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QUATERNARY MALACOFAUNA OF THE SMEDEREVO VICINITY (NE SERBIA)

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Abstract: A short description of gastropod fauna from loess sediments from the Smederevo vicinity is presented. The material was collected from four localities in 2002. Due to the terrain coverage observation of loess sediments was not possible on some occasions, while on the other hand, the correlation between our profiles and neighbouring boreholes were possible in some instances. Further studies will include other analyses from sediments, deposited in freshwater environments during the Early and middle Pleistocene and they will also include sedimentological analyses.

Key words: Quaternary, Smederevo, gastropods, loess, fossil soil, paleoecology.

Introduction

The study was conducted in the Danube area near Pozarevac in North-Eastern Serbia on a study area that spreads over about 15 km^2. These profiles are described as land loess and they are underlain by the sediments of middle and Late Pleistocene and Pontian age (Žujović 1893; Luković 1951; Stevanović 1951, 1992; Rudolf 1958; Aleksandrović 1959; Obradović 1960; Pavlović 1974, 1980; Rakić 1977, 1990; Marković-Marjanović 1978a,b; Marović 1984).

The 169 specimens were collected at four localities: 1. Smederevo, 2. Radinac, 3. Vrbovac, and 4. Vranovo (Fig. 1).

The material is kept in the collections of the Natural History Museum in Belgrade.

The methods of collection

The results of paleontological investigation are influenced by the way of getting the material. In this study Füköh's technique of collecting samples is followed (Füköh 1995). The paleontological material, including Quaternary malacological material can be collected in two basically different ways: with singling and with en-mass collection. In the case of singling the molluscan shells visible to the naked eye are collected from the sediments. The material for the malacological examination is extracted from the samples by washing the sediments through the mesh. The rocks used for the extraction of the samples must be soaked before processing (until they become pulpy). The specimens are further processed by sieving and rinsing with hydrogen peroxide. The fauna was generally well preserved, which allowed the identification of the species and the assessment of the sediment age. Determination of fossil material and paleoecological analyses followed the methods described by Ložek (1964) (Table 1). The explanation of symbols is according to Brohmer (1933), Soós (1943), Grossu (1956, 1993), Ložek (1964), Kerney (1983, 1999), Ciangerherotti (2000) and Pfleger (2000).

27 species of Pleistocene age were identified (Table 2). Profiles in the suburb of Smederevo yield the most diverse fauna represented by 80 examples. From the lithological point of

