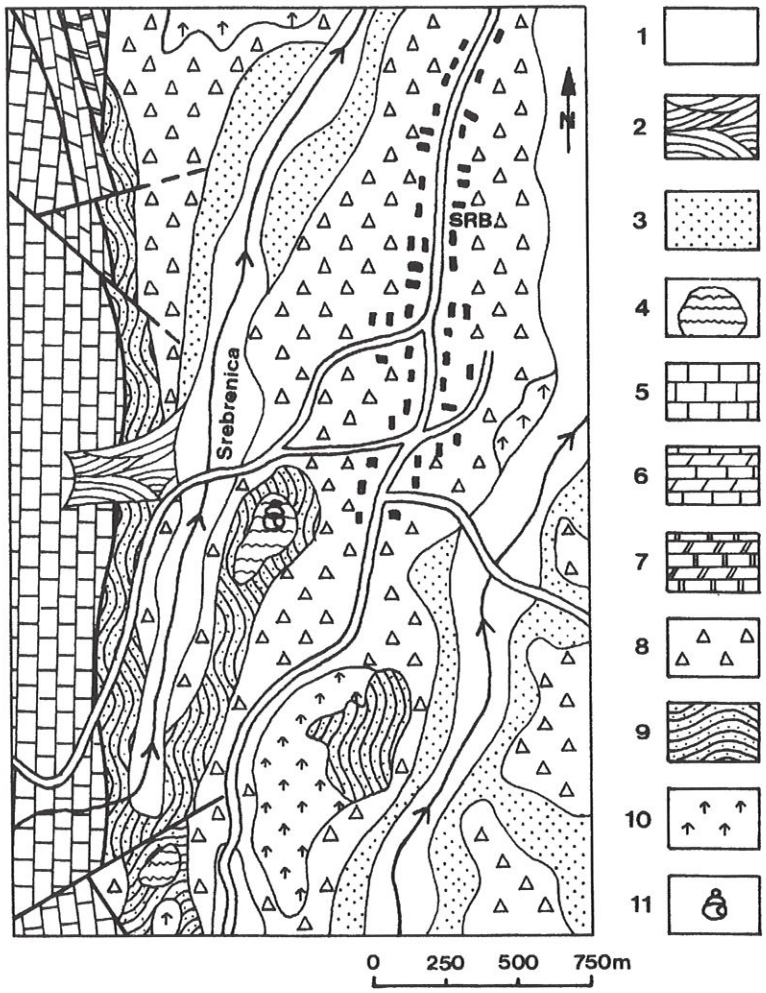

Fig. 2. Geological map of the Srb area: 1 alluvium (Quaternary), 2 talus (Quaternary), 3 diluvium (Quaternary), 4 clay, clayey-sandy marls (Pliopleistocene), 5 limestones (Malm), 6 limestones and dolomites (Dogger), 7 limestones and dolomites (Ladinian), 8 porous carbonate breccias (»Rauchwacke«), (Permian, partially Pre-Neogene and Quaternary), 9 clastic sediments, pelites, siltites and sandstones (Upper Permian), 10 evaporites: gypsum and anhydrite (Upper Permian), 11 sites with the fossils

nological material (JELEN, in ŠUŠNJARA & al., 1992). Permian sediments of this region are tectonically strongly disturbed and mostly covered with Quaternary deposits. In the western part of the region there is an uplifted complex of Triassic and Jurassic carbonate sediments. These sediments are composed of Ladinian, Doggerian and Malmian limestones and dolomites. They belong to the marginal part of the larger

nappe and its base is made of Permian sediments (CHOROVITZ, 1977). The contacts between Permian and Mesozoic sediments, however, are marked here by subvertical faults, while a series of longitudinal and transverse faults extend through carbonate Triassic and Jurassic rocks.

Pliocene and Pleistocene (Pliopleistocene) sediments in the Srb area have been discovered at two places (Fig. 2). The more northern outcrops, where fossils are found, consist of grey and bluish clays and grey and sandy-clayey marls. On the other site, on a steep slope of a deep gully, the sediments are eroded to a small outcrop of weathered sandy clays. These sediments were deposited on Upper Permian clastites. No contacts are visible.

Quaternary sediments cover the low elevations of this region and they are represented by a relatively thick diluvium derived from the erosion of the neighbouring sediments, predominantly Permian clastites, also alluvial river deposits as well as tali of the steep slopes of carbonate Mesozoic sediments in the western part of the region.

Geotectonically, the Srb area belongs to the Outer Dinarides zone. The sporadic freshwater basins were formed in this region in the Neogene, from Ottnangian to Quaternary times. Occasionally these basins were isolated lakes with endemic fauna.

PALAEONTOLOGY

A sample of sandy marl contained well preserved flora and fauna. The following fossils were determined:

Odontohydrobia croatica n. sp.
Limnidia likana n. sp.
Valvata (Cinncina) piscinalis O. F. MÜLLER
Limnaea (Radix) cf. *peregra* O. F. MÜLLER
Bithynia cf. *tentaculata* LINNÉ
Pisidium sp.
Erpetocypris sp.
Charathalus cf. *thuringensis* NÖTZOLD
Charathalus varia
Charites sp.

To this list of fossils we could add the earlier discovered (GORJANOVIĆ-KRAMBERGER, 1912) mastodon tooth:

Anancus arvernensis CRO. et JOB.

NEW SPECIES

Established by Zlata Jurišić-Polšak

Familia: *Hydrobiidae*

Subfamilia: *Hydrobiinae*

Genus: *Odontohydrobia* PAVLOVIĆ 1927

Odontohydrobia croatica n. sp.
Pl I., Figs. 1–6

Locus typicus: Srb, Lika, Croatia

Stratum typicum: Pliopleistocene, sandy marl

Derivatio nominis: This is the first species of the genus *Odontohydrobia* recognized from Croatia and thus named »*croatica*«(lat.).

Holotypus: Inv. no. 10696, Geological-Palaeontological Department of Croatian Natural History Museum.

Paratypi: Inv. no. 10697

Material: 238 specimens

Description: The shell is made of six distinct oval whorls which are clearly separated by a suture. The spire is growing uniformly in width, thus the shell is conical in shape. The aperture is inclined oblique elliptic and at the top angular in shape. The inner lip is mostly flattened to the last whorl thus covering the umbilicus. The columellae of all samples exhibit a larger or weaker fold or small tooth. In some specimens this tooth is not visible until the shell is not positioned in semiprofile. The outer lip, slightly beaked, is extended downwards. On the otherwise smooth surface of the shell the enlargement will reveal slight growth lines. Some specimens exhibit three or four spiral, slightly impressed lines (Pl. I, Figs. 1–4).

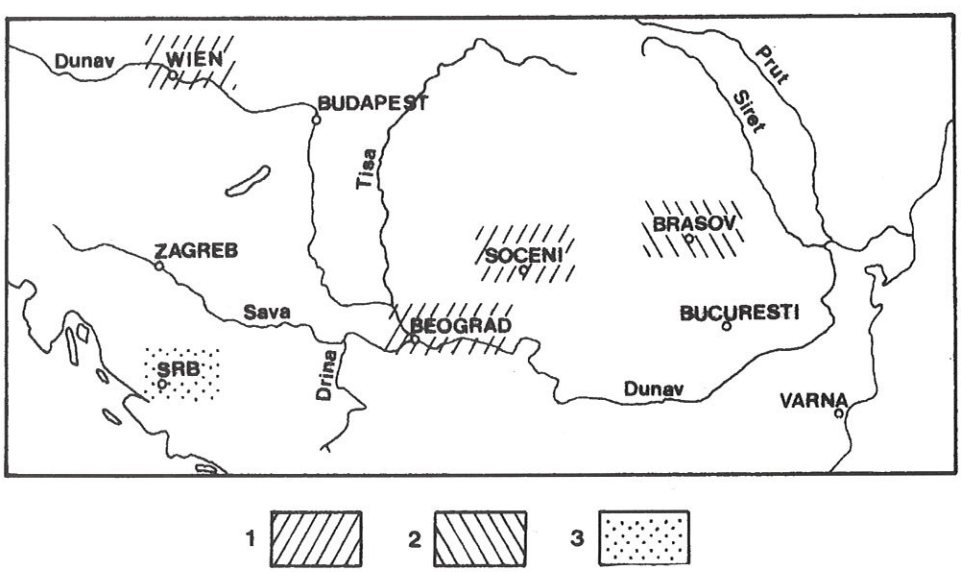

Fig. 3. Localities with the genus *Odontohydrobia*: 1 Upper Pannonian, 2 Lower Pliocene, 3 Pliopleistocene

Dimensions: holotypus 4.5 : 2.20 mm, paratypi (5 specimens) 4.35 : 2.00 – 5.70 : 2.50 mm.

