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PAVEL BOSÁK, JERZY GŁAZEK, IVAN HORÁČEK & ADAM SZYNKIEWICZ

New locality of Early Pleistocene vertebrates – Żabia Cave at Podlesice, Central Poland

ABSTRACT: Żabia Cave at Podlesice in the Cracow-Wieluń Upland, Central Poland, is the vertical pit filled with complex sequence of deposits containing rich vertebrate fauna. The presence of *Microtus (Allophaiomys) pliocaenicus* (Kormos), as well as *Ungaromys nanus* Kormos, *Mimomys* cf. *pusillus* Méhely, *Lagurodon arankae* Kretzoi, *Beremendia fissidens* Petényi, and *Sorex (Drepanosorex)* cf. *pachyodon* Pasa indicates low-Lower Biharian age of the locality. The stratigraphic correlation with well known localities of Early Pleistocene vertebrates in Poland (Kadzielnia, Kamyk, and Kozi Grzbiet) is briefly discussed.

INTRODUCTION

The central part of the Cracow-Wieluń Upland is built up of gently deeping to the north-east Upper Jurassic limestones which are partly covered by Pleistocene outwash sands. The tops of the Upland formed by massive Oxfordian limestones reach 504 m a.s.l. According to Różycki (1960, 1967, 1972, 1979), this area was not covered by continental glaciations and during the San Glaciation (Elsterian *II*) formed the concave nunatak (*cf*. Text-fig. 1*A*), while during the Odra Glaciation (Saale *I*) it stood out as the elevation in the glacier foreland. The outwash sands covering the hill sides reach the level of *c*. 420 m a.s.l.

The village Podlesice in the center of Cracow-Wieluń Upland is well known due to the discovery of fossil vertebrates (Kowalski 1951) in the Podlesice Cave at the slope of Dudnik Hill (*cf.* Text-fig. 1*B*). The stratigraphic interpretation of the locality has long been discussed (*e.g.* Kowalski 1956, 1962, 1964, 1974; Rzebik-Kowalska 1976). The geological investigations show that accumulations of fossiliferous layers were interrupted by several erosional events and interbedded by thick barren layers of calcite flowstone; it suggests this fauna represents a considerable long span of time (Upper Miocene to Upper Pliocene; *cf.* Głazek 1973).

The new locality in the Żabia (*Frog*) Cave (50°34′25″ N, 19°31′11″ E) was discovered by members of the Student Caving and Climbing Club of the Silesian Medi-

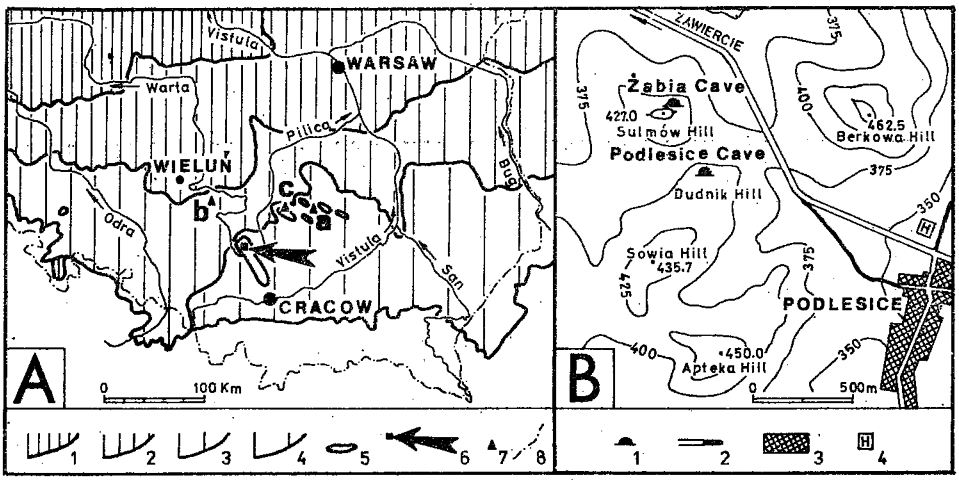

Fig. 1. General location of discussed sites

A — Limits of continental glaciations in south-central Poland (*after* Różycki 1972, 1979) in relation to the investigated localities (arrowed is the Żabia Cave): *1* Vistulian (Weichsel) Glaciation, *2* Warta (Warthe) Glaciation, *3* Odra (Saale *I*) Glaciation, *4* San (Elster *II*) Glaciation, *5* nunataks during the San (Elster *II*) Glaciation, *6* investigated area near Podlesice (*see* Text-fig. *1B*), *7* Early Pleistocene vertebrate localities (**a** — Kadzielnia, **b** — Kamyk, **c** — Kozi Grzbiet), *8* state boundary

B — Topographic sketch of the Podlesice area: *1* caves containing vertebrate-bearing deposits, *2* roads and cart-roads, *3* buildings, *4* turist hotel

cal University (*cf.* Mazik 1979) and presented to the authors during the 13th Speleological Symposium at Podlesice. The preliminary geological investigation and paleontological evaluations of test samples taken at that time are discussed in this paper. Further investigations on this locality will be sponsored by Polish Academy of Sciences as a part of the *MR II. 3* project.

