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PALEOECOLOGICAL CHARACTERISTICS OF MOLLUSCS OF THE PLEISTOCENE CORBICULA BEDS IN THE SAVA RIPARIAN AREA IN BELGRADE (SERBIA)

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A b s t r a c t: Pleistocene alluvial deposits of the Sava riparian area at Belgrade have a significant thickness, and because of the presence of clams of the genus *Corbicula* they were known as “beds with *Corbicula fluminalis*”. Freshwater bivalves (clams) of the genus *Corbicula* have considerable distribution and great climato-stratigraphic significance in the alluvial Quaternary deposits of the Sava River at Belgrade. The two morphotypes of these clams are present: Pleistocene *Corbicula* are connected to palaeoflows of the “pre-Sava”, while remains of contemporary *Corbicula* are spatially limited to the recent courses of the Sava River. Both of them are very successful invasive species which colonized most of European rivers. Based on the data from the investigated borehole, it can be concluded that in Pleistocene alluvial deposits *Corbicula* is not the dominant species, but that the largest number of specimens belong to the species *Litoglyphus naticoides*.

Key words: *Corbicula* beds, Pleistocene, paleoecology, Sava riparian area.

ПАЛЕОЕКОЛОШКИ КАРАКТЕРИСТИКИ НА МЕКОТЕЛИ ОД ПЛЕИСТОЦЕНСКИТЕ CORBICULA НАСЛАГИ ВО КРАЈБРЕЖНАТА ОБЛАСТ НА РЕКАТА САВА ВО БЕЛГРАД (СРБИЈА)

Квартерните седименти на крајбрежната област на реката Сава во Белград имаат значителна дебелина. Податоци за постари квартални формации можат да се добијат само преку длабоки дупнатини (односно истражно дупчење). Плеистоценските алувијални седименти во оваа област имаат значително распространување и големо биостратиграфско и економско значење. Помеѓу најзначајните мекотели видови во интергласијалните квартални алувијални седименти на реката Сава во Белград се плеистоценските школки *Corbicula*, детерминирани како *Corbicula fluminalis*. Како топло-водни видови, со наидувањето на ладните климатски фази во среден Плеистоцен, *Corbicula* школките се повлекле кон потопли области, населувајќи се во помлад Плеистоцен и Холоцен, во јужните делови на Каспискиот Басен, централна Азија, Индија и потоплите региони на Американскиот континент (Мејер и Прис, 2000; Ненадиќ и др., 2019). Видот *Corbicula* е автохтон во рецентно време во тропските и субтропските региони во Африка, Азија, Малезискиот полуостров, Филипини, Нова Гвинеја и источна Австралија (Мортон, 1986). Испитуваниот фосилен материјал е земен од дупнатина во седименти од Плеистоценска старост, кој се наоѓа на левиот брег на реката Сава (Белград, Србија). Дупнатината RB 53/P-1 има вкупна длабочина од 28.20 m (GPS координати RB 53/P-1: 44°48'34" N; 20°26'38" E, надморска височина 76.08 m). Географската положба на дупнатината е прикажана на слика 1.

Клучни зборови: *Corbicula* наслаг, плеистоцен, палеоекологија, крајбрежна област Сава

INTRODUCTION

Quaternary sediments of the Sava riparian area at Belgrade have a relatively large thickness. Data on older Quaternary formations can only be obtained from deep boreholes (by exploration drilling).

Alluvial sediments of the Pleistocene age in this area have considerable distribution, great biostratigraphic and economic importance.

Among the most important molluscs species from the interglacial Quaternary alluvial deposits of the Sava River at Belgrade is Pleistocene *Corbicula*

clams usually identified as *Corbicula fluminalis*. As a warm-living species, with arrival of cold climatic phases in the Middle Pleistocene, *Corbicula* withdrew to warmer areas, settling, in younger Pleistocene and Holocene, southern parts of the Caspian Basin, central Asia, India and warmer regions of the American continent (Meijer & Preece, 2000; Nenadić et al., 2019). The *Corbicula* species is in recent days autochthonous in tropical and subtropical regions of Africa, Asia, the

Malaysian Archipelago, the Philippines, New Guinea, and Eastern Australia (Morton, 1986).