Affinities: Stratigraphic range of all hitherto known species of the genus *Odontohydrobia* is Upper Pannonian to Lower Pliocene and all described species evolved in the Paratethyan basin (Fig. 3). Genus *Odontohydrobia* with its four new species (*O. ranojevici, O. wagneri, O. clessini and O. bathyomphaloides*) from the Upper Pannonian sediments of Karagač near Belgrade was described by PAVLOVIĆ (1927). New additional species of that genus *O. dacica* from the Lower Pliocene of Brasov in Romania was subsequently described by JEKELIUS (1932). Later, the same author (JEKELIUS, 1944) identified two species determined by PAVLOVIĆ (*O. wagneri, O. clessini*) and additional species of *Odontohydrobia cryptodonta* from Upper Pannonian sediments of Turislav in Romanian Banat. A new species *Hydrobia (Odontohydrobia) leobersdorfensis* was determined by PAPP (1951) from the Upper Pannonian sediments of Leobersdorf in the Vienna basin.

Odontohydrobia specimens from Srb, Croatia, are larger than all hitherto known species. In size and shape they exhibit some affinities with Lower Pliocene species of *O. dacica*. The specimens of the new species have more rounded whorls as well as deeper sutures than the specimens *O. dacica*.

In spite of mutual similarity of the above mentioned species, we think that the new species of *O. croatica* evolved separately and in isolation from the species *O. dacica* (Fig. 3). Their affinities would suggest parallel, convergent evolution. Thus, isolated and distant basins originated similar forms, but we cannot consider them as a unique species. There is a rather large distance between Lika and Romanian Banat and certainly there was a rather different history of these environments. The two areas belong to various geotectonical units (*O. dacica* is derived from Dacian basin, while *O. croatica* evolved from freshwater, lacustrine basin from the Outer Dinarides zone) and thus we ought to presume the existence of a land barrier between these regions. Therefore we could exclude faunal interchange between the basins. We know that the Sava drainage system, eventually connecting these distant regions, was formed by the end of Pleistocene and Holocene (ŠUŠNJAR & BUKOVAC, 1979) and thus we should exclude gene flow by means of former water-ways.

The new species, considering the stratigraphic range of the associated fauna, belongs to the Pliopleistocene age. Therefore the species represents the latest form discovered so far.

Genus: *Limnidia* SCHÜTT 1973.

Limnidia likana n. sp.
(Pl. I, Figs. 7–11)

Locus typicus: Srb, Lika, Croatia

Strątum typicum: Pliopleistocene, sandy marl

Derivatio nominis: The species was named *likana* (lat.) after Lika, region of Croatia.

Holotypus: Inv. no. 10698 Geological-Paleontological Department, Croatian Natural History Museum

Paratypi: Inv. no. 10699

Material: 26 specimens

Description: The shell is composed of five well rounded whorls which are separated one from another with markedly deep suture and thus it appears as an uncoiled shell. The surface of the shell is rather smooth, only the growth lines are visible. The growth in width is very slow, especially in the last three whorls. The penultime whorl is frequently as wide as the body-whorl. The aperture is inclined ovaly. The upper portion of the inner lip is tight to the body-whorl. In its medial portion the inner lip is divided from the shell thus partially uncovering the umbilicus. In its lower part the aperture margin is slightly extended outwards.

Dimensions: holotypus 2,80:1,20 mm, paratypi (4 specimens) 2,25:1,15 – 2,40:1,20 mm.

Affinities: The genus Limnidia was established by SCHÜTT (1973), following much earlier known species of *Hydrobia (Bythinella) skhiadica* BUKOVSKI (1895), from the Lower Pannonian of the Greek island of Chios. BUKOVSKI's species of *Limnidia skhiadica* was also found by SCHÜTT in northwestern parts of Turkish Anatolia, in sediments of Pannonian-Pontian age (SCHÜTT & KAVUSAN, 1984). Furthermore, the same species was identified (WILLMANN, 1981) in Pannonian sediments of the island of Rhodes as *Pseudamnicola (Limnidia) skhiadica.*

The new Croatian specimens from Srb differ from the above mentioned species of *Limnidia skhiadica* because the majority of the specimens show that the umbilicus is only partially open, while the aperture is nowhere fully separated from the spire. There is a stratigraphic difference as well. The species *L. skhiadica* has a time span from Lower Panonian to Upper Pontian, while our new *L. likana*, following associated fauna, appears in sediments of Late Pliocene to Early Pleistocene. The genus *Limnidia* is otherwise not present in later Pleistocene times nor in Recent.

ASSOCIATED FAUNA

GASTROPODA

Limnaea (Radix) cf. *peregra* (O. F. MÜLLER)
Pl. II., Figs. 1–6

The sample consists of 13 specimens in total and although no specimen is complete, only three shells are well preserved. Following LOŽEK (1964) this is palearctic species which appears in the Late Pliocene. It is frequently found in Pleistocene and Holocene lacustrine marshes of Slavonia (Eastern Croatia) (HEĆIMOVIĆ, 1986, GALOVIĆ & al., 1989). This is an eurythermic snail of shallow stagnant or slow waters and abundant vegetation.

Bithynia cf. *tentaculata* (LINNÉ)
Pl. II., Figs. 7–11

Three shells and a dozen opercula were preserved in our analysed sample. This is also palearctic species evolving in the Pliocene (ESU & GIROTTI, 1974). Although it is more common in warm periods it can be found in the cold phases of Pleistocene (LOŽEK, 1964). It is frequent in Pleistocene and Holocene lacustrine-marshy environments of Slavonia (MAGAŠ, 1987, and others). Today the species inhabits stagnant waters or slow streams rich in vegetation.

Valvata (Cincinna) piscinalis (O.F. MÜLLER)
Pl. III., Figs. 1–4

In our sample of the total of 49 specimens only six shells are well preserved. The species evolved in the Miocene and spans until Recent (ESU & GIROTTI, 1974). It is more typical for warm periods (LOŽEK, 1964) and the snail is abundant in Pleistocene and Holocene swamp or marshy sediments of Slavonia (ŠPARICA & al., 1984, and others).

LAMELLIBRANCHIATA

Pisidium sp.
Pl. III., Figs. 7–10

The analysed sediment sample from Srb contains 4 shells of this genus. Due to the lack of specialised literature and comparative material we were not able to carry out the specific determination. But, following the various forms of the shells we may suggest that there are at least two species of the genus represented in our sample (Figs. 7–8, and Figs. 9–10). The genus, evolved in Tertiary and present in Recent, is a cosmopolitan freshwater snail which in numbers of species and individuals inhabits different water environments (marshes, swamps and lakes).

OSTRACODA

Erpetocypris sp.
Pl. III., Figs. 5–6

The only single ostracod specimen, in its larval stage, was found in our faunal sample. The mandibular attachments are well preserved, but the central muscular attachment is not visible. Thus, it is hard to specify identification of the species. The genus *Erpetocypris* is associated with the freshwater fauna of small, shallow waters with muddy bottoms which are rich in vegetation. It has been determined in Miocene sediments of Krbavsko Polje (JURIŠIĆ-POLŠAK & al., 1994), and it is also known from the Pleistocene of the Dinaric karst (SOKAČ, 1975).