The field observations and samples reported have been collected by P. Bosák, J. Głazek and A. Szynkiewicz. Paleontological and stratigraphic data have been contributed by I. Horáček, while J. Głazek and A. Szynkiewicz are responsible for the final version of the paper and for regional correlations.

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soczański-Minkowicz (Geological Institute, Polish Academy of Sciences, Warsaw) and Dr. A. Sulimski (Paleobiological Institute, Polish Academy of Sciences, Warsaw) for discussion on stratigraphic problems, and to Dr. O. Fejfar (Geological Survey of Czechoslovakia, Praha) for stimulating remarks.

DESCRIPTION OF THE CAVE

The Żabia Cave (406.3 m a.s.l.), was discovered in the northern slope of the Sulmów Hill (427 m a.s.l.), NW of Podlesice (*cf.* Text-fig. 1*B*). The cave is developed in massive Oxfordian limestones and the total depth of the excavated part attained 18.5 m in 1979. The cave consists of three shafts (*I—III* in Text-fig. 2), jointed with two cave levels, each composed of one chamber with side passages. The Entrance Shaft (*I* in Text-fig. 2*A*) and passage entering the upper chamber (Triangle Chamber)

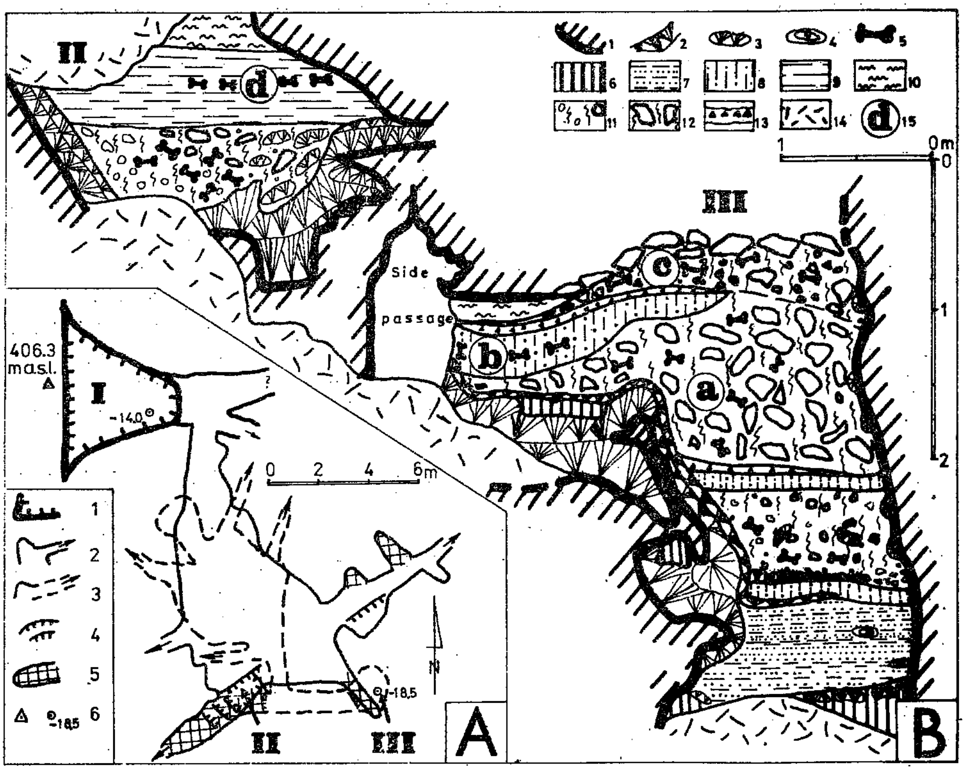


Fig. 2. Żabia (*Frog*) Cave and its deposits

A — Sketch map of the cave: *1* surface outline of the Entrance Shaft, *2* outline of upper cave level, *3* outline of lower cave level, *4* sharp drop in floor, *5* flowstones, *6* important survey stations (figures inside the cave denote depth from the surface); *I* — Entrance Shaft, *II* — Cold Treshold Shaft, *III* — Frdog Shaft **B** — West-east section of cave deposits in the Cold Treshold Shaft (*II*) and Frog Shaft (*III*): *1* limestone walls, *2* calcite flowstones, *3* flowstone debris, *4* carbonate-clayey concretions, *5* bones, *6* red clays, *7* layered silt and fine sands, *8* brown cave loams, *9* laminated brown clays, *10* laminated gray silts, *11* brown cave loams with corroded fine debris of limestones, *12* brown cave loams with corroded limestone boulders, *13* corroded fine debris of limestones in red brown silty-clayey matrix, *14* limestones scree, *15* location of samples (*cf.* Table 1) were completely filled with limestone scree, while the deeper parts of the cave were partly filled with speleothems and clastic sediments. In the second and third shaft (*II—III* in Text-fig. 2*B*), the cave sediments with bone material have been exposed during excavations.

