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MALACOFAUNA OF LATE QUATERNARY DEPOSITS FROM MUSELIEVO, NORTHERN BULGARIA

STEFAN WITOLD ALEXANDROWICZ

Polish Academy of Arts and Sciences, Sławkowska 17, 31-016 Kraków, Poland

ABSTRACT: Assemblages of subfossil molluscs were found in Pleistocene and Holocene deposits in Muselievo (Northern Bulgaria). The fauna of the loess and loess-like loams included land snails typical of a relatively warm climate and dry, open habitats. Only the uppermost part of the profile contained an assemblage similar to those described from loess of Central Europe. The mollusc fauna of the Holocene deposits forming the terrace of the Osam River was distinctly richer. It reflects changes in sedimentary conditions and habitat types during the Subboreal and Subatlantic phases. The similarity of the assemblages from the two stratigraphical units suggests that climatic differences between particular warm and cold phases were much less pronounced in the Balkan Peninsula, compared to Central Europe.

KEY WORDS: molluscs, Pleistocene, Holocene, Bulgaria

INTRODUCTION

The village Muselievo is situated in the valley of the Osam River, about 8 km from its outlet to the Danube. Geological research in the lower section of this valley, particularly concerning its Quaternary deposits, was for a long time stimulated by archaeological finds. The rich collection of Palaeolithic tools with bifacial leaf-like points, found in 1968 in Museliewo by N. Dzhambarov, was later studied in detail by CHMIELEWSKI (1977), while the loess stratigraphy of the area, based mainly on the occurrence of intercalations of fossil soil, was presented by MADEYSKA (1977). The rich collection of flint tools, as well as profiles of particular outcrops of the loess series, were subsequently described by HAESAERTS & SIRAKOVA (1979). The occurrence of mollusc shells in the deposits was mentioned in their publication, however the subfossil material was not identified.

Thanks to the kindness of Prof. J. Sirakov (Institute of Archaeology, Bulgarian Academy of Sciences) during the summer 1987, I had the possibility to take up geological field work in the mentioned area. In the course of these investigations, loess outcrops on the slopes surrounding the valley, as well as fluviatile sediments cropped out along the river bed and forming a terrace 4–5 m high, were studied in detail. On this occasion and also a few years earlier (ALEXANDROWICZ 1992, 1994, 1999a), I investigated subfossil molluscs in a few localities in northern Bulgaria: a loess series on the right bank of the Danube near Russe, Pleistocene and Holocene deposits from the archaeological site in Karlukovo, ca. 80 km NE of Sofia in the NW. part of the Balkan Mts (Stara Planina Mts), sediments covering the ruins of the ancient Roman town Ulpia Oecsus near Gigen (ca. 40 km N of Pleven) as well as recent thanatocoenoses of the Danube in Russe and of the Osam River in Muselievo (Fig. 1).

MATERIAL AND METHODS

Forty-six samples taken during the field work (14 from loess and 32 from river deposits) were washed in the laboratory and sieved; all identifiable mollusc shells and their fragments were retrieved. The whole

analysed material comprised 36 mollusc species represented by about two thousand specimens. Standard methods of malacological analysis described by LOŽEK (1964) and ALEXANDROWICZ (1987, 1999b) were applied. The species were divided into six comprehensive categories: F – snails of shaded habitats, X – xerophile species, O – open-country snails, M – mesophile species found in both shaded and open habitats, H – hygrophile snails, W – water species. Ecological spectra of mollusc assemblages from the Holocene silts, malacospectra of species (sc) and of specimens (sm), as well as constancy and dominance indices (C–D) calculated for particular layers, were used to characterise the assemblages. Few samples of the mollusc-bearing deposits were additionally radiocarbon-dated by Prof. dr hab. M. Pazdur and Prof. dr hab. A. Pazdur (Institute of Physics, Silesian Technical University in Gliwice). Numerous samples were also taken from the other mentioned localities (Russe, Karlukovo, Ulpia Oescus near Gigen) and examined with the same procedures and methods.