The investigated fossil material comes from the borehole of the Pleistocene age located at the left bank of the Sava River (Belgrade, Serbia). Borehole RB 53/P-1 has the total depth of 28.20 m (GPS coordinates RB53/P-1: 44°48'34"N; 20°26'38"E, altitude 76.08m). Geographical position of the borehole is presented on Fig. 1.

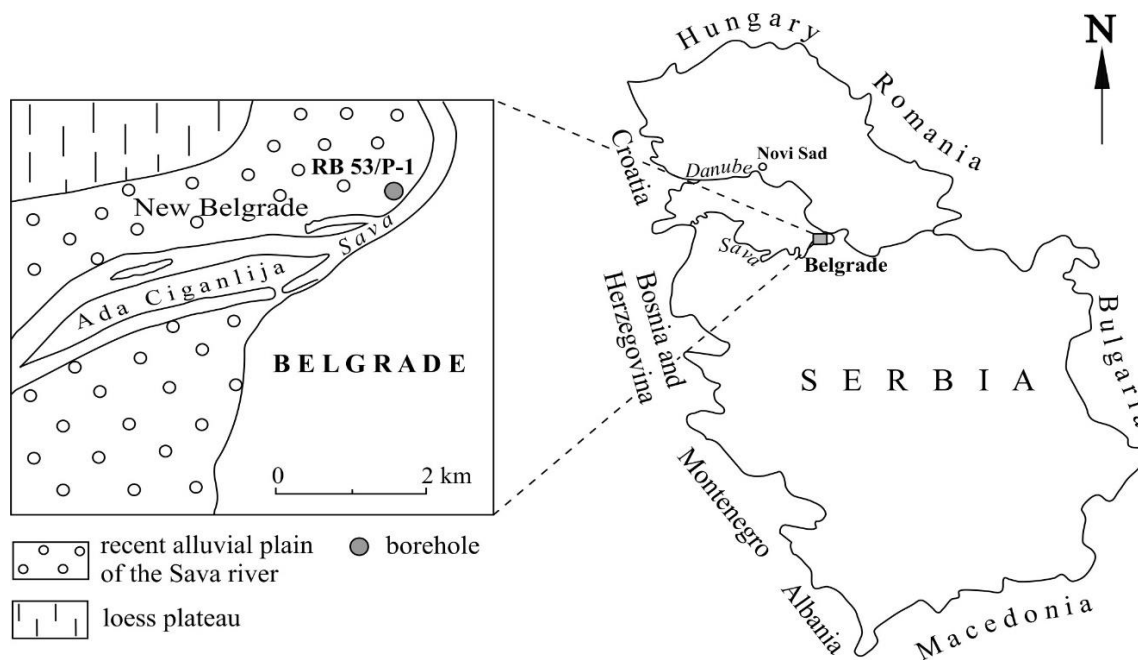


Fig. 1. Geographical position of the borehole RB 53/P-1

METHODS OF INVESTIGATION

The research has been realized by use of the following methods: palaeontological and palaeo-ecological analyses, sedimentological-petrological and classical stratigraphical principles of superposition.

The sediment from the borehole is processed in laboratory using finemesh screens with several sieves (0.10 to 0.60 mm). The fossil material (bivalves and gastropods) were determined and number of individuals of each species is counted following the depth of drilling of drillhole.

RESULTS AND DISCUSSION

Lithologically, the Pleistocene *Corbicula* beds are clastic fluvial sediments, among which prevail sandy gravels and gravelly sands (riverbed depo-

sits), which alternate with fine-grained silts and clays (floodplain deposits). These sediments in the riparian area of the Sava at Belgrade are mainly deposited over palustrine-lacustrine deposits of Plio-Pleistocene age or Upper Miocene deposits of the Pannonian and Pontian age (Nenadić & Gaudenyi, 2013; Knežević et al., 2018).

Based on the data from the borehole RB 53/P-1 the researched deposits contain three species of bivalves: *Corbicula fluminalis* (Müller), *Unio crassus* (Philipsson), *Dreissena polymorpha* (Pallas), and six species of gastropods: *Lithoglyphus naticoides* (Pfeifer), *Holandriana holandrii* (Pfeifer), *Microcolpia daudebartii acicularis* (Ferrusac), *Theodoxus danubialis* (Pfeifer), *T. transversalis* (Pfeifer), and *Viviparus acerosus* (Bourguignat).

Out of nine samples, presence of *Corbicula* specimens is confirmed in seven, with the total number of twelve *Corbicula* specimens.