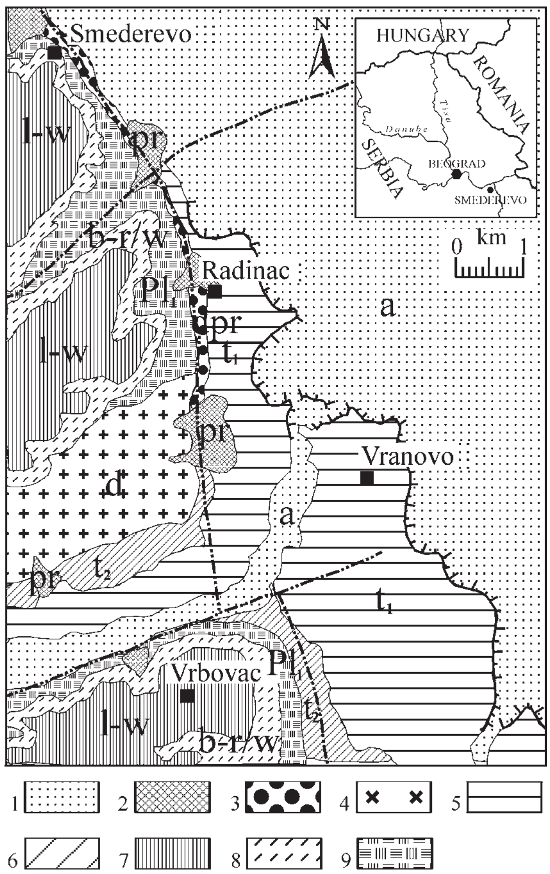

Fig. 1. The geographical location of all four sites (from the geological map, page Smederevo L 34–126 (Pavlović 1980)). **1. a** — alluvium; **2. p** — proluvium; **3. dpr** — proluvium-deluvium; **4. d** — deluvium; **5.** $\mathbf{t_1}$ — lower river terrace; **6.** $\mathbf{t_2}$ — higher river terrace; **7. l–w** — land loess (Würm); **8. b-r/w** — variegated sandy and pebbly clays and argillaceous sand (Riss–Würm); **9.** $\mathbf{Pl_1}$ — lower Pontian.

Table 1: List of the ecological groups mentioned in the text and explanation of symbols according to Ložek (1964).

ECOLOGIC GROUPS (FROM LOŽEK 1964)	
1W	Forest associated species
2W	Species living mainly in woods
2W(M)	Species living mainly in woods, but also in mesophilous places and both damp and dry biotopes
2W(S)	Open areas (steppe) in forest biotope
3W(H)	Forestal hygrophilous species
4S	Steppe dry sunny places
5O	Species living in open places without arboreous vegetation
6X	Dry and warm habitats
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
9P	Strongly hygrophilous species living in marshes or in similar very damp to wet places, generally very close to the water

view, this profile has the best developed dry land loess without any visible stratification and with a rich content of carbonate concretion.

Profile I: the brickyard "Nikola Krga" in downtown Smederevo

The analysis of the profile from the brickyard "Nikola Krga" in downtown Smederevo is performed in the combination with data from the core B-3/74 (Pavlović et al. 1974, 1980). The oldest sediments from the Lower Pontian are represented by 10 m of grey fine-grained sand. Sediments from the Lower Pleistocene lay transgressively above Pontian sands and are represented by 20 m of gravels, detrital silts, and silty sands (eolian terrace, 85–110 m, Günz–Mindel). Finally, the upper Pleistocene (Riss–Würm) is represented by land loess divided by fossil soils (60 cm in depth) (Fig. 2).

The lower part of the horizon has a diverse fauna with a high number of "warm forms" such as: *Bradybaena fruticum* (Müller) (5), *Arianta arbustorum* (Linné) (8), *Chondrula tridens* (Müller) (4) (Fig. 3.6), *Trichia striolata* (Pfeiffer) (2), *Cochlicopa lubricella* (Porro) (Fig. 3.2), etc. These species are known as "arianta fauna" and is associated with land gastropods characteristic of humid environments (forests, shrubs, grassland and meadows). They are also indicators of warmer phases of the late Würm.

According to Ložek (1964), *Vallonia pulchella* (Müller) is a speies found mostly in grassland and muddy (riverside habitats). During the Quaternary this form is typically found in warmer periods (interglacial stages) and it suggests that these areas were not directly influenced by the glaciations. In the South Morava Valley (Rakić 1977) the presence of *Vallonia pulchella* (Müller) proves that the effects of colder climate were present in the form of silt inundation facies and represent only one kind of change in the framework of persistent dynamic phase that happened at the time of climate fluctuations on the Northern Hemisphere.

In the upper part of the second (lower) horizon somewhat "colder" fauna was determined. This fauna is (Fig. 4) represented by *Pupilla sterri* (Voith) (13) (Fig. 3.4), *Vallonia tenuilabris* (Braun) (4), *Punctum pygmaeum* (Draparnaud) (3), *Vallonia costata* (Müller) (1), and others. Xerophilic species *Pupilla sterri* (Voith) and *Vallonia tenuilabris* (Braun) belong to the group of gastropods that are well adapted to dry conditions and are, therefore, found in arid environments. Xerophilic gastropods have coarse, and non-permeable shells while the opening of the mouth can be closed with heavy secretion that serves as a lid. Adaptation to dry conditions is evident by the change into the state of hibernation during the periods of droughts (anabiotic state). Hungarian author Sümegi (1991) found a strict correlation between the environmental changes and individual number of the species *Pupilla sterri* (Voith) and *Vallonia tenuilabris* (Braun). It can be used in paleoclimatic reconstruction as these species prefer a severe continental climate and are characteristic of steppe populations resistant to dry conditions.