FLORA

Charathalus cf. *thuringensis* NÖTZOLD
Pl. IV., Figs. 5–8, 12–14

1986. *Charathalus thuringensis* NÖTZOLD, Pl. II, Figs. 1–12

Numerous thalli (more than 40 fragments) have been discovered and they exhibit preserved nodes and internodes. Some specimens show a short sprouted phylloids. An unusual phenomenon, gyrogonites in its primary position, has been found (Pl. IV, Figs. 5–6). They are usually found separately from the thallus. This is so rare a finding that NÖTZOLD (1986) reports: *»DAILY and DURHAM (1964) publizierten das einzige dem Verfasser bekannte Fossil, an dem sich die vegetativen Thalusreste und die weiblichen Fortpflanzungsorgane im organischen Verband fanden«.*

The thallus cross-section (Pl. IV., Figs. 12–14) exhibits the central rounded tube, i. e. cavity, encircled by a rim of tubules. Although some thalli are more incrustated it can be observed that small tubes are positioned in two rows. Some thalli specimens exhibit 12 to 16 tubules, but their number averages 14. Some of these tubules are rounded and others are irregularly compressed.

The inner thallus diameter is cca 0.5mm, while the outer diameter amounts cca 1mm. In their dimensions as well in the tubules number the specimens from Srb show affinities with Pleistocene species of *Ch. thuringensis* known from German region of Thüringia.

Charathalus varia
Pl. IV., Figs. 9–11.

Several thalli specimens with longitudinally sculptured ridges were discovered in the fossil sample from Srb. The thalli cross-section is also rounded but tubules are not visible. The main tube is divided by ridges. There is a single specimen with longitudinally ridged sculpture as well, and just opposite the previously mentioned species with flat structure, this specimen exhibits short convex internodes (Pl. IV., Fig. 10).

Charites sp.
Pl. IV., Figs. 1–4

The sample from Srb contains a dozen complete gyrogonites of the genus *Charites.* At the place where they were attached to the thallus they exhibit pentagonal opening (Pl. IV., Fig. 4). Following the gyrogonites shapes it is possible that two species are represented in the sample.

PREVIOUS DISCOVERY OF MASTODON TOOTH AND ITS IMPLICATIONS

In GORJANOVIĆ-KRAMBERGER's (1912) monograph on the fossil proboscideans from Croatia there is a claim for the presence of Late Pliocene species of *Anancus arvernensis* at Srb in Lika. The mastodon tooth (molar) from this locality in that monograph is described and presented on Tab. I, Fig. 8 and today it is a part of the rich osteological collection of Miocene mammals in the Geological-Palaeontological

Department of the Croatian Natural History Museum. It is worth repeating here GORJANOVIĆ-KRAMBERGER's (1912:12) comment on this tooth: »*If we take into consideration that isolated skeletal parts – predominantly teeth – have been found in Bratovština near Petrinja, Srb, Bribir, Vrbovsko, in the stream of Čaplja near Brod and in Podvinje, then we may conclude that this genus during the Upper Pliocene was spread over the entire region of Croatia and Slavonia*«.

We should mention here some other, more recent, papers relevant to the stratigraphic position of this proboscidean species. Thus JEKELIUS (1932) reports the remains of *Anancus arvernensis* in Dacian sediments of the Brasov Basin, Romania, associated with a rather rich fauna of freshwater molluscs. Some of the snails identified there are common or similar to the taxa from Srb. These are molluscs: *Odontohydrobia dacica, Bithynia tentaculata, Valvata piscinalis* and the remaining fauna is composed of several species of the genera *Viviparus, Valvata, Hydrobia, Pseudamnicola, Pyrgula, Melanopsis, Gyraulus, Dreissenia, Limnocardium and Unio.*

MALEZ (1965) writes that the last decades have increased the number of mastodon discoveries from the sediments of the region between the rivers Sava and Drava. He states that »*The largest number of the collected mastodon remains come from Pliocene sediments, and they exclusively represent the species of Mastodon arvernensis – otherwise the most frequent mastodon in the Late Neogene of Central and South Europe*«.

Following RABEDER (1985) the species *A. arvernensis* appears from the Late Pontian to the Late Pliocene, while TOBIEN (1986) thinks that the remains of *A. arvernensis* in Mainzer Becken (Germany) are Pliocene in age. After ANDERSON (1989) the time span for genus *Anancus* in Europe ranges from Late Pliocene to Early Pleistocene. This would agree with ROCAFORTE & al. (1994) who lists discoveries of this species in the Late Pliocene as well as in the Pleistocene. Finally, MEIN (1990) attributed this species to MN 17 zone of the European mammalian chronology.

We should mention that many authors think that this species was present in Villafranchian facies which may be a transitional period between Pliocene and Pleistocene in Southern Europe (RÖGL & al., 1983). Thus the majority of authors associate *A. arvernensis* with Late Pliocene, i. e. to the MN 17 zone or exceptionally to MN 18 zone. Therefore we may conclude that stratigraphically this species belongs to the Pliocene, but it may well have survived into the Early Pleistocene.

Finally, we cannot claim that our newly discovered mallacofauna from Srb derive from the same stratum which yielded a mastodon tooth, but we can assume that both palaeontological findings originated from the same sedimentary basin, and thus we could presume an analogous or identical stratigraphic age.

PALAEOENVIRONMENT

Characeae are the floristic element of stagnant freshwater to brackish environments rich in calcium carbonates. Their habitat are shallow waters up to ten meters of depth and they are rarely found in swamps. The determined gastropod species *Radix peregra, Bithynia tentaculata* and *Valvata piscinalis* live in calm, stagnant or slow waters rich in vegetation. Relatively well preserved gastropod shells indicate stagnant waters as well.

Thus, we could assume that the area around Srb during the Late Pliocene or Early Pleistocene (Pliopleistocene) was a shallow lacustrine environment with rich vegetation. The earlier discovery of a mastodon would also indicate the lowland vicinity of the area.

DISCUSSION

The stratigraphic position of the newly discovered fossils from Srb cannot be established with certainty. No species would be indicative for a particular and more precise age. However, the genera such as *Odontohydrobia*, with its species spanning from the Uppermost Pannonian and Lower Pliocene, and *Limnidia* with representatives known from the Uppermost Sarmatian, Lower Pannonian and Pontian, could be a significant contribution to the evaluation of stratigraphy at Srb. These genera have not been yet discovered from Late Pleistocene nor Recent times, and thus they are considered to be Tertiary faunal elements. We should mention that the most numerous individual snail count in our sediment sample belong to the species *Odontohydrobia croatica* (69.59 %), which with the percent of the specimens *Limnidia likana* (7.6 %) makes 77.19 % of the whole fauna of Srb (Fig. 4). The species *Bithynia tentaculata* (3.21 %), *Valvata piscinalis* (14.32 %) and *Lymnaea peregra* (3.80 %), which originated in the Miocene and Pliocene, and also live in Recent time, are represented by a much smaller number. An exceptionally large number of individuals representing those species have been discovered in swampy, marshy or lacustrine Pleistocene and Holocene sediments of Slavonia, Eastern Croatia, and therefore, these species could be considered as dominant gastropods of these environments and times. The same taxa have been found in Tertiary lacustrine sediments, but in different faunal composition and in association with a species which became extinct in the Pleistocene.

On the other hand, *Charathalus thuringensis*, the species which resembles most closely our *Characeae* specimens has been found in Pleistocene sediments.

The sample analysed was too small and cannot be a sample including more complex faunal associations and their Miocene or Pliocene index species. Future work will certainly help to solve some of these problems.

