ACTA ZOOL. CRACOV. | 32 | 10 | 495—520 | KRAKÓW, 31. X. 1989

Adam NADACHOWSKI, Teresa MADEYSKA, Ewa ROOK, Barbara RZEBIK-KOWALSKA, Ewa STWORZEWICZ, Zbigniew SZYNDLAR, Teresa TOMEK, Mieczysław WOLSAN, Bronisław W. WOŁOSZYN

Holocene snail and vertebrate fauna from Nad Mosurem Starym Duża Cave (Grodzisko near Cracow): palaeoclimatic and palaeoenvironmental reconstructions

[With 6 text-figs]

Rekonstrukcja klimatu i środowiska holocenu na podstawie fauny ślimaków i kręgowców z Jaskini nad Mosurem Starym Dużej (Grodzisko koło Krakowa)

Abstract. Excavations in Nad Mosurem Starym Duża Cave were undertaken during the years 1967—1969. The sequence of deposits comprises layer 5 of Pleni-Vistulian age and layers 4—1 accumulated over a period from the close of the Atlantic phase of the Holocene to recent times. A rich and diverse subfossil fauna consists of 31 species of terrestrial snails, fish remains, 2 amphibians, 4 species of reptiles, 51 taxa of birds and 50 mammal taxa. Studies of faunal succession show that layer 5 was deposited in cold, moderately humid climate and steppe-tundra environment. The composition of faunal assemblages of the Sub-Boreal phase (layers 4, 3 and 2) suggests the wide expansion of coniferous and mixed forests in the climate becoming dryer. It is suggested that some Pleistocene relics, e. g. *Lagopus*, *Dicrostonyx*, and *Microtus gregalis*, survived in the Cracow region until the beginning of the Late Holocene. Fauna of layer 1 is relatively poor, containing mainly open country species, what is probably due to deforestation and thus connected with the human activity.

I. INTRODUCTION

Several caves and rock shelters situated in the Prądnik River Valley and in its vicinity (Ojców region, southern part of the Cracow-Wieluń Upland), were tested for human occupation during archeological excavations already started in the end of the 19th century (e. g. CHMIELEWSKI 1961, 1975; KOZŁOWSKI 1922; RÖMER 1883; ZAWISZA 1874). The majority of faunal assemblages obtained during these studies have yielded information on the Late Pleistocene temporal-spatial distribution of snail and vertebrate faunas (e. g. BOCHEŃSKI 1974; CHMIELEWSKI et al. 1967; KOWALSKI et al. 1965; MADEYSKA 1981; NADACHOWSKI 1982; STWORZEWICZ 1973). The Holocene malacofauna of the region was comprehensively studied from the calcareous sediments (ALEXANDROWICZ 1983; ALEXANDROWICZ, STWORZEWICZ 1983). The paucity of palaeontological

vertebrate sites assigned to the Holocene is not a result of their scarcity; it rather reflects a lack of interest on the part of palaeontologists. Holocene faunas are also little known because of the lack of suitable excavations. That is why the sequence of layers in Nad Mosurem Starym Duża Cave has a prime importance.

The cave and its sediments were described by T. MADEYSKA and E. ROOK, the malacofauna by E. STWORZEWICZ, and the vertebrates by Z. SZYNDLAR (amphibians and reptiles), T. TOMEK (birds), B. RZEBIK-KOWALSKA (insectivores), B. W. WOŁOSZYN (bats), A. NADACHOWSKI (rodents and ungulates) and M. WOLSAN (lagomorphs and carnivores). We are indebted to Professors S. W. ALEXANDROWICZ, Z. BOCHEŃSKI and K. KOWALSKI for critical reviews of the manuscript.

