

Pleistocene malacofauna of the Požarevac Danube Area (NE Serbia)

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Abstract. The results of recent analyses of loess samples from the localities: Ćirikovac, Klenovnik, Novi Kostolac, Zatonje and Kisiljevo, confirm the idea that malacological associations identify biotope characteristics. Using palaeontological analyses, 25 species of gastropods were identified. Statistical analyses, tables and histograms based on ecological indices separate malacological associations: forest and species living mainly in woods, but also in mesophilous places and both damp and dry biotopes, steppe, open biotopes, mesophilous and hygrophilous species. Based on the current literature on the Požarevac Danube Area, the species *Vertigo pygmaea* in Ćirikovac and *Columella columella* in Klenovnik were recorded for the first time. Based on the following species: *Succinella oblonga*, *Cochlicopa lubrica*, *Granaria frumentum*, *Vallonia costata*, *Vitrea crystallina*, *Pupilla muscorum*, etc. it could be concluded that loessoid eolian sediments have their origin in the arid climate during the Pleistocene.

Key words: Pleistocene, gastropods, palaeoecology, loess, loessoid sediments.

Апстракт. Проучавањем података из узорака са лесних профила на локалитетима у Ћириковцу, Кленовнику, Новом Костолцу, Затоњи и Кисилеву, дошла сам до резултата на основу којих се потврђује чињеница да малаколошка асоцијација одређује карактер биотопа. Палеонтолошким анализом идентификовано је 25 врста. Статистичком обрадом података, табеларно и хистограмом на основу заступљености еколошких валенци издвојене су малаколошке асоцијације: шумских и шумскомезофилних врста, степа, отворених биотопа, мезофилних и хигрофилних врста. Према досадашњим литературним подацима, на простору Пожаревачког Подунавља по први пут су пронађене врсте *Vertigo pygmaea* у Ћириковцу и *Columella columella* у Кленовнику.

На основу фауне: *Succinella oblonga*, *Cochlicopa lubrica*, *Granaria frumentum*, *Vallonia costata*, *Vitrea crystallina*, *Pupilla muscorum* и др., може се закључити да су лесовидни еолски пескови стварани у аридном климату за време плеистоцена.

Кључне речи: плеистоцен, гастроподи, палеоекологија, лес, лесне творевине.

Introduction

The Požarevac Danube Area is located along the right bank of the Danube River, from the mouth of the Velika Morava River to the city of Golubac. In the geomorphologic sense, this area belongs to Morava lowland and the Mlava valley, with an average altitude of 85–110 m (Fig. 1).

The relief of the area is composed of low-level lake terraces, desiccated by fluvial erosion. Fluvial erosion has had a huge effect as is evident by the broad fluvial planes and wide river valleys. Erosion significantly reduced the Pliocene lake coverage, and moved it

from the recent Danube valley further to the south, which was sometimes left in the form of fold belts (i.e., the Požarevac fold belt).

Quaternary eolian sedimentary loess and quicksand cover 97 % of the Požarevac Danube Area, being the most extensive in this geographic region. Quicksand is limited to the immediate beach areas and lies along a distance of 5–6 km from the Danube River, while loess stretches further to the south, up to 34 km from the river. In the Požarevac Danube Area, loess sediments were, at the time of their formation, represented by one continuous cover, which was later, as a result of erosion, lowered, and broken into several separated parts:

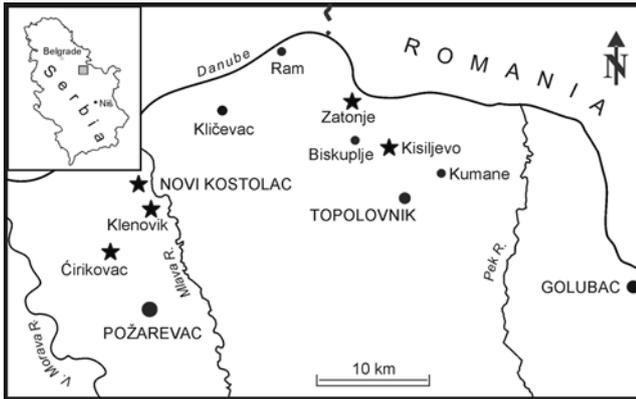


Fig. 1. Geographical position of the sites (black stars) with fossil macrofauna.

