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Molluscs in Eemian-Vistulian deposits of the Kolodiiv section, Ukraine (East Carpathian Foreland) and their palaeoecological interpretation

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A profile of loess several metres thick with palaeosoils, underlain by calcareous gyttja, outcrops in Kolodiiv, Ukraine. Rich and diverse assemblages of molluscs have been found in these deposits. Three types of mollusc communities can be distinguished. The oldest is dominated by freshwater taxa and corresponds to calcareous gyttja of Eemian age. The next two assemblages contain only snails typical of loess. The first of these indicates a cold and dry climate and open environment of arctic steppe type, with rapid accumulation of loess; the second assemblage represents a cold and humid climate and a relatively moist, open environment of tundra type.

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INTRODUCTION

Vistulian loess containing palaeosoil horizons build a well-developed terrace on the right bank of the Sivka River valley (Łanczont and Boguckyj, 2002; Fig. 1). The loess is underlain by palaeosoil, peat and calcareous gyttja of Eemian age. Several profiles of these deposits have been studied using a variety of methods (Madeyska, 2002). The internal structure of the loess terrace of the Sivka River is complex. Selected intervals of the profiles Kolodiiv 2A, 3 and 4 have been investigated malacologically: results from profile Kolodiiv 2A are given in Alexandrowicz *et al*. (2002). The samples represent three phases of sedimentary development (Fig. 2).

In this study, fifteen samples of mollusc bearing deposits have been analyzed (Fig. 2). They contain a rich and diverse fauna of snails and bivalves. The samples were washed and picked for mollusc shells and shell fragments. Some shell fragments could be determined only to genus. Standard methods of malacological analysis described by Ložek (1964) and Alexandrowicz (1987) have been used. Five ecological groups: woodland (F), open-country (O), mesophile (M), hygrophile (H) and freshwater (W) species have been distinguished in individual malacological spectra (MSI). Two-component and triangular diagrams illustrate the diversity of the fauna and the environmental changes.

The entire material comprises 36 species of molluscs including 13 taxa of land snails, 15 of freshwater snails and 8 of bivalves representing by 1069 specimens (Table 1). The number of taxa varied from 2 to 18 per sample, while the number of specimens from 10 to 256 respectively (Fig. 2; Table 1).

MOLLUSCAN ASSEMBLAGES

Three types of molluscan assemblages can be distinguished in profiles in the Kolodiiv section.

ASSEMBLAGE WITH FRESHWATER MOLLUSCS

This community has been found in calcareous gyttja in the lower part of the profile. A high content of freshwater snails and bivalves is characteristic feature of the described fauna (Fig. 2E). Three main groups of water molluscs have been noted. Species inhabiting shallow, temporary water bodies are represented by *Valvata macrostoma* Mörch., *Galba truncatula* (Müll.), *Pisidium obtusale* (Lam.) and others. Taxa typical of