The problem of the stratigraphic position of our new fossil association from sediments at Srb could be significantly resolved by the previously discovered mastodon tooth from this area. This tooth is ascribed to *Anancus arvernensis* (GORJANOVIĆ-KRAMBERGER, 1912). This species, following old as well as new literature, is almost always associated with Upper Pliocene. After ANDERSSON (1989) the time span for the genus *Anancus* in Europe is the Upper Pliocene to Lower Pleistocene. Following MEIN (1990) *A. arvernensis* corresponds to his 17 zone of mammalian chronology. Thus, *A. arvenensis* is a Pliocene species but possibly survived into the Early Pleistocene.

Questions regarding the stratigraphic position of sediments at Srb are partially caused by the fact that some *poljas* of Croatian Karst were previously thought to be Pliocene in age and today, based on ostracods, they are considered as Pleistocene derivations. Such cases are Ervenik Polje and Žegar Polje (MALEZ & al., 1968; 1969a; 1969b). In Kninsko Polje sediments with melanopsids are Neogene in age, while the

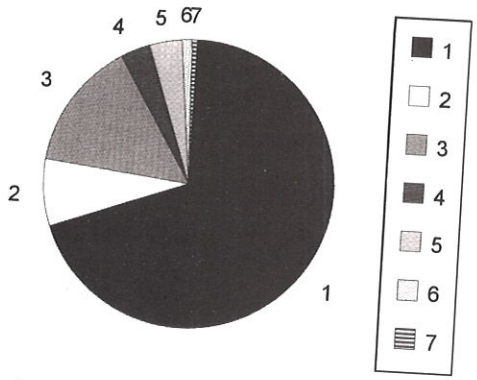

Fig. 4. Faunal spectrum of the Srb area: 1 *Odontohydrobia croatica*, 2 *Limnidia likana*, 3 *Valvata piscinalis*, 4 *Bithynia* cf. *tentaculata*, 5 *Limnaea (Radix)* cf. *peregra*, 6 *Pisidium* sp., 7 *Erpetocypris* sp.

terminal part of the sequence belongs to the Pleistocene (ŠIMUNIĆ, 1971; MALEZ, 1975). Contrary to this, there are cases where previously Pleistocene aged poljas, following analyses of freshwater molluscs, are now ascribed to Miocene, such as in Krbavsko Polje (JURIŠIĆ-POLŠAK & al., 1994).

Finally, we think that the Srb basin is Pliocene and that there is no palaeogeographic, either climatic or tectonic or any other reason, why sedimentation should break at the end of the Pliocene. Although, this was a time of continuos uplift of the Dinarides, sedimentation could continue well into the Pleistocene, with no visible sedimentological or palaeontological changes. Thus, transitional levels are hard to detect. Throughout Europe there are sites with continuos transition between Pliocene and Pleistocene. Some of these sequences are well documented, e. g. in Italy (ESU & al., 1993), but some are just taken as transitional levels (BOEUF, 1990; RUTTE, 1990; RADULESCO, 1990; AGUIRE & al., 1990; ROCAFORTE & al., 1994).

This is the first paper dealing with a Pliopleistocene site in Lika and we are well aware that new discoveries will add new knowledge and corrections. We hope we can encourage further investigations of geology and palaeontology of freshwater basins in the Outer Dinarides where that data is under strong bias and thus possibly wrong interpreted.

CONCLUSIONS

Sandy marls near Srb in Lika represent the terminal phase of lacustrine sedimentation.

Analysed fauna of molluscs and ostracods, as well as gyrogonites and fam. *Characeaea* thalli indicate a stagnant, shallow, relatively warm water environment rich in vegetation.

Newly established species of *Odontohydrobia croatica* and *Limnidia likana* evolved separated from the fauna of other basins and these taxa possibly represent endemic species.

The age of the site is presumably the transitional period of Pliocene and Pleistocene.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. H. SCHÜTT for his useful suggestions regarding identification of malacofauna. We would like to thank Dr. A. SOKAČ for her determination of ostracods. Photos are by N. BORČIĆ, while line drawings are by R. FILJAK. We acknowledge their help.

Received January 10, 1997

REFERENCES

ANDERSON, E., 1989: Who is who in the Pleistocene: A Mammalian Bestiary (40–89). In: MARTIN, P. S. & KLEIN, R. G.: Quaternary Extinctions. A Prehistoric Revolution. The Univ. of Arizona Press, Tuscon, Arizona.

AGUIRRE, E. & MORALES, J., 1990: Villafranchian Faunal Record of Spain. Quartärpaläontologie, 8, 6–11. Berlin.

BOEUF, O., 1990: Originalité et importance de la faune Plio-Pleistocene de Chilac (Haute-Loire, France). Quartärpaläontologie 8, 13–28. Berlin.

CHOROVICZ, J., 1977: Étude géologique des Dinarides le long de la structure transversale Split-Karlovac (Yougoslavie). These Univ. Pierre et Marie Curie. 322 p. Paris.

ESU, D. & GIROTTI, O., 1974: La malacofauna continentale del Plio-Pleistocene dell' Italia centrale. I.: Paleontologia. Geol. Romana 13, 203–293. Roma.

ESU, D., GIROTTI, O. & KOTSAKIS, T., 1993: Palaeobiogeographical observations on Villafranchian continental molluscs of Italy. Scripta Geol., Spec. Issue 2, National Museum of Natural History, Leiden, 101–119. Leiden.

GALOVIĆ, I., BRKIĆ, M. & BUZALJKO, R., 1989: Osnovna geološka karta 1: 100000. Tumač za list Vinkovci L 34–98. Geol. zavod Zagreb(1987), Geoinženjering OOUR Inst. Geol. Sarajevo (1979), 49 p. Sav. Geol. zavod Beograd. Beograd.

GORJANOVIĆ-KRAMBERGER, D., 1912: Fosilni proboscidi Hrvatske i Slavonije. Djela Jugosl. Akad. Zn. Umj. 21, 1–23, Zagreb.

HEĆIMOVIĆ, I., 1986: Osnovna geološka karta SFRJ 1:100000. Tumač za list Donji Miholjac L 34–73. Geol. zavod Zagreb (1984), 1–32. Sav. geol. zavod Beograd. Beograd.

JEKELIUS, E., 1932: Die Molluskenfauna der dazischen Stufe des Beckens von Brasov. Mem. Inst. Geol. Al Rom. II, 118 p. Bucuresti.

JURIŠIĆ-POLŠAK, Z., KRIZMANIĆ, K. & HAJEK-TADESSE, V., 1993: Freshwater Miocene of Krbavsko Polje in Lika (Croatia). Geologia croatica 46/2, 213–228. Zagreb.

LOŽEK, V., 1964: Quartärmollusken der Tschechoslowakei.. Rospr. Ust. Geol. 31, 1–374. Praha.

MAGAŠ, N., 1987: Osnovna geološka karta SFRJ 1:100000. Tumač za list Osijek L 34–86. Inst. Geol. istraž. Zagreb (1986), 1–54. Sav. geol. zavod Beograd. Beograd.

MALEZ, M., 1965: Erster Fund der Gattung Mastodon (Bunolophodon) grandincisivus Schlesinger im Pliozän von Slawonien. Bull. sci. Cons., Acad. RSF Yougosl., A, 10/12. Zagreb.

MALEZ, M. & SOKAČ, A., 1968: New conceptions on the age of the freshwater deposits of Ervenik and Žegar fields in Dalmatia. Bull. sci. Cons. Akad. RSF Yougosl. A, 13/11–12, 371. Zagreb.

MALEZ, M., SOKAČ, A. & ŠIMUNIĆ, A., 1969: The paleontologic characteristics and age of the lake chalk at Kninsko polje (Northern Dalmatia). Bull. sci. Cons. Akad. RSF Yougosl. A, 14/7–8, 216. Zagreb.

MALEZ, M. & SOKAČ, A., 1969: O starosti slatkovodnih naslaga Erveničkog i Žegarskog polja. III Simpozij Dinarske asocijacije. 81–93. Zagreb.