Mesophilic species represent transition between hydrophilic and xerophilic species and are represented with *Trichia hispida* (Linné) (3), *Punctum pygmaeum* (Draparnaud) (3), and *Clausilia dubia* Draparnaud (3) (Fig. 3.11) characteristic of moderately humid environments (forests and meadows).

The presence of hydrophilic species *Succinea oblonga* Draparnaud (13) (Fig. 3.10) and *Cochlicopa nitens* (Gallenstein) (1) suggests humid habitats from wet lake, swamp, and river banks to the soil and detrital material typical of the wet and dark forests. These species survive only in moist atmospheric conditions and wet soil where the loss of body water is reduced. Hydrophilic species are very sensitive to the change in the degree of humidity of their habitats.

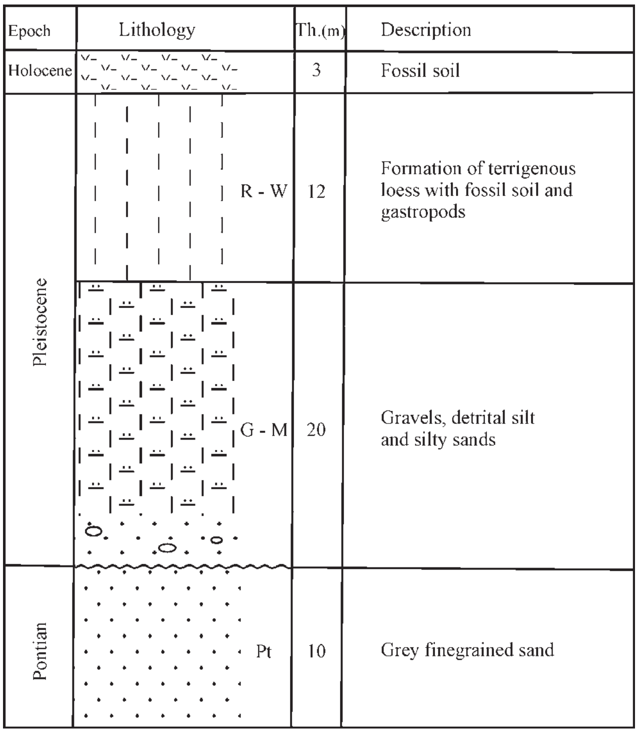

Fig. 2. Detailed view of the upper part of the section from Smederevo.

Table 2: Survey of Quaternary malacofauna of the area Smederevo.

Molluscan records	Paleoecological characteristics	Smederevo	Radinac	Vranovo	Vrbovac
Vitrea transsylvanica (Clessin)	1W			1	
Discus ruderatus (Férussac)		2	1		
Cochlodina cf. *transsylvanica* (Bielz)	2W(S)		2		
Bradybaena fruticum (O.F. Müller)		5	8		3
Arianta arbustorum (Linnaeus)	2W(M)	8	1		
Vitrea crystallina (Müller)					1
Trichia striolata (Pfeiffer)		2	4		1
Macrogastra cf. *ventricosa* (Draparnaud)	3W(h)	2			
Granaria frumentum (Draparnaud)	4S		1		
Pupilla sterri (Voith)		13		2	
Pupilla triplicata (Studer)				2	
Cepaea vindobonensis (Férussac)			2		
Helicopsis striata (O.F. Müller)			1		
Cecilioides acicula (O.F. Müller)					1
Chondrula tridens (O.F. Müller)		4	19	2	7
Catinella arenaria (Bouchard-Chantereaux)	5O	3			
Vallonia pulchella (O.F. Müller)		4	2		
Vallonia costata (O.F. Müller)		1		1	11
Vallonia tenuilabris (Braun)		4			
Pupilla muscorum (Linnaeus)		6	1	1	3
Cochlicopa lubricella (Porro)	6X	2			
Clausilia dubia Draparnaud	7Wf	3			
Punctum pygmaeum (Draparnaud)	7M	3			2
Trichia hispida (Linnaeus)		3	6		3
Succinea oblonga Draparnaud	8H	13			
Cochlicopa nitens (Gallenstein)		1			
Succinea putris (Linnaeus)		1			
		80	48	9	32
		169			