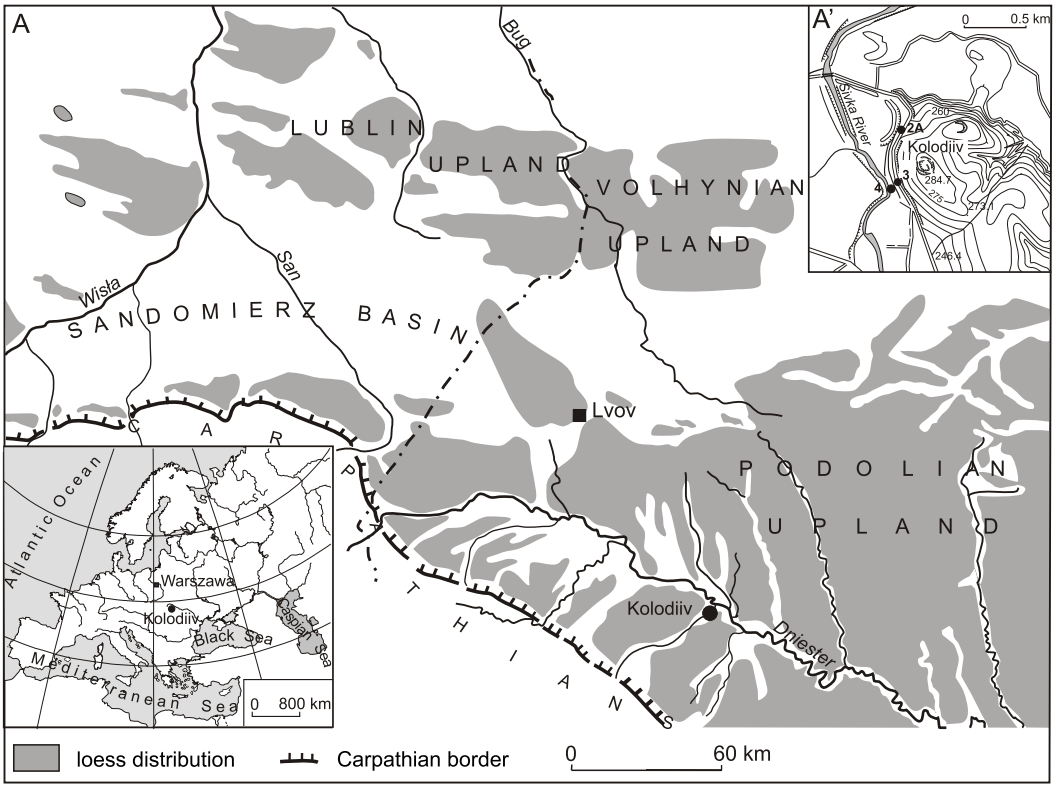

Fig. 1. A — location of profiles investigated at Kolodiiv; A' — sketch map of loess regional distribution (after Łanczont and Boguckyj, 2007)

permanent water bodies with a rich plant vegetation (*Valvata piscinalis* (Müll.), *Valvata cristata* (Müll.), *Sphaerium corneum* (L.) and others) belong to the second group. The last group comprises snails and bivalves living in slowly flowing rivers (*Pisidium nitidum* Jen., *Pisidium henslovanum* (Shep.)). Terrestial species were noted only as single specimens (Fig. 2, E, As; Table 1). This community is associated with a phase of relatively warm climate and the development of a small water body.

ASSEMBLAGE WITH PUPILLA

This fauna corresponds to loess in the middle and upper part of the sequence (Fig. 2, E, As; Table 1). This is a typical loess community (Ložek, 1965, 1990; Alexandrowicz, 1995). *Pupilla muscorum* (L.) and *Pupilla muscorum loessica* Ložek supplemented by *Vallonia tenuilabris* Braun are the main components of this community. According to earlier biometrical data, *Pupilla loessica* Ložek should be regarded as an ecotype of *Pupilla muscorum* (L.) adapted to a cold, periglacial climate and rapid accumulation of loess (Łopuszyńska, 2002). The community with Pupilla corresponds to a cold and dry climate and an open environment of arctic steppe type.

ASSEMBLAGE WITH SUCCINEA OBLONGA

The subspecies *Succinea oblonga elongata* Standb. (Ložek 1965, 1991; Alexandrowicz, 1995 and many other authors) has commonly been recorded in loess. However, biometrical analysis indicates that this subspecies is not a valid taxon (Łopuszyńska, 2002). The principal component of the community described is the nominal taxon accompanied by hygrophilous species such as *Vertigo parcedentata* (Braun) and *Vertigo genesii* (Gred.). A single specimen the freshwater mollusc *Radix labiata* (Rossm.) was noted. This fauna corresponds to a cold and humid climate and a relatively moist, open environment of tundra type. The community described occurs in the upper part of the sequence. It seems to correspond to the lowermost part of the loess succession overlying the Dubno soil horizon (Fig. 2, E, As; Table 1).

CONCLUSIONS

The molluscan assemblages described above reflect the evolution of environments associated with loess accumulation at Kolodiiv. The oldest community of molluscs occurs in calcareous gyttja in the lower part of the sequence (Fig. 3). Calcareous deposits fill the small lake basin. The fauna is dominated by freshwater species (Fig. 3, D), the malacological sequence reflecting the development of this water body. At first a small and shallow kettle was formed. This was inhabited by a relatively rich community with a high content of species typical of temporary water bodies. Higher in the kettle succession the water body became more permanent and deeper (Fig. 3, T_{II}). Species of snails and bivalves of wide ecological tolerance prevail and most probably are those of the Eemian Interglacial period. A single shell of a cold-loving taxon was found only in the up-