The most abundant species in a sample from the borehole is *Lithoglyphus naticoides*, followed by *Microcolpia daubertii acicularis*, *Holandriana holandrii*, and *Theodoxus danubialis* (Figure 2).

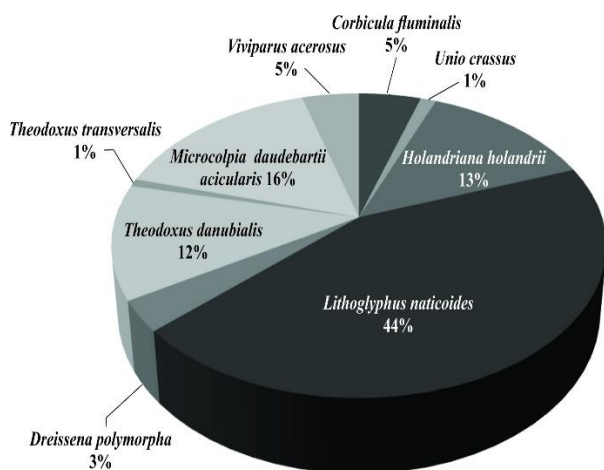


Fig. 2. Total percentage of specimens of *Corbicula* and associated species from borehole RB 53 P-1.

Most of the freshwater bivalve and gastropod species that are found in the investigated Quaternary sediments are also present in the recent ecosystems and therefore provides us with possibility to make comparative quantitative analysis.

Based on the palaeoecological characteristics of the present species, it can be inferred that the environment in which they lived was fluvial to lacustrine, moderate to occasionally fast-flowing, mostly with muddy, sandy and sometimes rocky riverbed. Some species, such as *Dreissena polymorpha*, also inhabit moving objects (boats, rafts and shells of other bivalves), but can also be found in underground channels and water pipes.

Although the Pleistocene *Corbicula* is not the dominant species in the studied segment of the area, it is undoubtedly of great biostratigraphic importance, and therefore it allows separation of lithologically almost identical Pleistocene and Holocene alluvial deposits in this area.

The dimensions of *Corbicula* shells diminish during Pleistocene, juvenile forms are wider and more rounded, connected to finer sediments (silts and clays), with small hydraulic energy, while the adult ones are more elongated and with thicker shells that define high energy of the habitat in which individuals grew (Gulyás et al., 2013).

Judging from analogy with recent *Corbicula*, this species lived in rivers in which summer temperatures varied between 22°C and 23°C, so it can be said that deposits with the Pleistocene *Corbicula* can be defined as climato-stratigraphical unit of warm fluvial phases (Gaudenyi et al., 2015).

CONCLUSION

Based on the data from borehole RB 53 / P-1, it can be concluded that in the Pleistocene deposits of the Sava riparian at Belgrade, known as the *Corbicula* beds, the dominant species is not *Corbicula fluminalis*, but *Lithoglyphus naticoides*. However, there is no doubt that the presence of *Corbicula fluminalis* has great biostratigraphic and palaeoclimatological significance.

Corbicula fluminalis is used in biostratigraphic research as characteristic, i.e. “index” fossil, for the age determination and correlation of the Pleistocene sediments. Also, deposits with Pleistocene *Corbicula* can be defined as climato-stratigraphical unit of warm fluvial phases.

Over the last few decades it has been established that clams of the genus *Corbicula* inhabit again the vicinity of Danube in northern Serbia and in the neighbouring countries (Paunović et al, 2007, 2012; Nenadić et al., 2019). Because of its characteristics which enable a successful colonizing, and its rapid spread through the European rivers, the taxon acquired status of invasive species. Although the cause of their return is not yet clear enough, it is considered, among other factors, that anthropogenic factor played a major role in this.

Compared to Pleistocene *Corbicula*, recent *Corbicula* are significantly more numerous in alluvial deposits. As far as the measurements of fossil and recent representatives of the *Corbicula* specimens are concerned, fossil *Corbicula* is smaller in size than its recent representatives.

According to data documented by DAISIE (Delivering Alien Invasive Species Inventories Europe, 2009) they are one of the most invasive species in fresh waters of Europe, with a markedly negative impact on the existing river ecosystem and its biodiversity. Although the cause of their return is not yet clear enough, it is considered, among other factors, that anthropogenic factor played a major role in this.

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