On the basis of faunistic information it is inferred that the loess at this locality was deposited in the Late Pleistocene during the Würm glacial period. The presence of *Discus ruderatus* (Férussac) (2) (Fig. 3.1) in the lower part of the second horizon where snail assemblage is dominated by *Bradybaena fruticum* (Müller), *Arianta arbustorum* (Linné), *Trichia striolata* (Pfeiffer), and *Chondrula tridens* (Müller) indicate the proximity of Riss–Würm interglacial stage. Depth of the loess is approximately 12 m, while the surface layer is represented by 3 m of anthropogenic deposits.

Profile 2: "Novi Kop brickyard Radinac", Radinac

In borehole Radinac B-7/74 and B-82/74 (Pavlović 1980) ostracode fauna was found at the depth of 18.0–8.5 m suggesting that in this part of the terrain the sediments of middle Pleistocene age were present. From 15.0–8.0 m the upper parts of the middle Pleistocene were present, while from 15.0 m the lower parts of the middle Pleistocene were represented by freshwater fauna (Fig. 5). Those sediments are represented with grey-bluish clays, gravelly clays, sands and gravels. From 8.0 to 2.5 m the younger parts of the middle Pleistocene could be found and they are represented by the light brown swamp clays, and clayey sand, with trace amounts of iron (aquatic facies). The upper two meters consist of dark yellow land loess made of sand, sandy siltstone, and brown to yellowish siltstone rich in calcium carbonate. Land gastropod fauna characteristic of loess habitats are represented by *Bradybaena fruticum* (Müller) (8), *Trichia striolata* (Pfeiffer) (4), *Cochlodina* cf. *transsylvanica* (Bielz) (2) (Fig. 3.12), *Discus ruderatus* (Férussac) (1) and others, generally characteristic of forest habitats and areas with sparse forest and shrub vegetation (the third stratum) (Fig. 4). This fauna suggests warmer phases during the colder periods. The great diversity of the steppe fauna including *Chondrula tridens* (Müller) (19), *Granaria frumentum* (Draparnaud) (1), *Cepaea vindobonensis* (Férussac) (1) and *Helicopsis striata* (Müller) (1) (Fig. 3.13) suggests warmer climate, milder winters and rather dry vegetative period (spring, summer, and autumn). The above species survived in tree-less environments mostly because herbs represented by xerophilic and microtherm species adapted to droughts and frost were abundant. "*Ch. tridens*-fauna" according to Ložek (1964) represents the fauna that is related to the formation of chernozem, which is a type of very fertile soil typical of steppe habitats.

Among those the pocket of fossil soil (0.9 m thick) rich in humus material with relict fine lenticular laminations was observed. This fossil chernozem is degraded and transformed into the brown clayey soil similar to the clayed loess. In the upper part the irregular aggregation of humus is observed suggesting solifluction processes. In Austria, the Czech Republic and Slovakia irregular aggregation of humus inside the loess formation is called "Humus Anreicherung" and is usually associated with the sediments from interstadial phases of the soil complex PK2 and other equivalents (Rakić 1977). In terms of