a) The nearest region between Velika Morava and Mlava rivers and from Požarevac to Kostolac constitutes the “Požarevac fold belt”; b.) Loess sediments between Mlava and Pek rivers follow the banks of the Danube River; from Ram to Pek River, loess outcrop at the lowest terrain between the villages Zatonja and Kisiljeva up to 100 m altitude, and to the highest terrain, where loess covers Tertiary relief from the village Topolovnik to Pek River; c.) Loess from Pek to the town of Golubac has the smallest geographic distribution and is situated at the base of loessoid sand, which according to its morphology and higher absolute altitude could not belong to the Požarevac Slope.

The Holocene is represented with the formations of lower river terraces, fluvial and slope sequences. In the Ram Danube Area (south of Ram, Topolovnik, Kumane, Biskuplje and Kličevac), eolian loessoid sands are well distributed and positioned over the Older Pleistocene sediments of the “Kličevac Formation”. The loessoid sediments of the Smederevo–Ram Danube Area are often changed into deluvial formations, composed of gravel which indicates repeated sedimentation through rinsing processes.

Literature on this subject is numerous and includes: ŽUJOVIĆ (1889, 1893), CVJIĆ (1924), STEVANOVIĆ (1949), MARKOVIĆ-MARJANOVIĆ (1951), MILOJEVIĆ (1960), MILAKOVIĆ (1973), MALEŠEVIĆ *et al.*, (1980), RAKIĆ (1980), DIMITRIJEVIĆ & KNEŽEVIĆ (1988), STEVANOVIĆ *et al.* (1992), etc.

Material and methods

Quaternary malacofauna was collected from sediments in two ways: as individual specimens (visible to the naked eye) and in bulk samples of 3 kg. The specimens visible to the naked eye were collected individually.

During the mechanical processing and extraction of individual fossils from the loess sediments, hand tools,

such as trowels, knives and brushes, were used. The taxonomical determination of the “naturally prepared fossils” was done depending on the degree of preservation, on the genus or species level. The extracted fossil snails with preserved sculpture were studied and prepared again in the laboratory. The restoration of the broken shell fragments was made by glue and polish. Employing table lenses, the extremely fragile and tiny specimens were “quickly” transferred in order to preserve the shell specimens. In order to perform the identification of macrofauna with stronger shells, when it was necessary to determine the elements of oral aperture, regularity and structure, these specimens were washed with 3% H₂O₂.

The fossil material was identified under binocular lenses, using the comparative collection of fossil and recent molluscs from the Collection of Natural History Museum, Belgrade, collected by PETAR PAVLOVIĆ, as well as foreign literature (BROHMER *et al.* 1962; GROSSU 1956, 1993; FRANK 2004; LOŽEK 1964; KERNEY *et al.* 1983, 1999; ŠILEJKO 1984; KROLOPP & SÜMEGI 1993, 2000; SOÓS 1943, 1959; and PFLEGER 2000).

During the preparation of the histogram, ecological valences for species were used according to LOŽEK (1964). In the text, the percent representation is shown in parentheses after the name of the species. The statistic processing of the results is shown Table 1 and in the histogram in Fig. 7. The material was inventoried and labeled under the Inventory number K 6306-6402 and kept in the collection of the Natural History Museum, Belgrade.