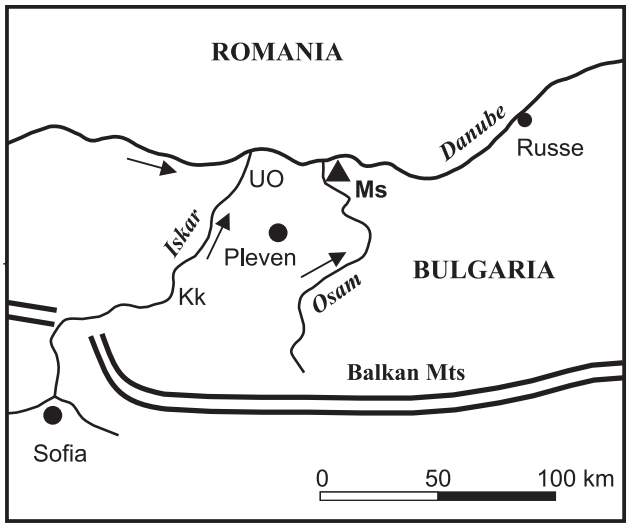

Fig. 1. Map of northern Bulgaria with the sites described or mentioned in the text indicated: Ms – Muselievo, UO – Ulpia Oescus, Kk – Karlukovo

RESULTS

PLEISTOCENE LOESS FAUNA

The loess series profile is accessible in an old abandoned quarry "Kariera", described in detail by HAESAERTS & SIRAKOVA (1979). The outcrop is up to 14 m high, situated in the lower part of the slope on the right side of the Osam valley, close to the outlet of the Jeglovski Stream. Quaternary deposits cover banded and marly limestones of Upper Cretaceous (Maestrichtian) age, visible at the bottom of the quarry and forming the rocky slope in its northern part. Four layers of mollusc-bearing deposits were distinguished (HAESAERTS & SIRAKOVA 1979): KT, KU, KC and KD (from bottom to top):

[KT] (2 m): yellow and yellowish-grey calcareous loess-like loam containing locally numerous fragments of mollusc shells. These are mainly helicids, with an admixture of completely preserved small snails;

[KU] (2–4 m): brown and grey loess-like loam with an admixture of humus, intercalated by lenses enriched in small fragments of limestones and marls. Numerous snail shells and their fragments are contained in this layer, partly representing the horizon of fossil soil;

[KC] (3–4 m): yellow and brown loess-like loam with intercalations and lenses of limestone rubble, particularly rich close to the rocky slope in the northern part of the outcrop. Traces of fossil soil dated as 30,000±1,200 years BP (GD-2804) occur within these sediments. Snail shells and especially their fragments were found in the whole described layer;

[KD] (6–9 m): yellow loess with thin intercalations of sandy loess and with traces of bioturbations. The recent soil is well developed at the top. Mollusc remains are sporadic.

The loess of slope type, described also as loess-like sediments, predominates in the profile. It is characterised by the occurrence of fossil soils and, first of all, rock fragments distributed irregularly or forming lenses and intercalations. Such a kind of loess is associated with creeping of soil and rock debris, as well as with hillwash. Only the uppermost layer is most similar to typical loess.

The mollusc fauna of the described loess is relatively poor but rather diverse, with 17 species. Snails of dry and sunny habitats are the most important components of the assemblages. The richest assemblages occur in the lower and middle part of the sequence (layers KT and KU) while in the upper part (KD) only 5 species, represented by few specimens, were found (Table 1).

The first assemblage, found in calcareous loess-like loam (layer KT), is composed nearly exclusively of xerophile snails: *Helicopsis striata*, *Helicella obvia*, *Zebrina detrita* and *Chondrula microtraga*. It contains also numerous fragments of broken shells of *Helix* (*H. pomatia*). The next one, distinguished in layer KU, is also dominated by species of dry and sunny habitats (ecological group X), but additionally open-country snails typical of grasslands (ecological group O) occur there. The significant number of specimens of *Granaria frumentum* and the occurrence of *Pomatias elegans* are noteworthy.