MALEZ, M., SOKAČ, A. & ŠIMUNIĆ, Al., 1975: Kvartarne naslage Krbavskog polja u Lici. Acta geol. 8, 413–440. Zagreb.

MEIN, P., 1990: Updating of MN Zones. In: LINDSAY, E. H., FAHLBUSCH, V. & MEIN, P. (eds.): European Neogene Mammal Chronology, 73–90, Plenum Press. New York.

NEUMAYR, M., 1879: Mastodon arvernensis aus der Paludinen- Schichten Westslavoniens, 176–180, Verh. Geol. R.A. Wien.

NÖTZOLD, T., 1986: Vegetative Charophytenreste aus dem Quartär Thüringens (DDR). Quartärpaläontologie 6, 123–129. Berlin.

PAPP, A., 1951: Die Molluskenfauna des Pannon im Wiener Becken. Mitteil. Geol. Gesell. Wien, 44, 222 p. Wien.

PAVLOVIĆ, P., 1927: Donjopontiski mekušci iz okoline Beograda. Pos. izdanja Srp. Kralj. akad. 17, 121 p. Beograd.

RABEDER, G., 1985: Die Säugtiere des Pannonien. Chronostratigraphie und Neostratotypen. B VII, M6, Pannonien, 440–463. Budapest.

RADULESCO, C., 1990: The Plio-Pleistocene Mammalian Succession of the Oltet Valley, Dacic Basin, Romania. Quartärpaläontologie 8, 225–232. Berlin.

ROCCAFORTE, P., SORBINI, L. & PICCOLI, G., 1994: The fossiliferous sites with Tertiary Vertebrates in Northeastern Italy. Mem. Sci. Geol. 46, 373–400. Padova.

RÖGL, F. & STEININGER, F. F., 1983: Vom Zerfall der Tethys zu Mediterran und Paratethys. Ann. Naturhist. Mus. Wien, 85/A, 135–163. Wien.

RUTTE, E., 1990: Die Fossilfundstellen des Mittelmaincromer im stratigraphischen Vergleich mit den benachbarten Fundstellen. Quartärpaläontologie 8, 233–236. Berlin.

SCHLICKUM, W. R. & STRAUCH, F., 1979: Die Land- und Süsswassermollusken der pliozänen Deckschichten der rheinischen Braunkohle. Abh. Senckenberg. Naturforsch. Gesellsch. 536, 1–144. Frankfurt a. Main.

SCHÜTT, H., 1973: Eine Molluskenfauna aus dem Neogen von Chios (Agais). Arch. Moll. 103 (1/3), 29 p. Frankfurt a. Main.

SCHÜTT, H. & KAVUSAN, G., 1984: Mollusken der miozänen Süsswasserablagerungen in der Umgebung vom Harmancik bei Kütahya-Bursa in Nordwestanatolien. Arch. Moll. 114(4/6), 217–229. Frankfurt a. Main.

ŠIFTAR, D., 1986: Starost evaporita u području Sinj – gornji tok Une. Geol. vjesnik 39, 55–60. Zagreb.

ŠIMUNIĆ, An., 1971: Neogen i kvartar Kninskog polja. Magistarski rad. Geološki odjel Prirodoslovno-matematičkog fakulteta u Zagrebu. Zagreb.

ŠPARICA, M. & BUZALJKO, R., 1984: Osnovna geol. karta SFRJ 1: 100000. Tumač za list Nova Gradiška L33–107. Geol. zavod Zagreb (1983). 1–54. Geoinženjering OOUR Inst. Geol. Sarajevo (1983). Sav. geol. zavod Beograd, Beograd.

ŠUŠNJAR, M. & BUKOVAC, J., 1979: Osnovna geološka karta 1:100 000. Tumač za list Drvar L33–129. Inst. geol. istraž. Zagreb, 1969 Savezni geol. zavod Beograd, 44 p. Beograd.

ŠUŠNJARA, A., SAKAČ, K. & GABRIĆ, A., 1992: Upper Permian Evaporites and associated Rocks of Dalmatia and Bordeline Area of Lika and Bosnia. Geologia Croatica 45, 95–114. Zagreb.

TCHERNOV, E., 1992: Eurasian-African biotic exchanges through the Levantine corridor during the Neogene and Quaternary. Courier Forsch.-Inst. Senckenberg, 153, 103–123. Frankfurt a. Main.

TOBIEN, H., 1976: Zur paläontologischen Geschichte der Mastodonten (Proboscidea, Mammalia). Mainzer geowiss. Mitt. 5, 143–225. Mainz.

TOBIEN, H., 1986: Die paläontologische Geschichte der Proboscidier (Mammalia) in Mainzer Becken (BRD). Mainzer Naturw, Archiv 24, 155–261. Mainz.

WIEGANK, F., 1981: Palaeomagnetische Untersuchungen zur Klarung der stratigraphischen Position und des absoluten Alters pliopleistozäner Ablagerungen im Sudwesten der DDR. Quartärpaläontologie 4, 179–187. Berlin.

WILLMANN, R., 1981: Evolution, Systematik und stratigraphische Bedeutung der neogenen Süsswassergastropoden von Rhodos und Kos / Ägais. Palaeontographica, Abt. A, 174, 10–235. Stuttgart.

SAŽETAK

Novi pliopleistocenski gastropodi iz Like, Hrvatska

Zlata Jurišić-Polšak, Krešimir Sakač i Marija Poje

Područje Srba u Lici (granično područje Hrvatske i Bosne) izgrađeno je od permskih, trijaskih i jurskih naslaga, te sedimenata pliocensko-pleistocenske starosti koji predstavljaju završni član sedimentacije slatkovodnog bazena na tom području, a prekrivene su kopnenim kvartarnim naslagama.

Pliopleistocenski pjeskoviti lapori sadrže neke taksone koje još nisu nađene u Hrvatskoj. Radi se o novim vrstama slatkovodnih mekušaca *Odontohydrobia croatica* i *Limnidia likana*, koje su tercijarnog podrijetla. Dio slatkovodnih mekušaca (*Valvata (C.) piscinalis, Limnaea (Radix)* cf. *peregra, Bithynia* cf. *tentaculata, Pisidium* sp.), kao i ostaci flore (gyrogoniti i thalusi fam. *Characeae*) nagovješćuju pleistocensko razdoblje. GORJANOVIĆ-KRAMBERGER (1912) odredio je iz Srba molar mastodona *Anancus arvernensis.*

Nove vrste

Postavila Z. Jurišić-Polšak

Odontohydrobia croatica n. sp.

Tab. I, sl. 1–6

Opis: Kućica se sastoji od 6 izrazito zaobljenih zavoja, jasno međusobno odvojenih suturom. Zavoji polako i jednolično rastu u širinu, pa kućica ima stožasti oblik. Ušće je koso jajoliko, gore kutno. Unutrašnja usna priljubljena je u većine primjeraka uz zadnji zavoj, pa prekriva pupak. Kod svih primjeraka na kolumeli se nalazi jače ili slabije izražen nabor ili zubić. Kod nekih od njih taj se zubić ne zamjećuje, dok se ne zakrenu u poluprofil. Vanjska usna je lagano kljunasto izvučena prema dolje. Na inače glatkoj površini kućice pod povećanjem se vide nježne linije prirasta. U nekih primjeraka vide se tri do četri spiralne, blago udubljene linije (sl. 1–4, tab. I).

Sličnosti: Stratigrafski raspon svih dosada nađenih vrsta roda *Odontohydrobia* je gornji panon do donji pliocen i sve su nastale u Paratethys bazenu. Primjerci iz

Srba većih su dimenzija od svih dosadašnjih, a veličinom i varijabilnošću oblika slični su donjopliocenskoj vrsti *O. dacica* JEKELIUS. Primjerci nove vrste imaju zaobljenije zavoje i dublje suture nego što je slučaj kod primjeraka vrste *O. dacica*.