Results and discussion

Čirikovac

According to the Basic Geological Map (MALEŠEVIĆ *et al.* 1980), on the “Kostolac (Požarevac) fold belt”, between Požarevac and Čirikovac, deluvial-proluvial sediments (dpr) lie discordantly over the Pontian sediments – “Kličevac Formation”. The major components of the “dpr” are gravels, sand and silty-sands up to 10 m thick, while in the base is loessoid sandy-clayey-silts, 5 m thick (Fig. 2), in which a diverse land fauna of the Upper Pleistocene was identified: *Pupilla sterri* (VOITH), *Chondrula tridens* (MÜLLER) and *Granaria frumentum* (DRAPARNAUD); species of open habitats: *Pupilla muscorum* (LINNÉ), *Vertigo pygmaea* (DRAPARNAUD) and *Vallonia pulchella* (MÜLLER); the mesophilous species *Trochulus hispidus* (LINNÉ) and hygrophilous species: *Sucinella oblonga* (DRAPARNAUD) and *Catinella cf. arenaria* (BOUCHARD-CHANTEREAUX) (Pl. 1, Fig. 7). The top level of this profile is composed of fossil soil, 0.5 m in thickness. From the loessoid sands, the only fossil-bearing layer, the warmth-loving *Trochulus striolatus* (PFEIFFER) (Pl. 1, Fig. 9) was recorded as the only representative of forest-mesophilous species (24%). It inhabited

Table 1. Survey of Quaternary malacofauna with a column of percentage distribution on different localities, of the Požarevac Danube area. Explanation of symbols according to LOŽEK (1964). **1W**, forest associated species; **2W(M)**, species living mainly in woods, but also in mesophilous places and both damp and dry biotopes; **4S**, steppe dry sunny places; **5O**, species living in open places without arboreous vegetation; **7M**, mesophilous species which sometimes, can live in damp or dry places; **7Wf**, mesic rupestral and scree-forest species; **8H**, humidity requiring, cold resistant species; **No**, number of the specimens.

Paleoeco. character.	Molluscan records	L o c a t i o n s									
		Čirikovac		Klenovnik		Novi Kostolac		Zatonje		Kisiljevo	
		No.	%	No.	%	No.	%	No.	%	No.	%
1W	<i>Discus ruderatus</i> (FÉRUSSAC)			9	6.25	8	3.69			1	0.21
	<i>Cochlodina laminata</i> (MONTAGU)			1	0.7			5	5.21	1	0.21
	<i>Aegopinella nitens</i> (MICHAUD)			10	6.94	8	3.69	1	1.04	51	11.36
2W(M)	<i>Vitrea crystallina</i> (MÜLLER)			4	2.78	4	1.84	15	15.63		
	<i>Trichulus striolatus</i> (PFEIFFER)	39	24.84	19	13.20	18	8.3			117	26.06
	<i>Arianta arbustorum</i> (LINNÉ)					5	2.3			2	0.44
	<i>Fruticicola fruticum</i> (MÜLLER)							1	1.04	21	4.68
4S	<i>Pupilla sterri</i> (VOITH)	1	0.64			2	0.92				
	<i>Chondrula tridens</i> (MÜLLER)	52	33.12	43	29.86	55	25.35	3	3.13	10	2.23
	<i>Granaria frumentum</i> (DRAPARNAUD)	12	7.64	14	9.72	14	6.45	27	28.13	71	15.82
	<i>Cecilioides acicula</i> (MÜLLER)									2	0.44
5O	<i>Pupilla muscorum</i> (LINNÉ)	10	6.37	6	4.17	19	8.75	8	8.33	7	1.56
	<i>Vertigo pygmaea</i> (DRAPARNAUD)	3	1.91								
	<i>Vertigo alpestris</i> ALDER							2	2.08		
	<i>Columella columella</i> (MARTENS)			1	0.7						
	<i>Vallonia costata</i> (MÜLLER)			2	1.39	25	11.52	2	2.08	24	5.35
	<i>Vallonia pulchella</i> (MÜLLER)	8	5.1	5	3.47						
	<i>Catinella</i> cf. <i>arenaria</i> (BOUCHARD-CHANTEREAUX)	3	1.91								
7M	<i>Euconulus fulvus</i> (MÜLLER)			3	2.08			3	3.13		
	<i>Punctum pygmaeum</i> (DRAPARNAUD)			5	3.47	10	4.61	8	8.33	4	0.89
	<i>Trichulus hispidus</i> (LINNÉ)	26	16.56	11	7.64	17	7.83	1	1.04	71	15.82
	<i>Cochlicopa lubrica</i> (MÜLLER)			5	3.47	7	3.23			43	9.58
7Wf	<i>Clausilia dubia</i> DRAPARNAUD			4	2.78	11	5.07	3	3.13		
	<i>Orcula dolium</i> (DRAPARNAUD)			2	1.39	8	3.69	6	6.25	17	3.79
8H	<i>Succinella oblonga</i> (DRAPARNAUD)	3	1.91			6	2.76	11	11.45	7	1.56
		157	100	144	100	217	100	96	100	449	100