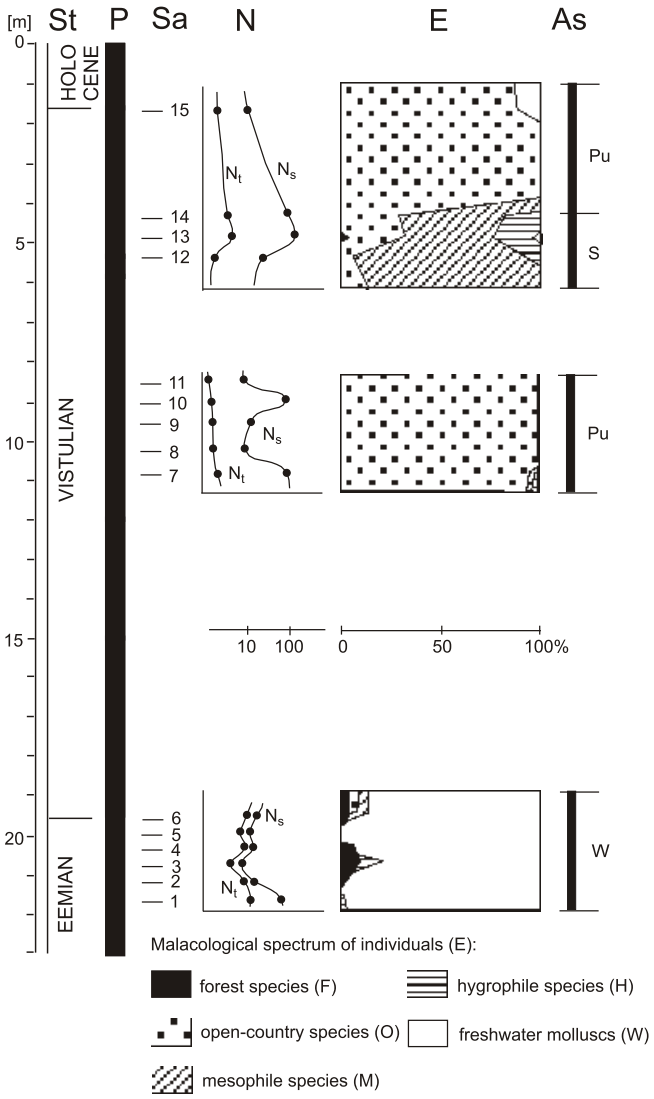

Fig. 2. Malacofauna of the loess at Kolodiiv

St — stratigraphy, P — profile, Sa — samples, N — number of species (N_t) and specimens (N_s), As — molluscan assemblage: Pu — assemblage with Pupilla, S — assemblage with Succinea oblonga, W — assemblage with freshwater molluscs

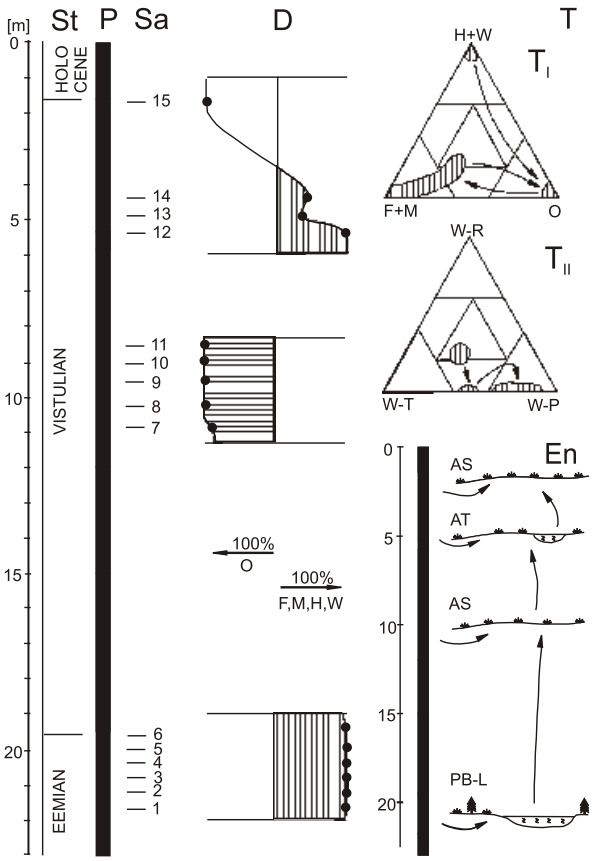

Fig. 3. Molluscan successions of the loess at Kolodiiv

D — two-component diagram; T — triangular diagrams: T_I — environmental changes, T_{II} — changes of freshwater molluscs: W-T — species of temporary water bodies, W-P — species of permanent water bodies, W-R — species of flowing water; En — evolution of the environment: AT — arctic tundra, AS — arctic steppe, PB — peatbog, L — lake; other explanations as in Figure 2