The fauna from layer KC is somewhat different. It includes species of partly shaded habitats – members of *Bradybaena*, *Helix* and *Lindholmiola*. Shells and shell fragments of the last mentioned snail, which lives in scrubs and sparse forests, are relatively numerous. Another two species – *Impatrietula seductilis* and *Helicopsis filimargo* – were noted only in this layer. In the uppermost part of the sequence (layer KD) the fauna is quite different, composed mostly of *Helicopsis striata*, *Pupilla muscorum* and *Vallonia pulchella*, noted as com-

Table 1. Mollusc assemblages from Late Quaternary deposits in Muselievo: E – ecological group: F – snails of shaded and partly shaded habitats, X – xerophile species, O – open-country snails, M – mesophile species of shaded and open habitats, H – hygrophile snails, W – water species. Number of specimens: I – 1–3, II – 4–9, III – 10–31, IV – 32–99, V – 33–99 (after ALEXANDROWICZ 1987)

No	E	Taxon	Loess				Fluviatile deposits			
			KT	KU	KC	KD	F1	F2	F3	F4
1	F	*Bradybaena fruticum* (O. F. Müller)			I				I	
2	F	*Lindholmiola corcyrensis* (Deshayes)	I	I	III					I
3	F	*Monachoides incarnatus* (O. F. Müller)					I			
4	F	*Helix pomatia* (Linnaeus)	III		II		II		I	
5	X	*Cochlicopa lubricella* (Porro)					III			III
6	X	*Granaria frumentum* (Draparnaud)	I	III		I				I
7	X	*Truncatellina costulata* (Nilsson)								I
8	X	*Zebrina detrita* (O. F. Müller)	II	II	I				I	I
9	X	*Chondrula tridens* (O. F. Müller)			I	I	III		I	I
10	X	*Chondrula microtraga* (Rossmässler)	II	III	I	I			I	III
11	X	*Cecilioides acicula* (O. F. Müller)							I	I
12	X	*Helicopsis striata* (O. F. Müller)	III	I	II	II	IV		III	IV
13	X	*Helicella obvia* (Hartmann)	II	II	III		I			III
14	X	*Cepaea vindobonensis* (Férussac)	I	I			II		II	
15	O	*Pomatias elegans* (O. F. Müller)		I						
16	O	*Vallonia costata* (O. F. Müller)							II	I
17	O	*Vallonia pulchella* (O. F. Müller)		I		II	IV	II	IV	III
18	O	*Imparietula seductilis* (Rossmässler)			I					I
19	O	*Pupilla muscorum* (Linnaeus)				II			II	II
20	O	*Verigo pygmaea* (Draparnaud)						I	II	
21	O	*Monacha cartusiana* (O. F. Müller)		I			III		II	I
22	M	*Succinea oblonga* (Draparnaud)								II
23	M	*Laciniaria plicata* (Draparnaud)	I	I			I			
24	M	*Bulgarica varnensis* (Pfeiffer)					I		I	
25	M	*Helicopsis filimargo* (Krynicki)			II					
26	H	*Oxyloma elegans* (Risso)					III	III	I	
27	H	*Zonitoides nitidus* (O. F. Müller)						I	II	
28	W	*Theodoxus transversalis* (Pfeiffer)						I	I	
29	W	*Lithoglyphus naticoides* (Pfeiffer)					II		II	
30	W	*Galba truncatula* (O. F. Müller)					I	III	II	
31	W	*Radix labiata* (Rossmässler)						II	II	
32	W	*Planorbarius corneus* (Linnaeus)					II			
33	W	*Planorbis planorbis* (Linnaeus)					III	V	II	
34	W	*Gyraulus crista* (Linnaeus)						II		
35	W	*Segmentina nitida* (O. F. Müller)						I		
36	W	*Pisidium casertanum* (Poli)					I	III		

ponents of assemblages described from loess of Central Europe and from areas south of the Carpathians (LOŽEK 1965, ALEXANDROWICZ 1995). The absence of species requiring relatively warm climate is an important feature of this fauna (Table 1).

The archaeological finds derive from another loess outcrop in Muselievo ("the main profile"). It is situated close to Kariera and was described i.a. by MADEYSKA (1977), HAESAERTS & SIRAKOVA (1979) and SIRAKOVA & IVANOVA (1988). In the upper part of the profile loess and sandy loess containing a limited number of snail shells were distinguished. Specimens of *Helicopsis striata*, *Lindholmiola corcyrensis*, *Pupilla muscorum*, *Granaria frumentum* and few other species were found there.