Epoch	Lithology	Th. (m)	Description
Late Pleistocene		1.5	Fossil soil
		5	Loessoid sandy-clayey-silts
Middle Pleistocene		10	Gravels, sand and silty-sands
Pontian		12	Gray bluish clays
		10	Gray fine-grained sands with tiny lens of graybluish lays
		8	Coal

Fig. 2. Detailed view of the upper part of the section from Čirikovac.

moist forest habitats and high grasses, along the ecotone boundary belt between forest and grasslands.

A colder climate is indicated by steppe fauna (41.4%): *Pupilla sterri* (0.64%), *Chondrula tridens* (33%) and *Granaria frumentum* (7%), while species inhabiting

open biotopes: *Pupilla muscorum* (6%), *Vertigo pygmaea* (2%), *Vallonia pulchella* (5%) and mesophilous *Trichulus hispidus* (16%) were weakly represented.

One of the most common representatives of the genus *Vertigo*, *Vertigo pygmaea*, (Pl. 1, Fig. 5) was recorded only at the locality of Čirikovac. It occurs in association with species inhabiting open habitats, as well as those living in forests. In the Late Pleistocene, *V. pygmaea* became more common in the sediments originating in cooler and moister periods (KROLOPP & SÜMEGI 1993). From the genus *Vertigo*, *V. pygmaea* is one of a few typical of loess formations (KROLOPP & SÜMEGI 2000).

Klenovnik

A profile of the Pleistocene sediments was discovered close to Klenovnik on the road to Kostolac, after the right turn towards the school. These sediments lie over Pontian gray coarse-grained quartz sands, 2.5 m thick. The profile (Fig. 3) shows brown silty sands (1.0 m thick), overlaid by reddish sandy clays (1.5 m thick)

and light brown silty sands a (2.5 m thick). The exposed profile is covered with silty sands with a low humus content, 0.5 m thick.

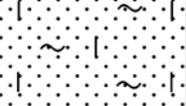
Epoch		Lithology	Th (m)	Description
Quaternary	Hol.		0.5	Silty sands low in humus content
	Pleistocene		2.5	Light brown silty sands
			1.5	Reddish sandy clays
			1.0	Brown silty sands
Neogene	Pontian		2.5	Gray coarse-grained quartz sands

Fig. 3. Detailed view of the upper part of the section from Klenovnik.

In the silty sands, a diverse gastropod fauna composed of species confined to certain habitats was discovered. The forest species were few in numbers: *Discus ruderatus* (FÉRUSAC) (6.25%), *Cochlodina laminata* (MONTAGU) (0.7%) and *Aegopinella nitens* (MICHAUD) (6.94%). The mesophilous species of forest biotopes: *Vitrea crystallina* (MÜLLER) (2.78%) and *Trochulus striolatus* (13.20%) belong to species living in conditions of mesic forests. The forest-steppe zone was replaced by steppe, with the characteristic species *Chondrula tridens* (29.86%) and *Granaria frumentum* (9.72%). The species of open spaces, inhabiting biotopes ranging from wetland meadows to steppe: *Pupilla muscorum* (4.16%), *Columella columella* (MARTENS) (0.7%) (Pl. 1, Fig. 3), *Vallonia costata* (MÜLLER) (1.38%), *Vallonia pulchella* (MÜLLER) (3.47%), were replaced by mesophilous species: *Euconulus fulvus* (MÜLLER) (2.08%), *Punctum pygmaeum* (DRAPARNAUD) (3.47%) (Pl. 1, Fig. 10), *Trochulus hispidus* (7.64%), *Cochlicopa lubrica* (MÜLLER) (3.47%), and species of screen forests and rocks: *Clausilia dubia* DRAPARNAUD (2.78%), *Orcula dolium* (DRAPARNAUD) (1.38%).