DESCRIPTION OF CAVE DEPOSITS

The cave walls are covered by layered coarse crystalline calcite. The top part of calcite partly consists of fine-laminated flowstone. The lower part of the section exposed in the shaft *III* (Text-fig. 2*B*) consists of red clays, at the top of which fragments of corroded calcite flowstones appear. The top of these clays is eroded, and covered by laminated sediments up to 80 cm thick. Light gray laminae (to 5 mm thick) are formed by silts (redeposited loess?), whereas dark laminae (to 10 mm thick) are composed of fine-grained sands with fragments of clays. Sandy laminae display distinct cross- and lense-shaped internal lamination. In places these laminated sediments contain small clayey-carbonate concretions. Next layer of laminated flowstone is strongly fractured and corroded. The weathered flowstone-crust is overlain by brown silty cave loams. These loams are overlain by next corroded flowstone layer. The sequence continues by brown silty clays with an admixture of fine sand, as well as fragments of corroded limestones and coarse crystalline calcite. These clays contain bones which however have not been investigated yet; the thickness of the layer reaches 70 cm. The overlying thin layer of silty-clayey loam is covered with thin layer of brown cave loam with fine strongly corroded limestone debris. The whole discussed sequence is covered by thick brown clayey-sandy cave loam with corroded boulders of limestones (diameter to 25 cm) and coarse crystalline calcite. This deposit contains bones of large vertebrates and numerous remains of small vertebrates (samples *a-c* in Text-fig. 2*B* and Table 1).

The upper part of cave filling deposits is exposed in the shaft *II* (Text-fig. 2*B*), where crystalline flowstones are overlain by brown cave loam with numerous corroded debris of limestones and flowstones. These deposits contain bones of large vertebrates. Over eroded loams brown laminated clays with bones of small vertebrates occur (sample *d* in Text-fig. 2*B* and Table 1). The top of sequence is formed by gray sandy clay covered by limestone scree.

THE FAUNA AND ITS STRATIGRAPHIC SIGNIFICANCE

From four test-samples (0.5—1.5 kg) of cave deposits (*a-d* in Text--fig. 2*B*) a relatively rich material of fossil vertebrates was obtained (*see* Table 1 and Pls 1 and 2) by washing.

The presence of the vole, *Microtus (Allophaiomys) pliocaenicus* (Kormos), the index fossil (Pl. 2, Figs 15—17) of the Lower Biharian represents the key for stratigraphic interpretation of the faunal assemblage. The FAD — first appearance datum — of *Microtus (Allophaiomys) pliocaenicus* defines the beginning of the Biharian and the absence of *Allop-*

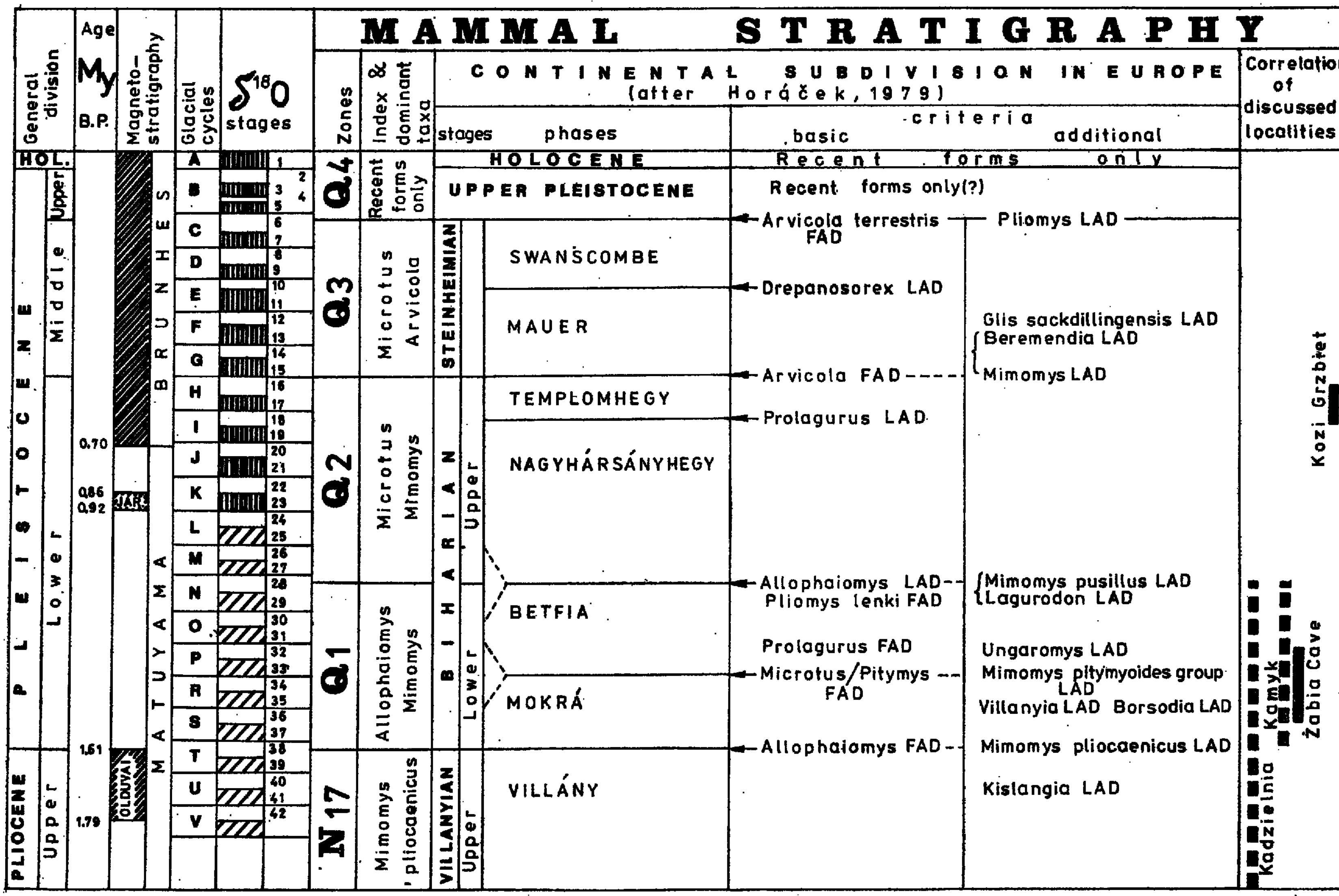
haiomys-like morphotypes does characterise the *Microtus* spp. populations in the Upper Biharian (*see* Text-fig. 3). The additional important feature is abundant occurrence of Villanyian faunal elements which disappeared at the end of the low-Lower Biharian, e.g.: *Ungaromys nanus*