FAUNA OF HOLOCENE FLUVIATILE DEPOSITS

Deposits forming the large terrace on the left bank of the Osam River are well visible in an outcrop about 70 m long and up to 5 m high. They were described in five sections situated about 10–15 m from one another. The whole stratigraphic profile comprises four layers distinguished as F1–F4, each represented by at least five samples, taken in particular sections (Table 1). The bedrock of these deposits is not accessible in the outcrop but close to it gravel and sand crop out as underlying sediment. The sequence of layers from bottom to top is the following:

[F-1] (0.5–2 m): yellow sandy loam and silt with traces of lamination, more or less compact, containing mollusc shells and their fragments, locally numerous. These are mainly land snails with an admixture of aquatic species. A fossil soil with brownish-yellow limonitic intercalations occurs at the top of this layer;

[F-2] (0–1.5 m): grey and dark-grey loamy or sandy silt enriched in organic matter and plant debris, thick in the northern part of the outcrop and decreasing in thickness to the south. It was dated as 3,850±100 years BP (Gd-4276). The mollusc fauna is relatively rich, represented mainly by numerous shells of water snails (Planorbidae). An ancient pavement built of flat limestone fragments up to 30 cm in size covers the silt over a distance of 10–15 m;

[F-3] (1–1.2 m): grey and yellowish-grey silt and loamy silt with thin intercalations of sandy silt or fine-grained sand, containing numerous small shells of land snails with an admixture of aquatic molluscs. Radiocarbon dating indicates the age of 2,610±110 years BP (Gd-4278);

[F-4] (1.5–2 m): yellow sandy silt with few intercalations or lenses of sand and fine-grained gravel. Shells of land snails are relatively numerous. A well developed recent soil crowns the top of this layer.

The mollusc fauna found in the described deposits is relatively rich and diverse (Table 1). The richest assemblage occurs in the lowermost part of the sequence (F-1). Specimens of xerophile snails and open country species constitute nearly 80% of the assemblage, while the proportion of species reflected by the species spectrum (sc) is more equalised (Fig. 2). According to indices C–D (constancy and dominance) the most important components of the fauna are: *Helicopsis striata* (5/5), *Vallonia pulchella* (4/4), *Planorbis planorbis* (5/3), *Cochlicopa lubricella* (4/3) and *Chondrula tridens* (4/3).

A markedly different assemblage occurs in layer F-2 (Table 1). It is composed nearly exclusively of water molluscs reaching about 60% of the taxa and 95% of the specimens (Fig. 2). The dominant species, characterised by the highest C–D indices, are *Planorbis planorbis* (5/5), *Pisidium casertanum* (5/3) and *Galba truncatula* (4/3). Almost all the remaining species are accessory components with the lowest values of C–D indices (1/1).

Snails representing three ecological groups constitute the mollusc assemblage from layer F-3 (3-sm). The most numerous open-country species (over 60% of the specimens) are accompanied by xerophile snails and water molluscs, each group forming about 20% of the specimens. The species spectrum reflects more equalised poportions of particular ecological groups (Fig. 2). *Vallonia pulchella* (5/5), *Helicopsis striata* (5/4) and additionally also *Planorbis planorbis* (4/3) are the most important components of the fauna.

In the uppermost layer (F-4) xerophile snails, accompanied by open-country species, dominate distinctly, which is reflected in the malacospectra of both species and specimens (Fig. 2, 4-sc, 4-sm). These are mainly three species: *Helicopsis striata* (C/D – 5/5), *Vallonia pulchella* (4/4) and *Helicella obvia* (4/3), additionally also *Cochlicopa lubricella* and *Chondrula microtraga* (Table 1). Aquatic molluscs are absent.