In the region of the Požarevac Danube Area, the species *Columella columella* was recorded only at this locality. It is a species typical of loess formations, indicating the existence of specific cold tundra areas in Upper Würm, but was also present in the more hygro-

philous parts of the steppe (SÜMEGI & RUDNER 2001). It commonly appears in association with other characteristic loess species, such as *Sucinella oblonga*, *Vallonia tenuilabris*, etc.

In these sediments, land fauna of a steppe association was best represented (39.58%), a certain indication that they were formed by wind-blown particles being laid upon the already formed accumulative plain. Such a cover of aeolian dust is connected with the last glaciation or Würm in a broader sense.

Novi Kostolac

In the vicinity of the coal pit Novi Kostolac, at the surficial pit Drmno, Pontian sediments (Fig. 4) are represented with fine to coarse gravels bound with clay 2 m thick, yellowish, slightly silty sands 1 m thick. Overlying these sediments are sandy loessoid silty sands 5 m thick with a rich association of Pleistocene molluscs: Forest species include *Discus ruderatus* (3.69%) and *Aegopinella nitens* (3.69%). Mesophilous species of a forest biotope are: *Vitrea crystallina* (1.84%), *Trochulus striolatus* (8.3%) and *Arianta arbustorum* (LINNÉ) (2.3%) (Pl. 1, Fig. 12). The following interval of cold winters and a fairly dry vegetation period during the summers caused the appearance of the most common steppe species *Chondrula tridens* (25%), *Granaria frumentum* (6.45%) and *Pupilla sterri* (0.92%) of interstadial stage. The mesophilous species: *Pupilla muscorum* (8.75%) and *Vallonia costata* (11.5%) were especially important in areas characterized by open

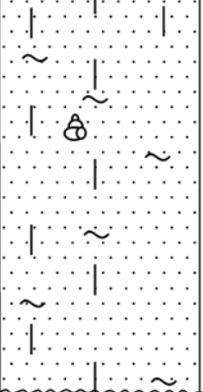
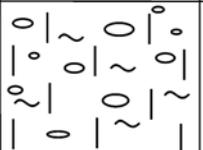
Epoch	Lithology	Th. (m)	Description
Pleistocene		5	Loessoid silty sands
		1	Yellowish, slightly silty sands
Pontian		2	Fine to coarse gravels bound with clays

Fig. 4. Detailed view of the upper part of the section from Novi Kostolac.

steppe biotopes. The species *Vallonia costata* is highly tolerant, a so-called species of “transition zones” between open and woodland habitats (KROLOPP 1995). The mesophilous species: *Punctum pygmaeum* (4.6%), *Trochulus hispidus* (7.83%), *Cochlicopa lubrica* (3.2%) replaced the species of screen forest biotopes: *Clausilia dubia* (5%), *Orcula dolium* (3.69%).

The humidity from tree leaves or from moist soil was suitable for life of hygrophilous species, such as *Sucinella oblonga* (2.76%). According to the malacological results from the analyzed locality, the appearance together of warmth-loving, cold-loving and mesophilous fauna is obvious evidence that the loess series was deposited during several phases of stadial and interstadial.

Zatonje

At the road Ram–Biskuplje, on the right bank of the Danube, at the exit from the village of Zatonje, a profile of sandy sediments, about 12 m thick occurs, which consist of eight determined layers (Fig. 5). The thickest, fifth layer included the fauna of steppe biotopes: *Chondrula tridens* (31.3%), *Granaria frumentum* (28.13%). The species *Sucinella oblonga* (11.45 %) in most of the European loesses is typical snail assemblages of loess steppe. Three ecological groups were present, mesophilous species: *Euconulus fulvus* (3.13%) (Pl. 1, Fig. 8), *Punctum pygmaeum* (8.33%), *Trochulus hispidus* (1.04%); species of open biotopes: *Pupilla muscorum* (8.33%), *Vertigo alpestris* ALDER (2.08%) (Pl. 1, Fig. 2), *Vallonia costata* (2.08%) and species inhabiting forest detritus and rocks: *Clausilia dubia* (3.13%) and *Orcula dolium* (6.25%).