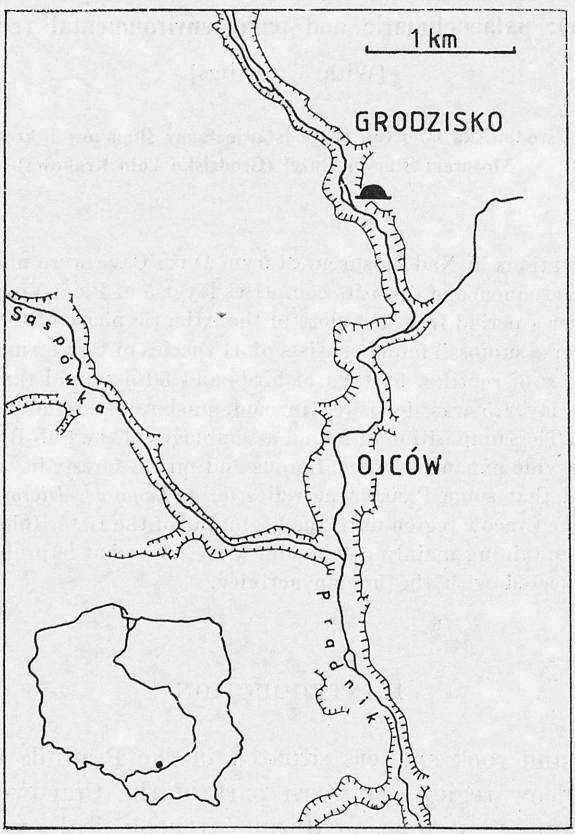

Fig. 1. Location of Nad Mosurem Starym Duża Cave at Grodzisko

II. THE CAVE AND LITHOSTRATIGRAPHY OF DEPOSITS

Nad Mosurem Starym Duża Cave in village Grodzisko near Cracow (50° 14'N. 19° 50'E) is located on the left bank of the river Prądnik, 10 m above the stream bed (Fig. 1). It is a small cave, about 9 m long with a big opening,

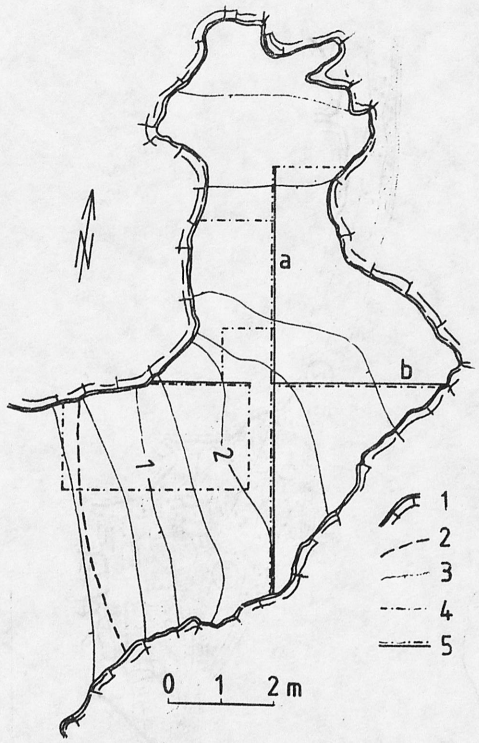

Fig. 2. Plan of Nad Mosurem Starym Duża Cave. Explanations: 1 — cave walls, 2 — drip-line, 3 — contours in metres above the sediments level at the entrance of the cave, 4 — trenches, 5 — profiles illustrated in the Fig. 3 — a and Fig. 4 — b. Drawing by T. Madeyska based on the field documentation of E. Rook

facing west. The cave chamber is 5 m wide just behind the entrance, further becomes narrower (2.25 m) and in the end widens again (3.75 m) (Fig. 2).

The excavations were undertaken during the years 1967—1969 (Rook 1970a, b, 1980). The trench established in 1967 was situated in the frontal part of the chamber: subsequently it was broadened in the same part of the cave and in the entrance. Just behind the entrance the rocky sill was found dividing the sediments of the cave into two parts (Figs 3 and 4).

On the basis of the investigations it is possible to reconstruct the sequence of the cave deposits (from the rocky bottom to the surface) as follows:

Layer 6 Loamy clay contained neither archaeological nor palaeontological materials

Layer 5. Loess-like loam of Pleistocene age, without artifacts, occurring only in the slope outside the cave.

Layer 4. Loam occurring only inside the cave: with artifacts of the Neolithic age, assignable to the classical phase of the Radial Decorated Pottery culture.

Layer 3. Clay with fine rubble has yielded artifacts of Early Bronze Age and Neolithic materials (Bošaca culture). Archaeological materials occurred only inside the cave.

Fig. 3. Longitudinal (N-S) section through the sediments (the profile "a" on the Fig. 2). The sediment description in the text. Drawing by T. MADEYSKA based on the field documentation of E. ROOK