INTERPRETATION

The mollusc fauna of Quaternary deposits in Bulgaria, still relatively poorly known, was described mainly by PETRBOK (1925, 1931, 1938, 1948). In several loess outcrops, particularly in the vicinity of Russe and Varna, he found assemblages dominated by xerophile snails typical of a relatively warm climate, such as *Helicella obvia*, *Zebrina detrita*, *Cepaea vindobonensis*, *Chondrula microtraga* and *Granaria frumentum*, accompanied by *Helix pomatia* and *Lindholmiola corcyrensis* (PETRBOK 1925, 1931, 1938, 1940). A fauna with *Pupilla muscorum*, *Succinea oblonga* and *Helicopsis striata* was also reported by him from a few places. These last species

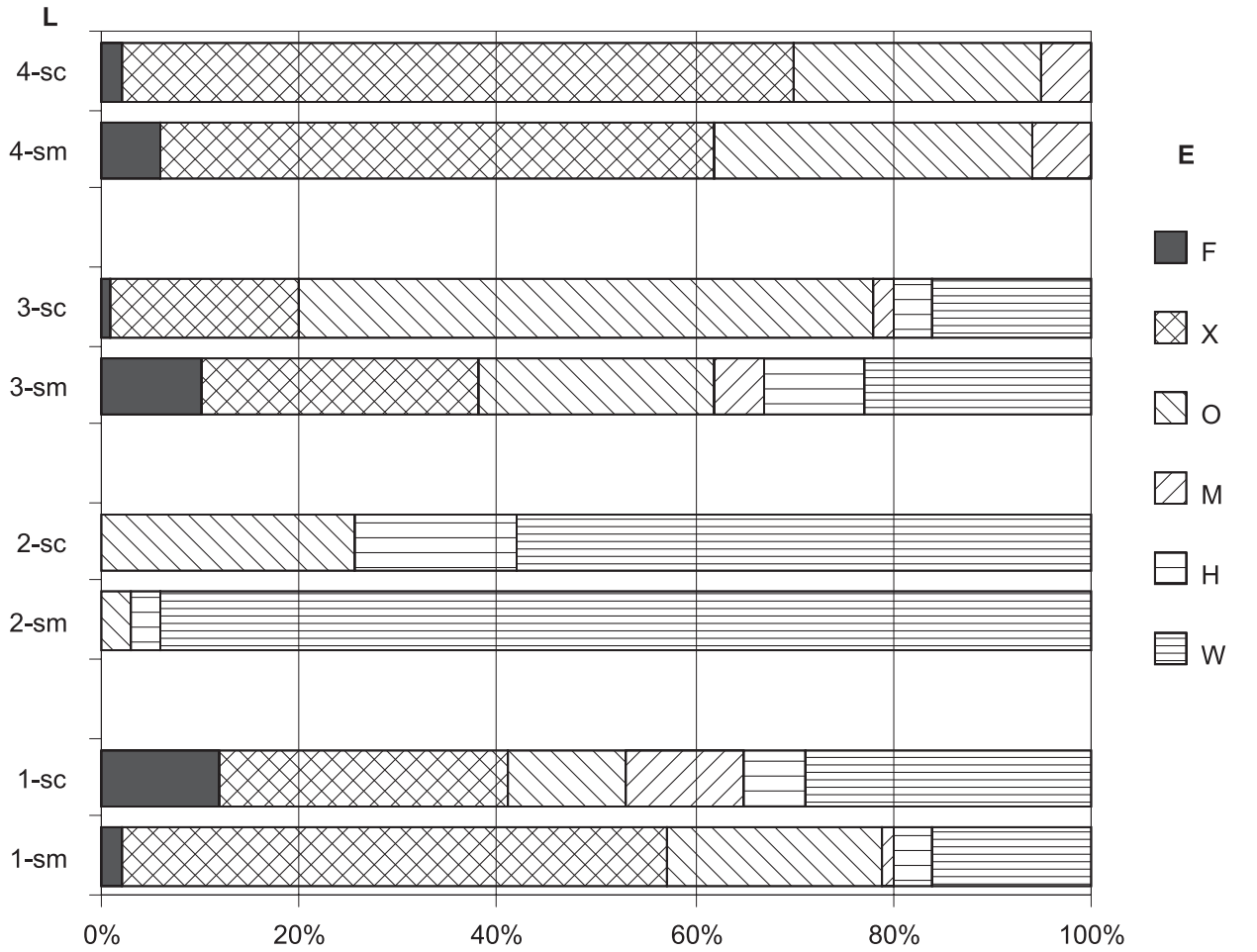

Fig. 2. Ecological spectra of mollusc assemblages from Holocene fluviatile deposits in Muselievo. L – layers 1–4 described in the text, sm – malacospectra of species, sc – malacospectra of specimens, E – ecological groups (for explanations see Table 1)

were interpreted by LOŽEK (1964, 1965) as typical of loess accumulated in cold climatic conditions.