In the gray, fine-grained quartz sands with small lenses of sandy silts (Fig. 5), the fauna of a forest biocoenosis was also recorded: *Cochlodina laminata* (5.21%), *Aegopinella nitens* (1.04%), as well as that of mesic forest biotopes: species *Vitrea crystallina* (15.63%) (Pl. 1, Fig. 11) and *Fruticicola fruticum* (MÜLLER) (1.04%). The species *Vertigo alpestris* was recorded for the first time at the open profile of the locality Zatonje. It is characteristic only for the Upper Pleistocene (Würm), including loess (but it is not typical) (KROLOPP & SÜMEGI 2000). This petrophilous species may be locally an indicator of forest and shrub habitats, during cold and moist climatic periods. According to the collected fauna, the hypothesis of MARKOVIĆ-MARJANOVIĆ (1951) on a multi-phase nature of land loess is supported. Additional proof are the limestone rock plates 1 cm thick, which appear serially in the water wells of the village Zatonje at a depth of 21 m. The other layers are not fossil-bearing.

Kisiljevo

Between the villages Kisiljevo and Biskuplje, discordantly over Miocene sediments, lay the Lower Pleisto-

Epoch	Lithology	Th (m)	Description
Holocene		0.5	Dark brown sands with low humus content
Pleistocene		0.8	Brown fine-grained sands
		2	Light brown silty sands
		5	Gray fine-grained quartz sands with lens of sandy silts and large rounded sandstone concretions
		0.4	Gray silts with tiny carbonate concretions
		1.5	Gray fine-grained sands
		0.2	Thinly layered ribbon clays
		1	Gray sands with medium-sized to large grains

Fig. 5. Detailed view of the upper part of the section from Zatonje.

cene deluvial folds of the “Kličevac Formation”, composed of gravel, sands, silts and tufa (RAKIĆ 1980). In the broader area of the village Kisiljevo toward Topolovnik, the sands are joined in inundation layers by various silts, which are, especially at the surface, of alluvial character and transformed into a loessoid or fluvial horizon 5 m thick (Fig. 6). It contains Holocene malacofauna of a forest biotope: *Discus ruderatus* (0.21%), *Cochlodina laminata* (0.21%), *Aegopinella nitens* (11.36%) (Pl. 1, Fig. 4); and mesophilous fauna *Trochulus striolatus* (26.06%), *Arianta arbustorum* (0.44%), *Fruticicola fruticum* (4.68%). This fauna was included in the formation of a biocenosis belonging to the forest-steppe type, which later became less diverse and turned into some kind of steppe. The species: *Chondrula tridens* (2.23%), *Granaria frumentum* (15.82%) (Pl. 1, Fig. 1) and *Cecilioides acicula* (0.44%) showed that the steppe conditions were maintained for some time. The species *Pupilla muscorum* (1.56%) and *Vallonia costata* (5.35%) confirm the existence of a common feature of steppe adaptations and life in open terrains. The mesophilous species are *Punctum pygmaeum* (0.89%), *Trochulus hispidus* (15.82%) and *Cochlicopa lubrica* (9.58%), while *Orcula dolium* (3.79%) (Pl. 1, Fig. 6) and *Sucinella*

oblonga (1.56%) represented transitional forms of these and neighbouring associations.

Epoch	Lithology	Th. (m)	Description
Holocene		5	Silts and loess sediments
Pleistocene		20	Gravels and silty sands
Pannonian		250	Fine-grained silty sands
Sarmatian		150	Brown fine-grained sands with graybluish clays

Fig. 6. Detailed view of the upper part of the section from Kisiljevo.