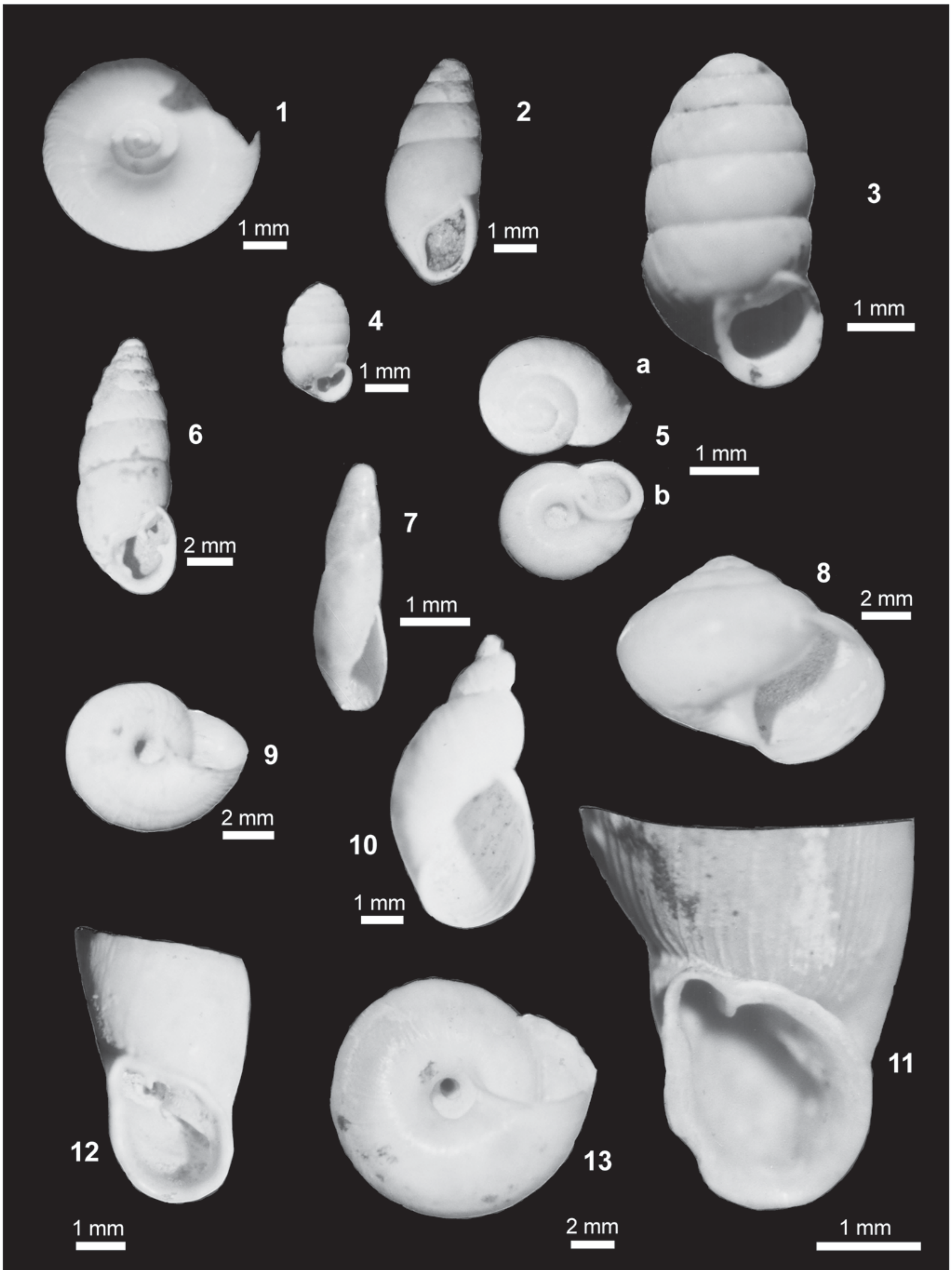

Fig. 3. **1** — *Discus ruderatus* (Férussac), Smederevo. **2** — *Cochlicopa lubricella* (Porro), Smederevo. **3** — *Pupilla muscorum* (Linné), Vranovo. **4** — *Pupilla sterri* (Voith), Smederevo. **5a,b** — *Vallonia costata* (Müller), Smederevo. **6** — *Chondrula tridens* (Müller), Smederevo. **7** — *Cecilioides acicula* (Müller), Vrbovac. **8** — *Bradybaena fruticum* (Müller), Vrbovac. **9** — *Trichia hispida* (Linné), Vrbovac. **10** — *Succinea oblonga* Draparnaud, Smederevo. **11** — *Clausilia dubia* Draparnaud, Smederevo. **12** — *Cochlodina* cf. *transsylvanica* (Bielz), Radinac. **13** — *Helicopsis striata* (Müller), Radinac.