permost part of the interval described. Calcareous gyttja laterally passing into peat and palaeosoil belong to the Kolodiiv succession (Łanczont and Boguckyj, 2002). This is overlain by Early Vistulian palaeosoils completely devoid of malacofauna (Alexandrowicz *et al*., 2002). The succeeding snail community has been found in loess locally developed between the Kolodiiv and Dubno soil horizons and in the lower part of the Dubno palaeosoil. This community corresponds with a cold climate and with a dry open environment typical of arctic steppe (Fig. 3, D, T_I, En). A poor and less diverse fauna dominated by *Pupilla muscorum* (L.) was recognized in this interval. The presence of the ecotype *Pupilla muscorum loessica* Ložek indicates the first phase of increase in the rate of loess accumulation. The youngest molluscan assemblages occur in the loess overlying the Dubno soil horizon. The malacological succession begins with a community dominated by *Succinea oblonga* Drap. accompanied by hygrophilous snails. This fauna corresponds to an interval of milder and more humid climate (Fig. 3, D, T_I, En). The second phase of increased loess accumulation is marked by the occurrence of a fauna with Pupilla in the uppermost interval of the profile described. This may correspond to the Upper Pleniglacial.

The mollusc fauna described from Kolodiiv reflect both the evolution of climate and the differentiation of habitats and environment. The sequence of molluscan assemblages may be related to models of the development of molluscan communities described from Ukraine (Alexandrowicz *et al*., 2002), South Poland (Alexandrowicz, 1995), the Czech Republic (Ložek, 1965, 1990) and even in west Europe (Remy, 1969; Puissegur, 1978).

Photographs of selected species described from the Eemian calcareous gyttja and Vistulian loess are shown on Figures 4 and 5.

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Table 1

Malacological composition of the Kolodiiv site

E	Taxon	KOLODIIV														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
F	*Discus rotundatus*			1	1		1									
F	*Semilimax kotulae*													1		
F	*Monachoides vicinus*		1		1											
O	*Pupilla muscorum*							103	10	21	70	6	3	34	18	9
O	*Pupilla muscorum loessica*							57	12	11	54	5		43	25	8
O	*Vallonia tenuilabris*								2	1	14					
O	*Euomphalia strigella*						1									
M	*Carychium tridentatum*						1									
M	*Succinea oblonga*							3					33	110	70	
M	*Columella columella*												11	18	13	
H	*Succinea putris*	1		1				3							5	
H	*Vertigo genesii*													10		
H	*Vertigo parcedentata*													40	23	
W	*Valvata piscinalis*	12			4		3									
W	*Valvata cristata*	5	3		3		4									
W	*Valvata macrostoma*	23	4													
W	*Stagnicola palustris*	1														
W	*Radix labiata*	7	3			2								10		1
W	*Galba truncatula*		4	1		1										
W	*Planorbis carinatus*				1	1										
W	*Anisus vortex*				4	4										
W	*Gyraulus albus*	3	3		2	2	7									
W	*Gyraulus laevis*															2
W	*Gyraulus gredleri*	2	2		3	6	8									
W	*Gyraulus crista*	1		1	3	1	3									
W	*Segmentina nitida*	1	1													
W	*Acroloxus lacustris*	1	3	1	1											
W	*Ancylus fluviatilis*	1														
W	*Sphaerium corneum*	2	2	2	2	2	2									
W	*Pisidium nitidum*	20					2									
W	*Pisidium pseudosphaerium*	1														
W	*Pisidium obtusale*	7			2											
W	*Pisidium casertanum*		3	3	3	2										
W	*Pisidium lillieborgi*						2									
W	*Pisidium supinum*	3														
W	*Pisidium henslovanum*	3					2									
Total		**94**	**29**	**10**	**30**	**21**	**36**	**166**	**24**	**33**	**138**	**11**	**47**	**256**	**154**	**20**