Conclusions

By analyzing the abundances of malacofauna from loess sediments of the Požarevac Danube Area, several biotopes were recognized (Fig. 7): forest, open areas within forest biotopes, steppe, open biotopes, forest-mesophilous areas and moist biotopes.

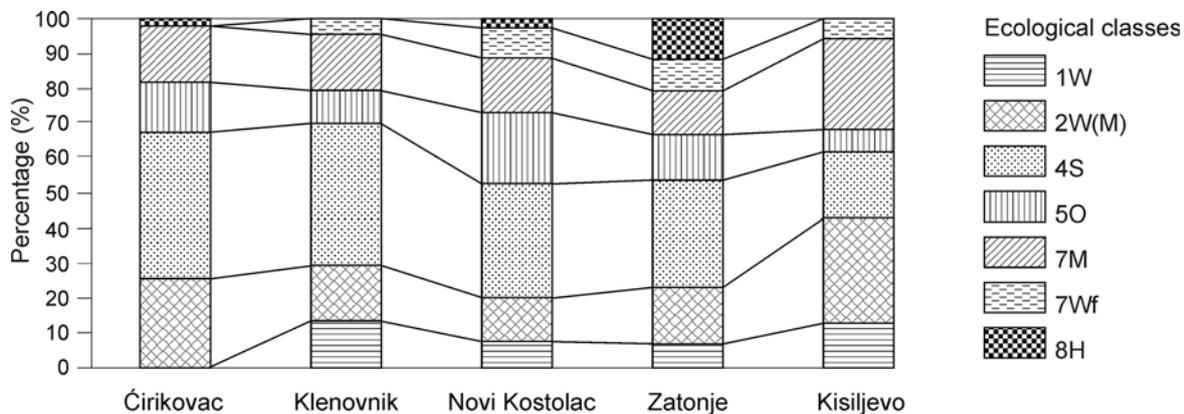


Fig. 7. Percentage distribution of the terrestrial gastropod fauna on the basis of ecological groups.

Forest and forest-mesophilous species are abundant with 32%; the most common species is *Trochulus striolatus* (Ćirikovac, Klenovnik, Novi Kostolac and Kisiljevo). The “warmth-loving forms” also belong to this group, and they appear mostly in the relatively warmer phases of the late Würm.

Steppe fauna is abundant with 28.78%, with species *Chondrula tridens* and *Granaria frumentum* present at all localities. The steppe species lived in intrazonal biotopes (forest valleys, flooded forests along rivers, etc.), while some of them are representatives of mesophilous groups. The steppe climate was characterized by cold

and arid winters and humid summers; the succession of “cold-loving forms” and “warm-loving forms” indicate that the loess was deposited in three Würm stadials, while the basal part was deposited during the Riss–Würm interglacial. The majority of these dry, grass, steppes represented the biogeography area of the Pannonian–Dakian steppe, suggesting diluvium origin (MATVEJEV 1961).

The open biotope consists of places of moist meadows and steppe. It is hypothesised that the S and SE winds in the southern parts, enabled the development of open biotopes for many species represented with 11.76%.

The mesophilous species were continually distributed along all of the studied profiles, they are represented with 24.92 %, and could live in fallen leaves and in relatively moist meadows.

According to some hypotheses (RAKIĆ 1977), the ecological conditions with more humid environment formed during the deposition of the oldest horizon, matching the penultimate phase of glaciations. Although the terrestrial fauna of gastropods had the widest distribution, it does not necessarily mean that the sediment was formed on land, because terrestrial forms could also indicate open grassland areas in the vicinity of water or moist ground. The presence of hygrophilous species (2.54%) may indicate that this loess was also occasionally flooded, but still not long enough to develop water fauna.

During the Riss–Würm interglacial, an analogous type of Balkan–Middle European ecological conditions

was occasionally widely distributed in Europe. In the regional sense, the sediments of the “Kličevac Formation” of the Požarevac Danube Area can partially be correlated with similar sediments of the “Srem Formation” at the slopes of Fruška Gora Mountain and the “Zagajička Formation” in Southern Banat (RAKIĆ *et al.* 1998).