Table 1

Species composition of fossil-bearing samples taken from the Żabia Cave at Podlesice (minimal numbers of individuals)

Taxon	Sample no.				Total
	a	b	c	d	
Celtis sp. /semina/	-	-	-	3	3
Pisces, Cypriniformes g. sp.	-	1	-	-	1
Amphibia, Anura g. sp.	-	1	1	1	3
Bufo bufo Linnaeus	-	-	1	-	1
Bombina cf. veriegata Linnaeus	-	-	1	-	1
Rana cf. temporaria Linnaeus	-	-	1	-	1
Rana cf. arvalis Nilsson	-	-	5	-	5
Reptilia, Lacertilia g. sp.	-	1	3	?	4
Anguis sp.	-	-	1	3	4
Ophidia cf. Elaphe sp.	-	-	-	3	3
Aves, Passeriformes g. sp.	-	1	-	-	1
Lyrurus tetrix Linnaeus	1	-	2	-	3
Tetrao urogallus Linnaeus	-	-	1	-	1
Mammalia					
Sorex cf. minutus Linnaeus	1	1	1	5	8
Sorex aff. runtonensis Hinton	6	5	6	1	18
Sorex ex gr. pachyodon/margaritodon	2	6	4	-	12
Episoriculus cf. castellarini /Pasa/	-	-	-	1	1
Beremendia fissidens /Petényi/	-	2	7	7	16
Petenyia cf. hungarica Kormos	-	-	-	1	1
Crocidura cf. kornfeldi Kormos	-	-	-	1	1
Talpa cf. minor Freudenburg	-	2	2	5	9
Erinaceus sp.	-	-	1	-	1
Myotis sp. cf. nattereri /Kuhl/	1	1	1	1	4
Myotis sp. ex gr. bechsteini /Kuhl/	-	1	1	-	2
Sciurus sp.	-	-	-	1	1
Glis cf. sackdillingensis /Heller/	-	-	-	1	1
Muscardinus cf. avellanarius Linnaeus	-	1	3	-	4
Sicista sp.	4	-	1	-	5
Apodemus /Sylvimus/ sp.	-	-	8	6	14
Cricetus cricetus nanus Schaub	3	8	4	1	16
Allocricetus cf. ex gr. bursae/ehiki	-	1	2	2	5
Ungaromys nanus Kormos	2	-	-	9	11
Pliomys episcopalis Méhely	1	1	12	5	19
Clethrionomys cf. sebaldi Heller	-	5	2	-	7
Mimomys cf. pusillus Méhely	1	5	3	?	9
Mimomys aff. savini Hinton	-	2	1	-	3
Microtus /Allophaiomys/ pliocaenicus /Kormos/	8	12	3	-	23
Lagurodon cf. arankae Kretzoi	1	1	-	-	2
Lemmus sp.	-	-	1	-	1
Ochotona sp.	1	4	1	-	6
Carnivora, Mustelidae	+	+	+	-	+
Carnivora, Canidae	+	?	?	-	+
Carnivora, Ursidae	?	-	?	-	+
Artiodactyla, Bovidae	?	-	+	-	+
Total no. of individuals	33	66	85	51	235
Total no. of species	15	22	31	19	42

Assignation of Early Pleistocene localities of mammalian fauna in Poland to the Central European Pleistocene zonation presented by Horàček (1979)