Unatoč njihovoj međusobnoj sličnosti, smatramo da se vrsta *O croatica* razvila samostalno i neovisno od vrste *O. dacica*, koja je i stratigrafski starija. Njihove sličnosti sugeriraju paralelni, konvergentni razvoj. Zbog velike udaljenosti između Like i Rumunjskog Banata, te postojanja kopnene barijere između tih regija, kao i nastanka u različitim geotektonskim jedinicama (*O. dacica* potječe iz Dacijskog bazena, dok *O. croatica* potječe iz slatkovodnog jezera smještenog u zoni Vanjskih Dinarida), nije moglo biti utjecaja lokalnih fauna jedne na drugu. Do miješanja fauna nije moglo doći niti površinskim tokovima, jer je Savski tok formiran tek krajem pleistocena ili početkom holocena (ŠUŠNJAR & BUKOVAC 1979).

Limnidia likana n. sp.
Tab. I, sl. 7–11

Opis: Kućica se sastoji od 5 veoma zaobljenih zavoja, koji su međusobom odvojeni izrazito dubokim suturama, pa zavojnica djeluje kao odvijena. Površina kućice je glatka, vidljive su samo linije prirasta. Rast u širinu je vrlo polagan, pogotovo kod zadnja tri zavoja. Predzadnji zavoj često je gotovo jednako širok kao i zadnji. Ušće je koso ovalno. Gornjim dijelom unutrašnja usna je priljubljena uz zadnji zavoj. Svojim srednjim dijelom unutrašnja usna lagano se odvaja od kućice, te djelomično otkriva pupak. Rub ušća u svome donjem dijelu blago je izvučen.

Sličnosti: Nova vrsta razlikuje se od vrste *Limnidia skhiadica* BUKOWSKI po tome što je kod većine primjeraka pupak samo djelomično otvoren, a ušće nikad nije sasvim odvojeno od zavojnice kao što je kod spomenute vrste. Također je razlika u starosti, jer vrsta *L. skhiadica* dolazi u naslagama donjeg panona do gornjeg ponta, a *L. likana* tek u naslagama gornjeg pliocena do donjeg pleistocena. Rod *Limnidia* ne živi danas, a dosad nije nađen ni u pleistocenu.

Stratigrafsku pripadnost fosila iz Srba teško je sigurno odrediti jer ni jedna vrsta nije izrazito provodna. Ipak, znatan prilog stratigrafskoj odredbi daju rodovi *Odontohydrobia* (čije su vrste poznate iz gornjeg panona i donjeg pliocena) i *Limnidia* (čiji su predstavnici dosad poznati iz najgornjeg sarmata, odnosno donjeg panona do ponta). U pleistocenu dosad nisu nigdje nađeni, a ne žive ni danas, pa ih možemo smatrati tercijarnim faunističkim elementima. Treba spomenuti da u našem uzorku sedimenta najveći broj primjeraka pripada vrsti *Odontohydrobia croatica* (69,59 %), što zajedno s primjercima vrste *Limnidia likana* (7,6 %) čini 77,19 % cjelokupne faune. Vrste *Bithynia tentaculata* (3,21 %), *Valvata piscinalis* (14,32 %) i *Limnaea peregra* (3,80 %), koje se javljaju u miocenu i pliocenu, a žive i danas, predstavljene su mnogo manjim brojem primjeraka. Izuzetno velik broj primjeraka tih vrsta nađen je u močvarnim ili jezerskim pleistocenskim i holocenskim sedimentima Slavonije, odnosno istočne Hrvatske, pa se smatraju dominantnim gastropodima takve sredine i tog vremena.

Iste vrste nađene su u tercijarnim jezerskim sedimentima, ali u drugačijem faunističkom sastavu i u asocijaciji s vrstama koje su izumrle prije pleistocena.

S druge strane, *Charathalus thuringensis*, vrsta koja ovdje obuhvaća najveći broj primjeraka *Characea*, nađena je u pleistocenskim sedimentima.

Analizirani uzorak bio je premali i ne uključuje kompletnu faunističku asocijaciju, te moguće već poznate provodne miocenske ili pliocenske fosile. Dodatna istraživanja sigurno će pomoći rješavanju tog problema.

Problem stratigrafskog položaja fosilne asocijacije sedimenata iz Srba može nam pomoći riješiti i raniji nalaz mastodona u tom području (GORJANOVIĆ-KRAMBERGER, 1912). Molar mastodona pripada vrsti *Anancus arvernensis*. Ta vrsta, prema starijoj i novijoj literaturi, gotovo uvijek se veže uz gornji pliocen. Prema ANDERSONU (1989), vremenski raspon roda *Anancus* za Europu je gornji pliocen do donji pleistocen. Prema MEINU (1990) *A. arvernensis* odgovara njegovoj 17 zoni kronologije sisavaca. Možemo zaključiti da je ta vrsta pliocenska, s mogućim preživljavanjem i u ranom pleistocenu.

Dilemu oko utvrđivanja stratigrafskog položaja stvara i činjenica da su neka polja u Hrvatskoj bila smatrana pliocenskim, a danas se na osnovu faune ostrakoda smatraju pleistocenskim, kao što je slučaj s Erveničkim i Žegarskim poljem (MALEZ & al., 1968; 1969a; 1969b). U slučaju Kninskog polja, sedimenti s melanopsidima su neogenski, dok je vršni dio svrstan u pleistocen (ŠIMUNIĆ, 1971; MALEZ, 1975). Naprotiv, postoje i slučajevi da je prvobitna pleistocenska starost polja na temelju proučavanja slatkovodnih mekušaca promijenjena u miocensku, kao što je slučaj s Krbavskim poljem (JURIŠIĆ-POLŠAK & al., 1994).

Konačno držimo da je bazen bio izvorno pliocenski, ali nema ni klimatskog, ni tektonskog, ni nekog drugog razloga, zbog kojeg bi bila drastično prekinuta sedimentacija krajem pliocena. Istina, okopnjavanja su tada bila u tijeku, ali sedimentacija se u mnogim bazenima nastavila još neko vrijeme i u pleistocenu, istina bez vidljivih sedimentacijskih i faunističkih pokazatelja, zbog čega je te prijelazne nivoe teško otkriti. Diljem Europe postoje lokaliteti s kontinuiranim prijelazom pliocena u pleistocen. Neki su dobro dokumentirani, npr. u Italiji (ESU & al., 1993), a neki tek naznačuju da se radi o prijelaznim nivoima (BOEUF, 1990; RUTTE, 1990; RADULESCO, 1990; AGUIRE & al..,1990; ROCAFORTE & al., 1994).

Pjeskoviti lapori Srba u Lici predstavljaju završnu fazu jezerske sedimentacije. Analizirana fauna moluska i ostrakoda, kao i gyrogonita i thalusa fam. *Characeae* ukazuje na stajaću, plitku, relativno toplu vodenu sredinu, bogatu vegetacijom. Novoustanovljene vrste *Odontohydrobia croatica* i *Limnidia likana* razvile su se samostalno i bez utjecaja faune drugih bazena, pa su vjerojatno endemične. Starost faune je vjerojatno pliopleistocen.

Budući da je ovo prvi rad o pliopleistocenskom lokalitetu u Lici, svjesni smo da će novi nalazi dati dopune i ispravke, no nadamo se da ćemo potaknuti istraživanja geologije i paleontologije slatkovodnih bazena u Vanjskim Dinaridima iz tog razdoblja, o kojem ima jako malo podataka ili zbog nedostatka fosila, ili možda zbog krive interpretacije i determinacije dosadašnjih nalaza.