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Резиме

Пleistocenска малакофауна Пожаревачког Подунавља (СИ Србија)

Проучавањем заступљености малакофауне на лесним профилима Пожаревачког Подунавља, установљено је неколико биотопа: шуме, отворени простори у шумским биотопима, степе, отворени терени, шуме мезофилног типа и влажни биотопи.

Шумске и шумскомезофилне врсте су заступљене 32%, овој групи припадају “топлољубиве форме”, које се јављају у релативно топлијим фазама касног вирма. Најзаступљенија врста је *Trichia striolata* (Ђириковац, Кленовник, Нови Костолац и Кисилево).

Степска фауна присутна је са 28.78%, а најзаступљеније су врсте *Chondrula tridens* и *Granaria frumentum* су заступљене на свим локалитетима. Степске врсте живе у интразоналним биотопима (шумским увалама, плавленим шумама дуж река и др.) а неке су и чланови мезофилних група. Степску

климу одликују хладно-суве зиме и жарка лета, смена заједница хладнољубиве и топлољубиве фауне. Састав гастроподске фауне указује да је лесна серија формирана за време Рис-вирмског интергласијала и у три вирмска гласијала. Већи део ових исушених, травнатих степа, сматра се да представља биогеографско подручје подпровинције панонско-дакијских степа, што указује да су степе “дилувијалне старости” (МАТВЕЈЕВ, 1961).

Отворене биотопе чине влажне ливаде и степе. Претпоставља се да је утицај Ј и ЈИ ветрова у јужним деловима степе, омогућио развој отворених станишта за 11.76% присутних врста.

Мезофилне врсте континуирано се појављују у свим истраживаним профилима са укупно 24.92%, могу живети и у опалом лишћу и на умерено влажним ливадама.

Постоје претпоставке (РАКИЋ 1977) да су се еколошке карактеристике које указују на влажнију

средину, одиграле за време депоновања најстаријег хоризонта, што би одговарало претпоследњој фази гласијације. Иако је заступљена углавном сувоземна фауна мекушаца тј. гастропода, то не мора да значи да је седимент стваран на сувом. Копнене форме указују на отворене травнате пределе, који су били у близини воде, односно влажног тла. Присуством хигрофилних врста (2.54%) може се претпоставити да су се више пута формирале баре, али ипак недовољно дуго да би се развила водена фауна.

За време рис-вирмске интергласијације, аналогни тип балканско-средње-европских еколошких услова био је повремено широко заступљен у Европи. У регионалном погледу седименти “Кличевачке серијом” Пожаревачког подунавља, делимично се могу корелисати са сличним наслагама “Сремске серије” на падинама Фрушке Горе, и “Загајичком серијом” у Јужном Банату (РАКИЋ 1998).

PLATE 1

- Fig. 1. *Granaria frumentum* (DRAPARNAUD). Kisiļjevo; × 8.
 Fig. 2. *Vertigo alpestris* ALDER. Zatonje; × 13.
 Figs. 3a, b. *Columella columella* (MARTENS). Klenovnik; × 13.
 Fig. 4. *Aegopinella nitens* (MICHAUD). Kisiļjevo; × 4.
 Figs. 5a, b. *Vertigo pygmaea* (DRAPARNAUD). Ćirikovac; × 26.
 Fig. 6. *Orcula dolium* (DRAPARNAUD). Kisiļjevo; × 8.
 Fig. 7. *Catinella* cf. *arenaria* (BOUCHARD-CHANTEREAUX). Ćirikovac; × 8.
 Figs. 8a, b. *Euconulus fulvus* (MÜLLER). Zatonje; × 13.
 Figs. 9a, b. *Trochulus striolatus* (PFEIFFER). Ćirikovac; × 4.
 Figs. 10a, b. *Punctum pygmaeum* (DRAPARNAUD). Klenovnik; × 27.
 Fig. 11. *Vitrea crystallina* (MÜLLER). Zatonje; × 13.
 Figs. 12a, b, c. *Arianta arbustorum* (LINNÉ). Novi Kostolac; × 3.