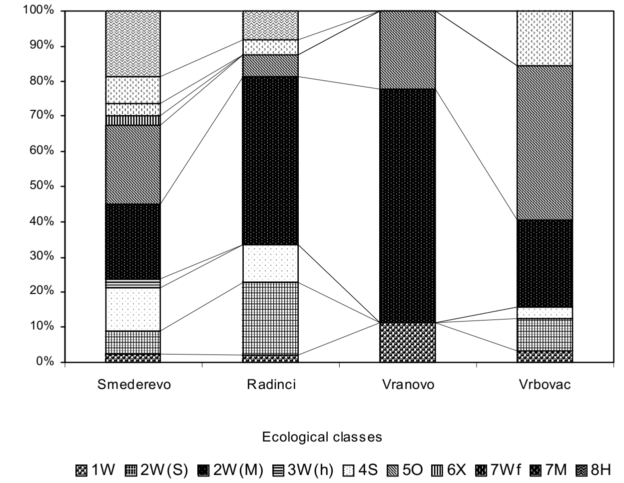

Fig. 4. Percentage distribution of the terrestrial gastropod fauna on the basis of ecological groups.

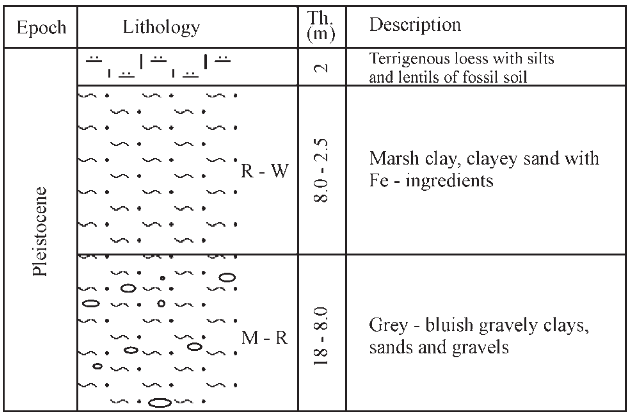

Fig. 5. Graphic logs of boreholes located in the Radinac.

grain size characteristics and mineral structures, the sandy and clay siltstones typically have a high siltstone content (60.0–80.0 %) and very irregular quantity of clay (7.0–18.0 %) and sand grains (up to 31 %).

Profile 3: Vranovo

The profile was observed in the area of a new brickyard outcrop in the village of Vranovo. Several parts of land loess are evident (I, II, III, and IV) and they have been partly extracted, while on the recently exposed profile fossil soils could be observed (A, B, and C). Land loess is dark yellowish to ochreous in colour, with a dusty texture coming from its silt component, rich in calcium carbonate, and with homogenous content across large areas. Analysis of calcium carbonates (6.4–37.5 %) was performed, and the results revealed syngenetic and epigenetic origins. The concretions known as loess nodules are especially important among epigenetic types. They have a very characteristic shape and can occur in two basic ways: either irregularly as in the body of whole rock or in the form of large masses in the lower part of the loess above fossil soil. Soil complexes A, B, and C, (each sequence is 1 m thick) indicate the breaks in the eolian accumulation and in the cases of their multiple succession with loess they are of great stratigraphic importance (Fig. 4).

If this degraded chernozem is compared with similar instances south-eastern of Iriga on the road to Bankovac, it is evident that in both cases fossil ground is divided into two or three humus layers or fossil soils and therefore at certain instances of prolonged profiles, it gives the impression of a larger number of paleopedologic complexes.