Differences between the mollusc assemblages from the Pleistocene loess of Central Europe on the one hand and from the Balkan or Iberian Peninsulas on the other, mentioned also by PETRBOK (1939) from Macedonia, were later analysed by LOŽEK (BRUNNACKER & LOŽEK 1969, BRUNNACKER et al. 1969, LOŽEK 1978). Based on his studies in the Neretva Valley near Mostar (BRUNNACKER et al. 1969) and in Southern Spain (BRUNNACKER & LOŽEK 1969), he distinguished a South European or Mediterranean type of the mollusc loess-fauna. It is dominated by species living either in the warm/temperate dry climate corresponding to glacial periods (pleniglacials) or in the warm/temperate, more or less humid climate corresponding to interglacials, interstadials or interpleniglacials. Poor snail assemblages, described from loess widespread north of the Carpathians, including species typical of arctic and subarctic steppes and tundra, were found in Southern Europe only in some loess layers of few localities.

According to the archaeological interpretation, the deposits accessible in the lower part of the outcrop Kariera in Muselievo (layers KT and KU) correspond to an interglacial preceding the last glaciation (HAESAERTS & SIRAKOVA 1979), but they may also be assigned to an interstadial of the Lower Vistulian (Würm). The fauna with helicids (*Lindholmiola*, *Helix*, *Helicopsis*, *Helicella*), accompanied by *Zebrina* and *Chondrula* (Table 1, KC), corresponds to the middle part of the last glacial, and partly to an interpleniglacial. A similar fauna was reported from an Aurignacian open-cast archaeological site near Varna (PETRBOK & SKUTIL 1950). On the other hand, the poor mollusc assemblage with *Helicopsis*, *Vallonia* and *Pupilla*, found in the upper part of the mentioned profile (KD), represents the youngest pleniglacial of the Vistulian (Würm). Such assemblages, most similar to the loess fauna from Southern Poland, Slovakia and the Czech Republic (LOŽEK 1964, 1965, ALEXANDROWICZ 1995) were also reported from the environs of Varna by PETRBOK (1925, 1938).

The mollusc fauna of the loess outcrop in the high slopes on the right bank of the Danube near Russe includes 12 species, among others: *Helicopsis striata*, *Granaria frumentum*, *Cepaea vindobonensis*, *Chondrula microtraga* and *Imparietula seductilis*. A similar fauna,

comprising additionally *Pupilla muscorum*, *Chondrula tridens*, *Zebrina detrita*, *Arianta arbustorum* and a few other species, was mentioned by PETRBOK (1925, 1931, 1948) from several loess outcrops between Nikopol and Russe. Subfossil snail shells were found also in cave sediments near Karlukovo, dated as ca. 30 thousand years BP (ALEXANDROWICZ 1992). These are mainly: *Helicopsis striata*, *Chondrula tridens*, *Granaria frumentum*, *Bradybaena fruticum*, and *Monacha cartusiana*. The mentioned assemblages correspond with the fauna from layers KT, KU and KC distinguished in the outcrop Karriera in Musselievo. All the listed species seem to be more or less typical components of Upper Pleistocene mollusc assemblages, which occur both in loess and in sediments filling karst forms.

Molluscs of the Holocene deposits in Bulgaria were described mainly by PETRBOK (1938, 1940, 1948). The fauna found in particular layers forming the terrace of the Osam River in Muselievo is noteworthy in being relatively rich and diverse. The sequence from layers F-1–F-4 begins with an assemblage characterised by the predominance of xerophile and open-country snails, reaching about 80% of the specimens. *Helicopsis striata* and *Vallonia pulchella*, accompanied by a few other species including the hygrophilous snail – *Oxyloma elegans*, are the main components of this assemblage (Fig. 2, 1-sm). Upwards it passes into a quite different assemblage, dominated by water snails, with *Planorbis planorbis* and *Galba truncatula* representing more than 90% of the specimens (Fig. 2, 2-sm). A small water body, which developed periodically on the valley bottom during the Subboreal phase of the Holocene, was inhabited by this kind of fauna.