Other explanations as in Figure 2

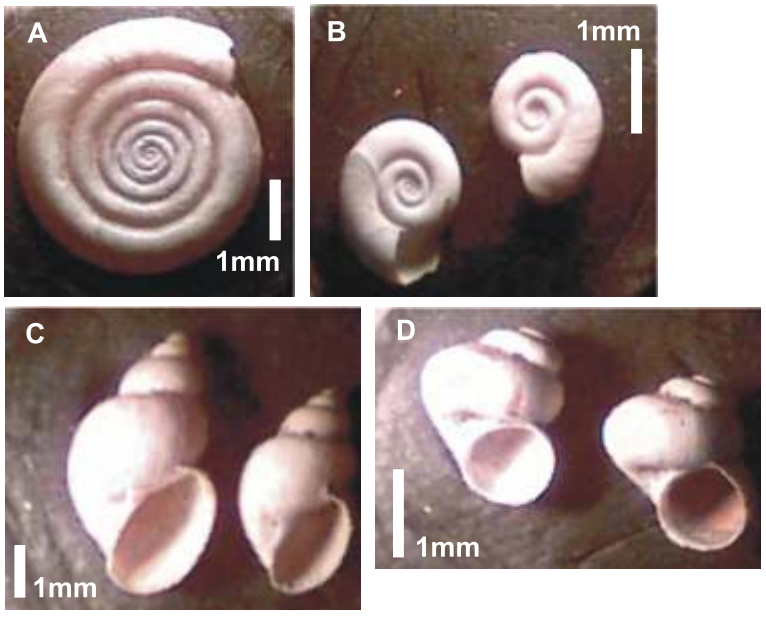

Fig. 4. Species of molluscs from Eemian calcareous gyttja

A — *Anisus vortex* (Linnaeus); **B** — *Gyraulus albus* (Müller); **C** — *Galba truncatula* (Müller); **D** — *Valvata piscinalis* (Müller)

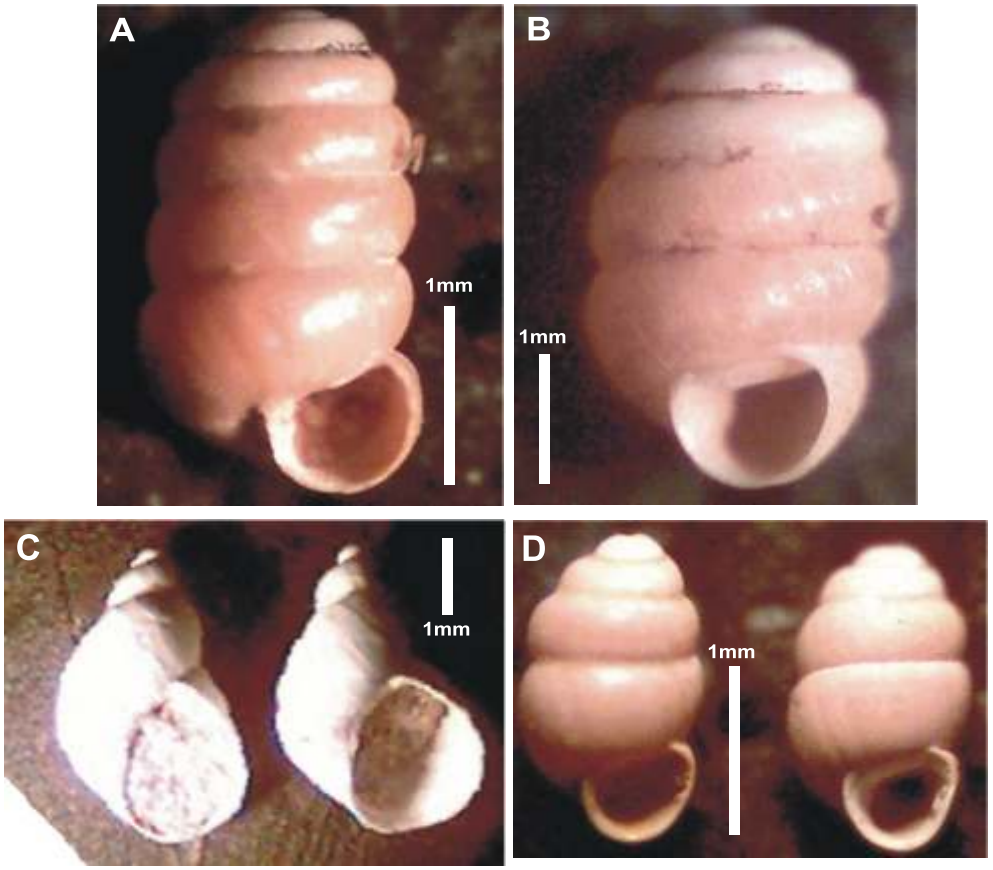

Fig. 5. Species of molluscs from Vistulian loess

A — *Columella columella* (G. von Martens); **B** — *Pupilla muscorum loessica* Ložek; **C** — *Succinea oblonga* Draparnaud; **D** — *Vertigo parcedentata* (Braun)

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