Kormos (*see* Pl. 2, Fig. 12), *Mimomys* cf. *pusillus* Méhely (*see* Pl. 2, Fig. 13), *Lagurodon arankae* Kretzoi (*see* Pl. 2, Fig. 14). The patterns of the morphological diversification in stratigraphically significant forms seem generally to be less advanced in the Żabia Cave than in those of the high-Lower Biharian localities, e.g. Betfia *2*, Monte Peglia, Mass Rambaul, Včeláre *4*, Chlum *6*, and Holštejn (*cf.* Chaline 1972, Fejfar & Horáček 1981, van der Meulen 1973). The degree of M_1 and M^3 differentiation in the *Microtus (Allophaiomys) pliocaenicus* (Kormos) population from the Żabia Cave (Pl. 2, Figs 15—17) approximately corresponds to the situation in populations from the localities Mokrá *1* near Brno, Včeláre *3*, or Osztrámos *8* (directly compared materials). In comparison with those localities, the population from the Żabia Cave seems to exhibit somewhat higher homogeneity in the formation of morphological and metrical characters and generally slightly higher rate of the evolutionary differentiation. Similarly, in the shrew *Sorex (Drepanosorex)* cf. *pachyodon* Pasa (*see* Pl. 1, Figs 3—4) the degree of evolutionary progressivity (the creating of the typical subgeneric characters) seems to be somewhat higher in the Żabia Cave material than that in the nominate form from the Soave Cava Sud, and in the Villanyian form *Sorex praearaneus* Kormos from the locality Villány *3* or Tegelen, but distinctly lower than these characters of the typical Biharian species *Sorex (Drepanosorex) margaritodon* Kormos (directly compared with the material from localities Včeláre *4*, Chlum *6*, and Holštejn representing the Betfia phase).

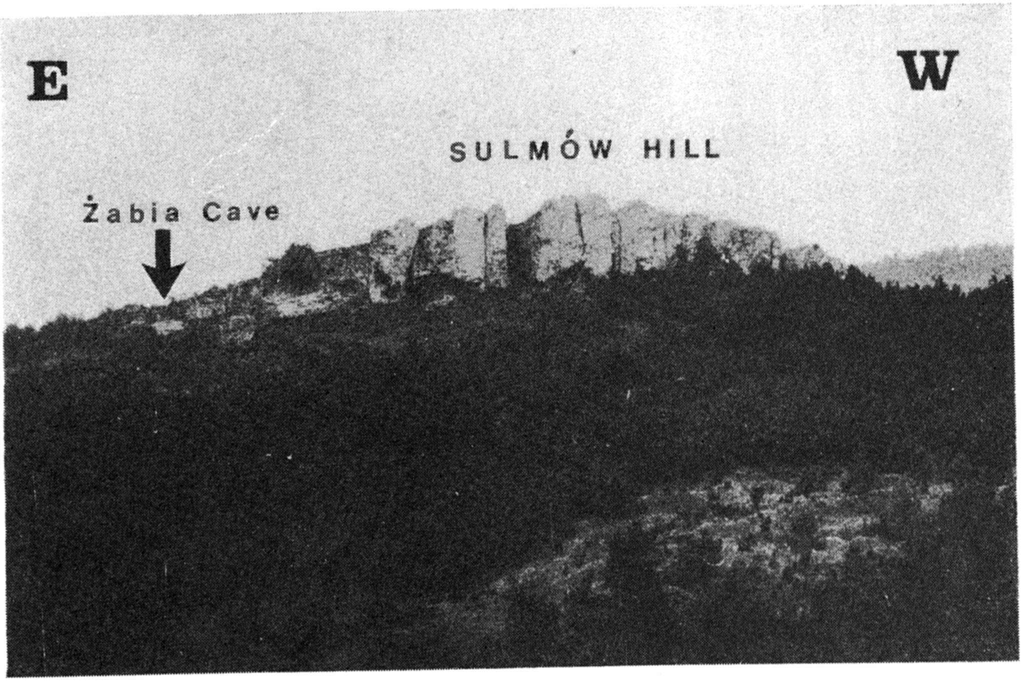
The assemblage of the Żabia Cave is thus younger than the Villanyian and older than the high-Lower Biharian, as apparently resulted from the above listed patterns. The most probable stratigraphic position of the fauna from the Żabia Cave is then: the low-Lower Biharian, the higher part of its lowermost phase Mokrá (Text-fig. 3).

PLATE 1

Northern view of the Sulmów Hill, to show location of the Żabia Cave (*photo A. Szynkiewicz*), and the fossil shrews (Mammalia, Insectivora) from the cave

1 — *Sorex* cf. *praealpinus* Heller, left mandibular fragment, sample *a*; **2** — *Sorex* cf. *praealpinus* Heller (?), right mandibular fragment, sample *a*; **3** — *Sorex (Drepanosorex)* cf. *pachyodon* Pasa, right I^1, sample *a*; **4a** — *Sorex (Drepanosorex* cf. *pachyodon* Pasa, right mandibular fragment, sample *a*; **4b** — caudal view of the condylar processus of the same specimen; **5** — *Beremendia fissidens* (Petényi), left mandibular fragment with M_1—M_3, sample *c*