Identical two- and three-fold subdivision of other fossil soil is considered a characteristic of pedologic complex PK2 , and are recorded from former Czechoslovakia, and fossil soils of upper Volozian interstage from the former USSR (Rakić 1977). Since the brickyard was abandoned it was neither possible to see the connection with the bedrock nor to infer the relation using the basic geological maps Pozarevac 1:100,000 (Malesević et al. 1980). Low diversity fauna composed of *Ch. tridens* (2), *P. triplicata* (2), and *P. muscorum* (1) (Fig. 3.3) and *P. sterri* (2) suggests that "pupilla" fauna (Fig. 4) according to Ložek (1964) was connected with the colder biotopes during the Würm period, therefore suggesting a colder climate at the time of the loess dust storms. However, V. Volkov (Rakić 1977) concluded that the percentage of these "cold" genera increases with the distance from the north suggesting that the previous assumption could have a relative effect and should be used with caution.

Profile 4: Vrbovac

Two uncovered profiles with the length of 20 m each are located in the village of Vrbovac. The profiles are vertically cut and the yellowish loess material could be seen. By structure it is described as sandy and loamy silt. It is rich in calcium carbonate (9.7 %) and occurs in the form of dispersed efflorescens and horizons of various depths. In this study, only parts that were up to 3 m in height were analysed because it was not possible to assess final parts of the vertical loess profiles. The relationship with bedrock (the material that is beneath the loess) was not evident because the profile was greatly covered with loess. On the basis of fauna (Fig. 4): *B. fruticum* (3) (Fig. 3.8), *Vallonia costata* (11) (Fig. 3.5a,b), *Ch. tridens* (7), *Cecilioides acicula* (Müller) (1) (Fig. 3.7), *Vitrea crystallina* (1), *T. hispida* (3) (Fig. 3.9) and *T. striolata* (1) it is evident that the loess material was formed during an arid phase of the Late Pleistocene.

Only one fossil soil (1 m thick, and dark brown in colour) was recognized from this locality. They are different from loess and in general they have greater percentages of clay, microlumpy structure and presence of humus, which is responsible for the brown colour.

Conclusions

Loess formation in Pannonian Basin started in the middle and finished at the end of the Pleistocene. Loess was deposited during the dry and arid climate, in grasslands (mostly steppe and cold tundra). Previous conclusions were proved by histograms and they can be used to deduce that in the profile "Nikola Krga" brickyard in Smederevo, and Novi Kop "Radinac" u Radincu, "warm forms" such as *B. fruticum*, *A. arbustorum*, *T. striolata* and *Ch. tridens* belonging to the "Arianta fauna" occur in relatively warmer phases of the late Würm. They are succeeded by the "colder fauna" type: *P. sterri*, *V. costata*, *V. tenuilabris*, *P. pygmaeum* etc. The succession of "colder" fauna with *Ch. tridens* and "warmer" fauna with *P. sterri* agrees with the idea of A. Taksić (Rakić 1977), who believes that during the deposition of loess in the vicinity of Vinkovac in the Würm it was characterized by successions of the cold and warm sequences. Regardless of different opinions this association from the ecological point of view is characteristic of steppe regions. Loess profiles are basically continuous because the horizons of loess and fossil soil could be correlated from the relatively distinct localities of "Nikola Krga" in downtown Smederevo, "Novi kop Radinac" in Radinac, Vranovo and Vrbovac. The fact that xerophilic species succeeded mesophilic species and are in turn succeeded by hydrophilic species is in agreement with known climate fluctuations. It was inferred that loess was deposited with periods of hiatus, with the deposition of every loess layer succeeded by the degradation of crust and the formation of fossil soil.

From the climatological point of view, fossil soil is interglacial or interstadial, therefore suggesting that the loess above and below it could only be formed during the glacial periods. More detailed stratigraphic interpretation of loess layers was not possible at this stage due to lack of fossil material. This study is an attempt to induce detailed analyses of loess formations in the vicinity of Smederevo.

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