The third assemblage, from layer F-3, contains mainly open-country snails (more than 60%) accompanied by xerophile and water species (Fig. 2, 3-sm). Shells of *Vallonia* (*V. pulchella* and *V. costata*) and *Helicopsis striata* are most numerous there, the occurrence of *Vertigo pygmaea* and *Bulgarica varnensis* is also noteworthy. The change of the mollusc fauna between the last two mentioned layers (F-2–F-3) falls at the beginning of the Subatlantic phase and follows the appearance of traces of human activity, indicated by the pavement, which covers layer F-2. In the youngest assemblage (F-4) water molluscs are absent, while xerophile snails, represented by four species (*Helicopsis striata, Helicella obvia*, *Chondrula microtraga* and *Cochlicopa lubricella*) and accompanied by *Vallonia pulchella*, clearly prevail (Fig. 2, 4-sm). The same species, accompanied by *Zebrina detrita*, are the main snails living recently on the surface of the described terrace.

The faunas of the Holocene deposits, particularly those from the two youngest layers, can be compared with the recent thanatocoenosis accumulated by the Osam River, found quite close to the mentioned outcrop and described as an assemblage composed of 42 species and over two thousand identified shells (ALEXANDROWICZ 1999a). The main difference between them is the proportion of water molluscs. In the recent river sediments they reach 38% of the species and 66% of the specimens while the respective values for the subfossil assemblage from layer F-3 are 23% and 16%. In layer F-4 they do not occur at all. On the other hand, the land snail fauna is quite similar, and 78% of the species were found both in the river thanatocoenosis and in the subfossil assemblage from the upper part of the terrace deposits. The assemblage should be interpreted as an ancient thanatocoenosis deposited a few thousand years ago.

A relatively poor mollusc fauna was found in the Holocene slope deposits in Karlukovo. It is composed of 16 xerophile and open-country snail species. Four of them: *Pomatias rivulare*, *Chondrula microtraga*, *Zebrina detrita* and *Bulgarica varnensis*, are represented by numerous specimens. This fauna is associated with sunny habitats covered by grass and shrubs, and rich in calcareous rock debris (ALEXANDROWICZ 1992). Similar but richer assemblages occur recently in such habitats in the suroundings of the site.

An interesting fauna of subfossil and living land snails, known also from loess, was described from the archaeological site in the village Gigen (ALEXANDROWICZ 1994). It occurs in ruins of the Roman town Ulpia Oescus, established in the first century AD and destroyed about six hundred years later. These ruins became later covered with grey and yellowish-grey silt with an admixture of humus and thin intercalations of fine-grained sand, interpreted as flood sediments of the Danube. In the past century they were partly dug up during archaeological investigations (BIERNACKA-LUBAŃSKA 1982). The mollusc assemblage found there is composed of 14 taxa. These are mainly snails associated with open, dry habitats such as grassland with trees and shrubs: *Chondrula microtraga*, *Helicopsis striata*, *Helicella obvia*, *Lindholmiola corcyrensis*, *Zebrina detrita*, *Cepaea vindobonensis* and *Pupilla muscorum*. An almost identical recent malacocoenosis inhabits the site at present. Aquatic molluscs are completely absent which indicates that the ruins, in historic times, were not flooded by the river but covered by wind-transported sediments (ALEXANDROWICZ 1994).

The relations between the mollusc faunas from different types of Pleistocene and Holocene deposits in Bulgaria, including the historic period (loess, sediments filling karst forms, fluviatile deposits forming river terraces or aeolic sediments covering ancient ruins) seem to be controlled mainly by the regional type of climate. In areas north of the Carpathians, namely in Poland, these assemblages are dissimilar or even nearly completely different. In Southern Europe they are rather similar; considering terrestrial snails only, about 63% of the species occur in both types of deposits. This is also true of recent malacocoenoses (DAMJANOV & LIKHAREV 1975). In consequence the

mollusc fauna suggests that the differences in climatic conditions between particular phases of glacial and interglacial periods were significantly greater in Central Europe than in the Balkan Peninsula and in the Mediterranean in general.

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