All drawings by I. Horáček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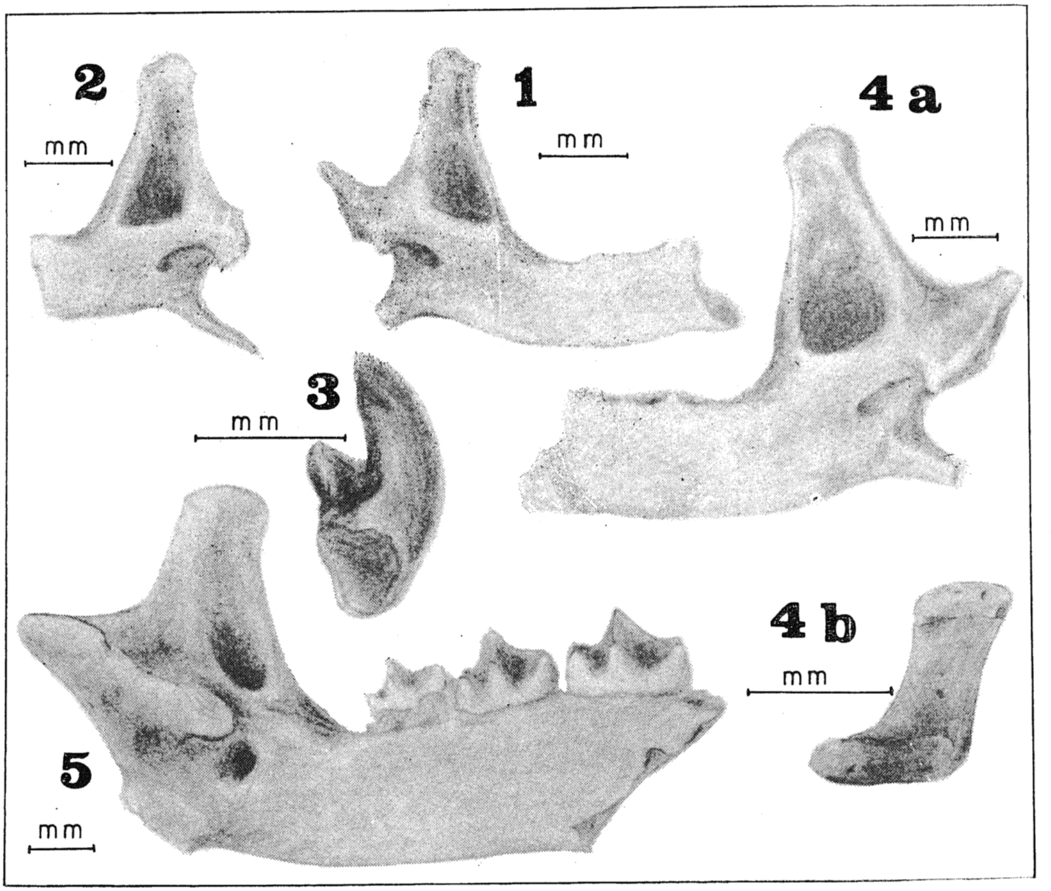
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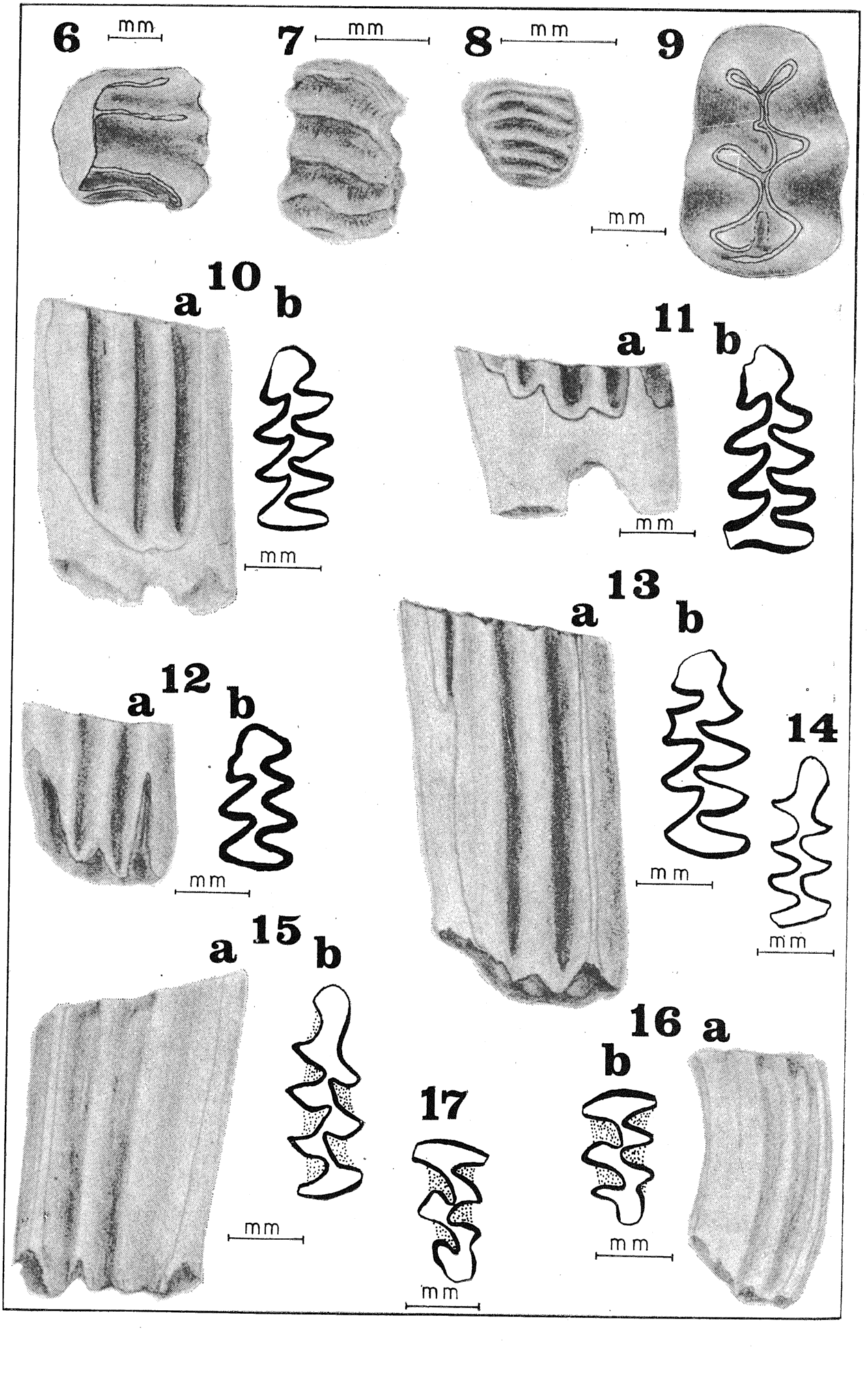
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DISCUSSION