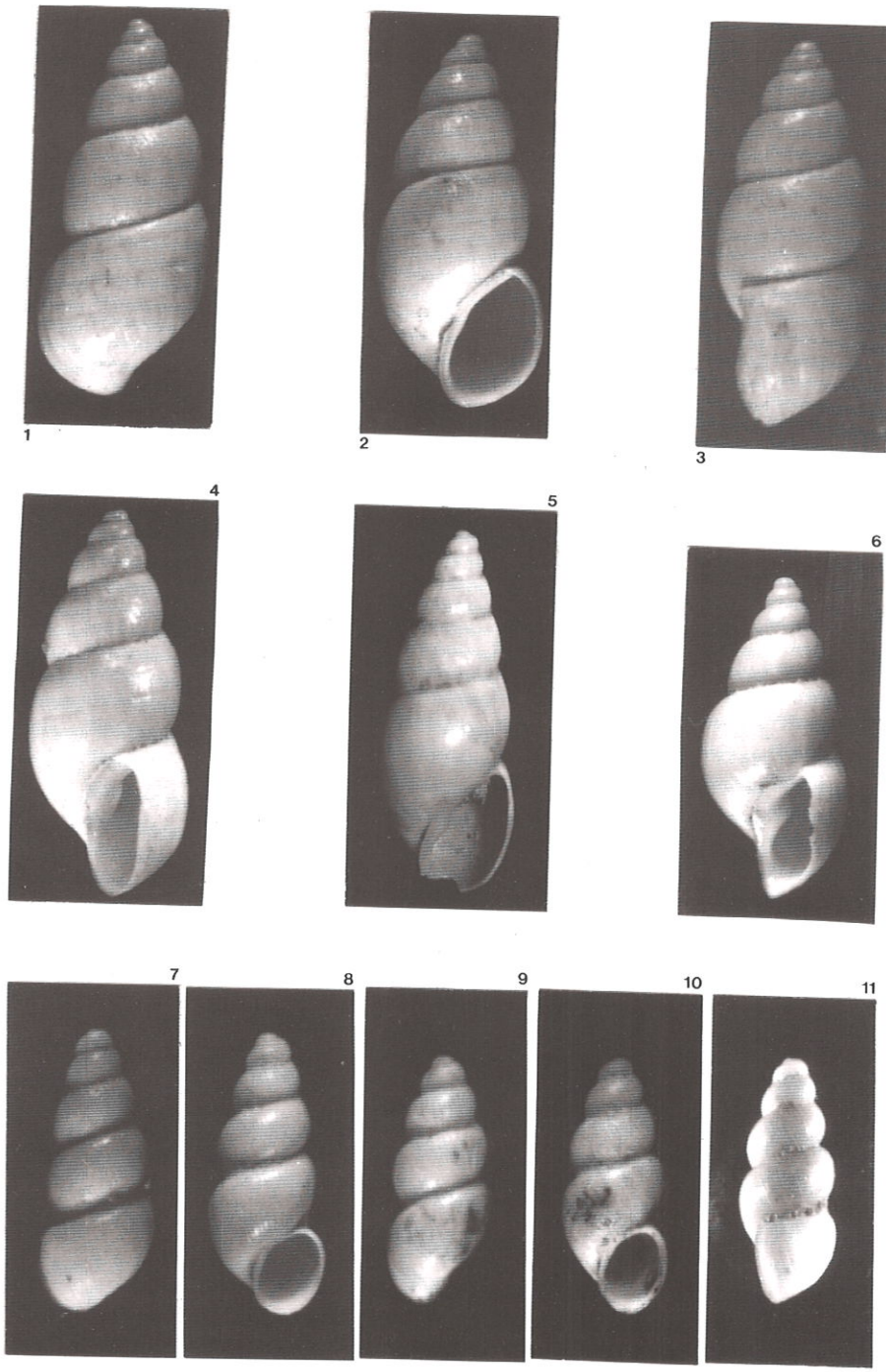

Plate I. 1–6 *Odontohydrobia croatica* n.sp., 11,5 X., 7–11 *Limnidia likana* n.sp., 15 X.

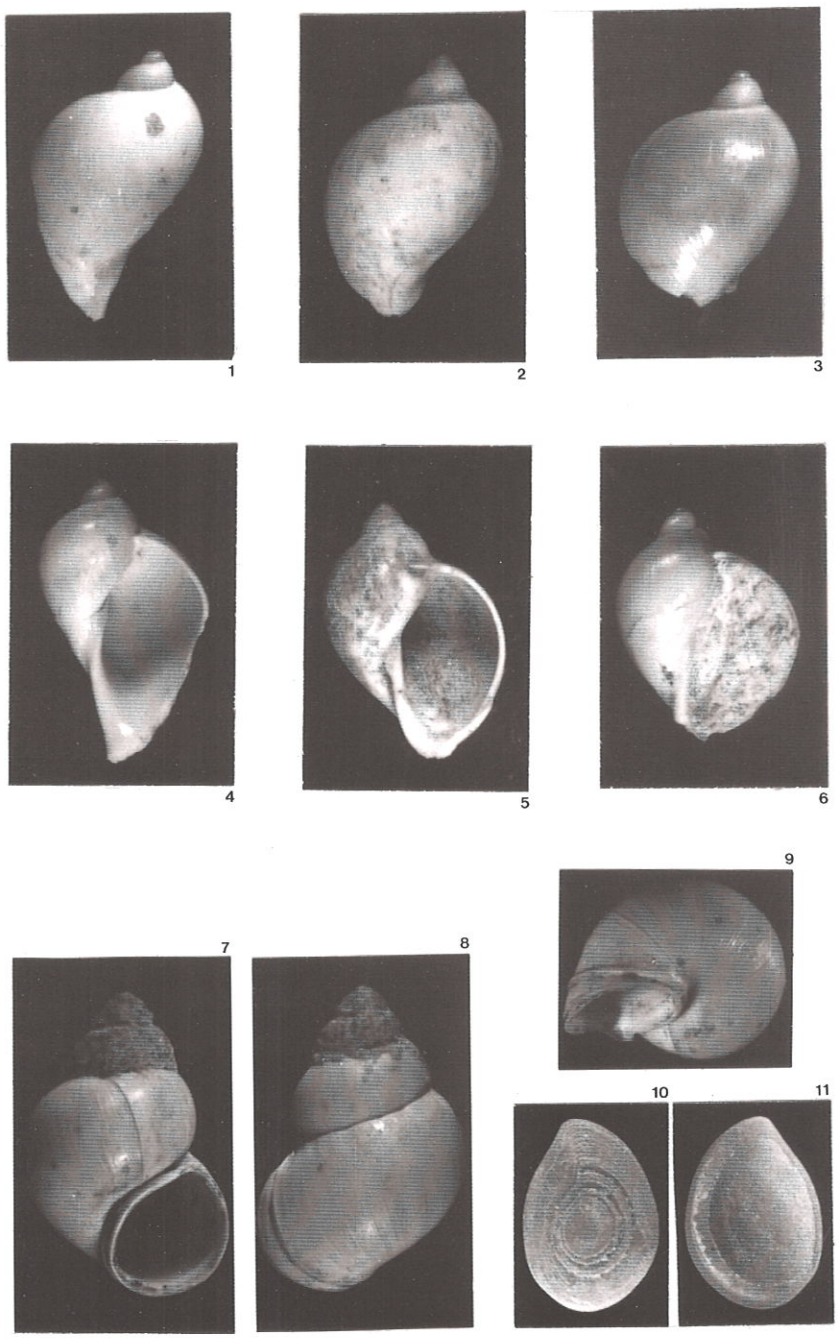

Plate II. 1–6 *Limnaea (Radix)* cf. *peregra* (O. F. MÜLLER), 6 X., 7–11 *Bithynia* cf. *tentaculata* (LINNÉ), 4 X. Operculum 6 X.