Although the faunal evidence is still poor to enable serious paleoenvironmental analysis, the differences in composition appeared among samples indicate different ecological conditions. The assemblage found in sample *a* represents the beginning of an interglacial; the expressive share of steppe forms *Cricetus*, *Microtus* and forms of mesophile forest *Sicista*, *Sorex*, etc. The assemblage of the sample *b* points to the forest phase; the presence of forest termophilous taxa like *Muscardinus*, *Mimomys* spp., *Beremendia*, aside steppe forms. The assemblage found in the sample *c* suggests xerothermic forest-steppe conditions; the dominance of *Pliomys episcopalis* Méhely, *Apodemus*, and *Beremendia*. The fauna found in the sample *d* indicates the presence of relatively warm forest and open areas environment (comp. *Sciurus*, *Beremendia*, *Anguis*, *Cricetus*, *Elaphe*). It consequently appears that several phases of the development of the glacial cycle or cycles in the basal Quaternary is proved in the Żabia Cave.

The reported fauna from Żabia Cave in comparison with the other localities of Early Pleistocene vertebrates in Poland has many common features with that from Kamyk (*cf*. Text-fig. 1*A*). At Kamyk, the fauna was found in the layered filling of karst fissure (Mossoczy 1958), but its paleontological description (Kowalski 1960) did not offer any location of the fossils within the sequence, and thus any precise correlation with this locality can not be presented. Generally, the fauna from Kamyk belongs to the Lower Biharian (*cf*. van der Meulen 1973; *see also* Text-fig. 3), to the Mokrá and/or Betfia phases, as pointed by the presence of *Microtus (Allophaiomys) pliocaenicus* (Kormos).

The comparison of the Żabia Cave fauna with that from Kadzielnia (*cf*. Text-fig. 1*A*) is difficult. This locality has never been geologically studied, and all the fossils were collected in different places within the

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PLATE 2

Fossil rodents (Mammalia, Rodentia) from the Żabia Cave

6 — *Sciurus* sp., occlusal view of left M^2, sample *d*; **7** — *Muscardinus* sp., right M^1, sample *b*; **8** — *Muscardinus* sp., left M_3, sample *b*; **9** — *Cricetus cricetus nanus* Schaub, right M_1, sample *a*; **10** — *Pliomys episcopalis* Méhely, right M_1, sample *c* (*10a* lingual view, *10b* occlusal surface); **11** — *Pliomys episcopalis* Méhely, right M_1, sample *c* (*11a* lingual view, *11b* occlusal surface); **12** — *Ungaromys nanus* Kormos, right M_1, sample *d* (*12a* lingual view, *12b* occlusal surface); **13** — *Mimomys* cf. *pusillus* Méhely; right M_1, sample *a* (*13a* lingual view, *13b* occlusal surface); **14** — *Lagurodon arankae* Kretzoi, left M_1, sample *a* (occlusal surface); **15** — *Microtus (Allophaiomys) pliocaenicus* (Kormos), left M_1 sample *b* (*15a* lingual view, *15b* occlusal surface); **16** and **17** — *Microtus (Allophaiomys) pliocaenicus* (Kormos), two right M^3, sample *a* (*16a* lingual view, *16b* and *17* occlusal surface).

All drawings by I. Horáček

quarry (Kowalski 1958). The occurrence (*see* Kowalski *in* Bartolomei & *al.* 1975) of *Mimomys pliocaenicus* (Major) with "*Allophaiomys* sp.", *Pliomys lenki* (Heller), *Villanyia exilis* Kretzoi and *Ungaromys* sp., suggests a mixed assemblage with forms of both Villanyian and Lower Biharian age (*cf.* Text-fig. 3). For this reason the Kadzielnia locality can not serve as *Pliomys lenki* FAD (*cf.* Kowalski *in* Bartolomei & *al.* 1975, p. 422).

Finally, the fauna from Kozi Grzbiet (*cf.* Text-fig. 1*A*) is evidently younger (*cf.* Text-fig 3), as demonstrated by the presence of *Dicrostonyx simplicior* Fejfar and *Pitymys gregaloides* Hinton, associated with *Beremendia fissidens* (Petényi), *Mimomys savini* Hinton, *Pliomys lenki* (Heller) in deposits with normal remanent magnetisation — Brunhes Epoch (*cf.* Kowalski *in* Bartolomei & *al.* 1975; Głazek & *al.* 1976, 1977).

CONCLUSIONS

The Żabia Cave is a vertical cavern filled with a composed sequence of sediments. The genesis of the filling has not yet been completely clear. Even the possibility of the glacial origin of the sandy and loess-like accumulations can not be excluded. Characters of the faunal assemblage allow the dating of vertebrates from the Żabia Cave as the lowest phase of the Biharian stage (*i.e.* phase Mokrá *sensu* Horáček 1979, or Villány 5 — Ostámos 8 *sensu* Fejfar & Horáček 1981). The beginning of the Biharian, *i.e.* FAD of *Microtus (Allophaiomys) pliocaenicus*, corresponds to the end of the Olduvai polarity event (*i.e.*, 1.61 My B.P.) and is frequently accepted as a Pliocene/Pleistocene boundary (Haq & *al.* 1977, Horáček 1979). The stratigraphical position of the basal Biharian fauna from the Żabia Cave is delimited by glacial cycles P-S (*sensu* Kukla 1977, 1978) which then correspond to 32—36 stages in $\delta\,^{18}O$ stratigraphy, *i.e.* approximately 1.4—1.55 My B.P. (*cf.* Text-fig. 3).

The analysis of the obtained material indicates also that several climatic phases of the basal Quaternary are lithologically and paleontologically represented in the locality, and thus further precise investigations of the Żabia Cave are needed, and stratigraphy of the Early Pleistocene may substantially be here supplemented.

Department of Geology
of the Charles University,
Albertov 6
128 43 Praha 2, CSSR
(P. Bosák)

Institute of Geology
of the Warsaw University,
Al. Żwirki i Wigury 93
02-089 Warszawa, Poland
(J. Głazek & A. Szynkiewicz)

Laboratory of Quaternary Geology
of the Institute of Geology and Geotechnics,
Navratilova 12,
110 00 Praha 1, CSSR
(I. Horáček)

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P. BOSÁK, J. GŁAZEK, I. HORÁČEK i A. SZYNKIEWICZ

STANOWISKO WCZESNO-PLEJSTOCEŃSKICH KRĘGOWCÓW W JASKINI ŻABIEJ KOŁO PODLESIC

(Streszczenie)

Jaskinia Żabia koło Podlesic na Wyżynie Krakowsko-Wieluńskiej (fig. 1) stanowi system pionowych studni, w których został odsłonięty profil osadów jaskiniowych zawierających bogatą faunę kręgowców (patrz studnie *II* i *III* na fig. 2, tab. 1 oraz pl. 1—2). Obecność w osadach szczątków takich gatunków jak: *Microtus (Allophaiomys) pliocaenicus* (Kormos), *Ungaromys nanus* Kormos, *Mimomys* cf. *pusillus* Méhely, *Bagurodon arankae* Kretzoi, *Beremendia fissidens* (Petényi) oraz *Sorex (Drepanosorex)* cf. *pachyodon* Pasa, wskazuje na wczesno-biharski wiek stanowiska (fazę Mokrej według Horáčka, 1979). Fazę tę skorelować można z cyklami glacjalnymi *P-S* według Kukli (1977, 1978) i stadiami 32—36 stratygrafii $\delta\ ^{18}O$ osadów głębokomorskich (fig. 3). Zróżnicowanie składu gatunkowego fauny (próbki *a-d*; patrz fig. 2 oraz tab. 1) odpowiada kilku zmianom klimatycznym zachodzącym podczas wypełniania jaskini osadami.

Porównanie ze znanymi wczesno-plejstoceńskimi faunami z terenu Polski (fig. 3) wskazuje, że fauna z Jaskini Żabiej jest najbardziej zbliżona do znanej ze stanowiska Kamyk na Wyżynie Krakowsko-Wieluńskiej (Kowalski 1960), a jest ona wyraźnie starsza od fauny z Koziego Grzbietu koło Chęcin (Kowalski *in* Bartolomei & *al.* 1975; Głazek & *al.* 1976, 1977). Porównanie z fauną zebraną na Kadzielni jest trudne, gdyż szczątki kręgowców pochodzące z różnych miejsc w obrębie kamieniołomu (*patrz* Kowalski 1958; Kowalski *in* Bartolomei & *al.* 1975) zawierają formy różnego wieku: najwyższego pliocenu (Willanianu) — *Mimomys pliocaenicus* (Major), formy dolnobiharskie — *Allophaiomys* oraz takie, które pojawiły się u schyłku dolnego biharu — *Pliomys lenki* (Heller).