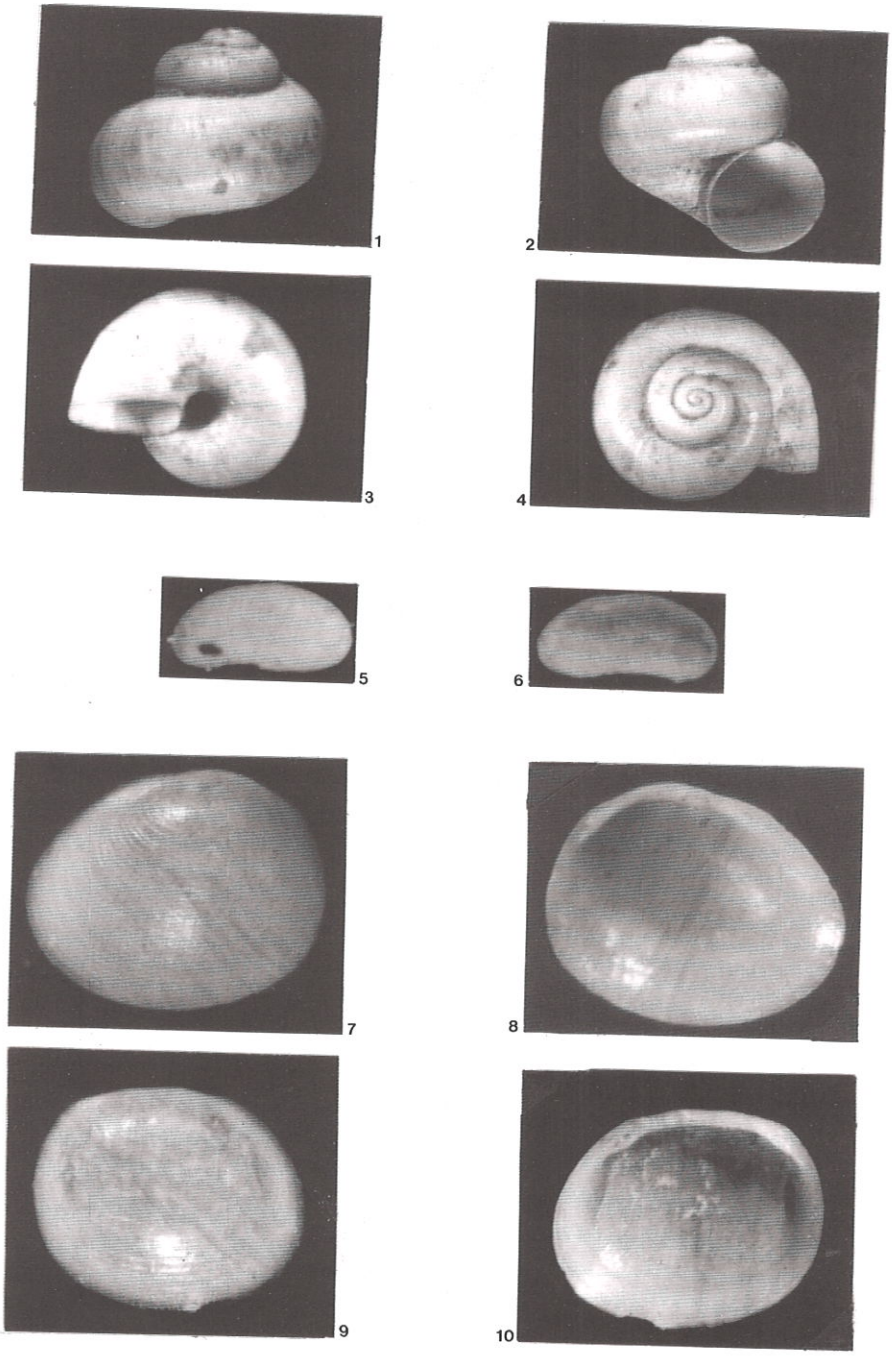

Plate III. 1–4 *Valvata (Cincinna) piscinalis* (O. F. MÜLLER), 5 X., 5–6 *Erpetocypris* sp., 22 X., 7–8 *Pisidium* sp., 30 X., 9–10 *Pisidium* sp., 30 X.

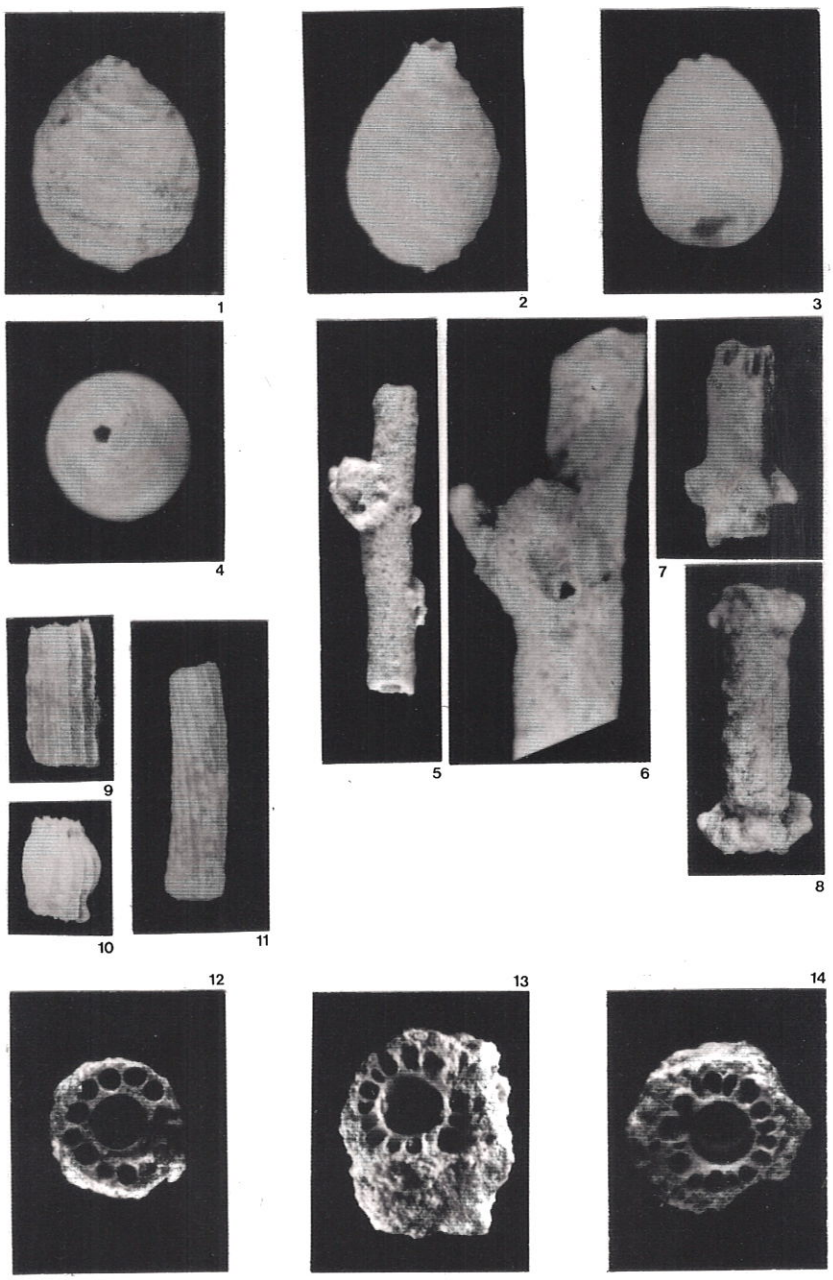

Plate IV. 1–4 *Charites* sp. (gyrogonites), 32 X., 5–6 *Charathalus* cf. *thuringensis* NÖTZOLD. Fig. 5 – 8 X, Fig. 6 – 14,5 X., An example of thalus in organic association with gyrogonites., Figs. 7–8 *Charathalus* cf. *thuringensis* NÖTZOLD, 9 X., Figs. 9–11 *Charathalus* varia, 14 X., Figs. 12–14 *Charathalus* cf. *thuringensis* NÖTZOLD, 14,5 X., Cross-sections.