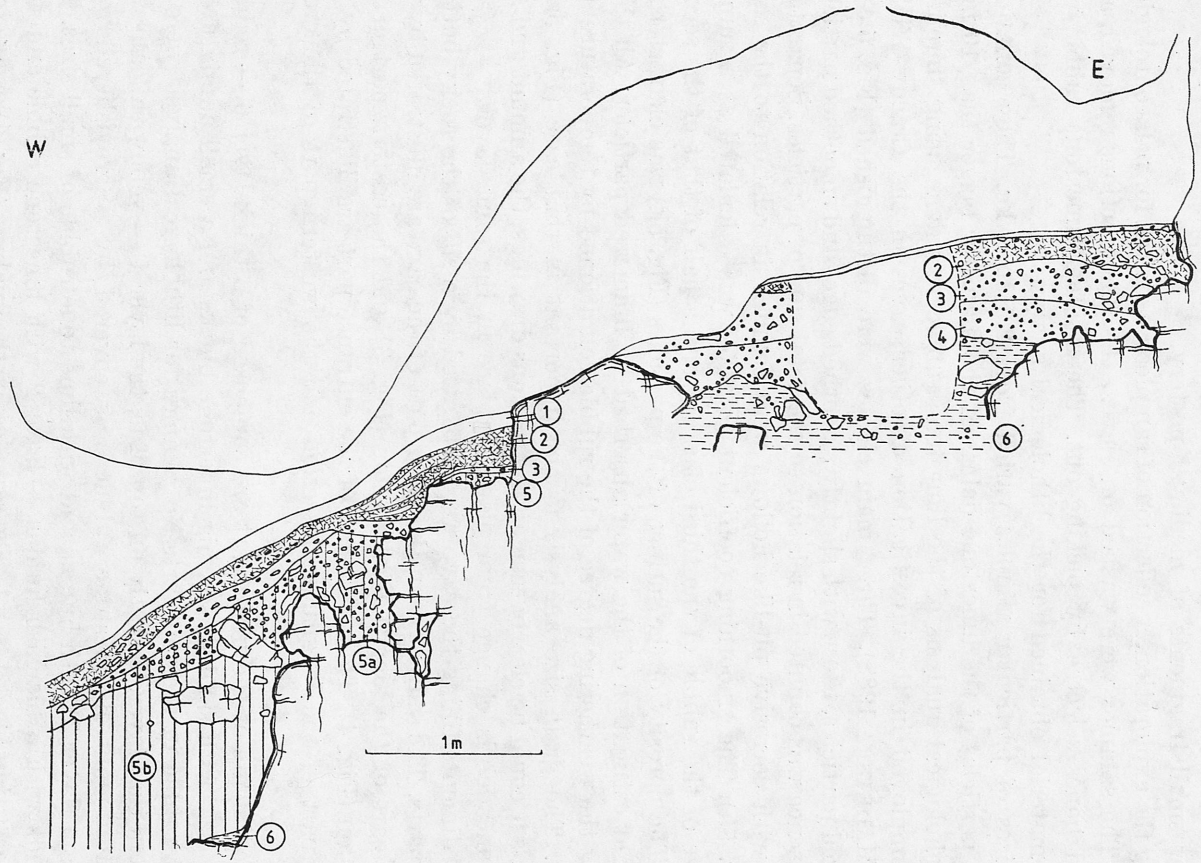

Fig. 4. Cross-section (E-W) through the sediments (the profile "b" on the Fig. 2). The sediment description in the text. Drawing by T. Madeyska based on the field documentation of E. Rook

Layer 2. Holocene humus with a fairly small amount of rubble contained late La Téne potsherds of Lusatian culture, some Early Bronze Age artifacts as well as the pottery of the Neolithic age (Lengyel culture) found in the secondary position on the slope in front of the cave.

Layer 1. Level of recent sediments has yielded numerous modern potsherds and a few small fragments of medieval pottery.

During the exploration, a collection of samples was taken for palaeontological analysis. The samples were washed on sieves, the fine fractions removed, and shells and bones selected by picking out. The residual limestone rubble was the only material obtained for the lithological analysis.

The sizes of particular samples varied from 2.5 to 9 kg. They contained 300—600 particles of the limestone debris of the diameter bigger than 10 mm. The morphological analysis of the limestone rubble was done using simplified method employed in the investigation of other caves in the Cracow-Wieluń Upland (MADEYSKA 1988). Three main classes were distinguished (Fig. 5 e-g): sharp edged particles, those with slightly smoothed edges and smoothed particles. Their presence was counted in relation to the total sum of particles. Separately, particles with corrosive pit-like hollows were counted in relation to the same sum (Fig. 5h). The smoothing coefficient (Fig. 5i) was calculated as a sum of percentage of the rubble of the third class (g) and a half of that of the second class (f). The porosity of the surface of the particles (Fig. 5k) was characterized by a weight estimation of the water absorbed by immersed particles. All these data show the weathering degree of the rubble conditioned by temperature and humidity. The grain size analysis is not important in that case (Fig. 5a-d) because, as it could be clearly seen on the sections drawings, the amount and size of limestone debris change from place to place in the same layer.

The sediments filling the cave were separated by a sill of the rocky bottom into two parts. The sediments in the inner part of the cave are illustrated by the northern part of the longitudinal section (Fig. 3) and the eastern part of the cross-section (Fig. 4). The sediments of the entrance part are illustrated by the southern part of the longitudinal section and the western part of the cross--section.

The sediments of the inner part are composed of a thick layer 6 — reddish and grey clay with sand lenses, big limestone blocks and a small admixture of limestone rubble in the top part. No samples for lithological analysis were received from that layer. Directly on top of it, the layer 4 — yellowish loam with a variable amount of limestone rubble was covered by a greyish-yellow or brown loam (layer 3) with humus and with limestone rubble of small sizes. The profile ends with a blackish humus — layer 2 with limestone rubble and with the youngest thin black layer 1. The samples for the analysis (Fig. 5) derive from the corner place by the rocky wall near the eastern end of the cross-section. The morphology of the limestone particles clearly shows the consequent increase of the smoothing in the direction to the youngest sample. The porosity changes are not so consequent because of the presence of porous calcareous

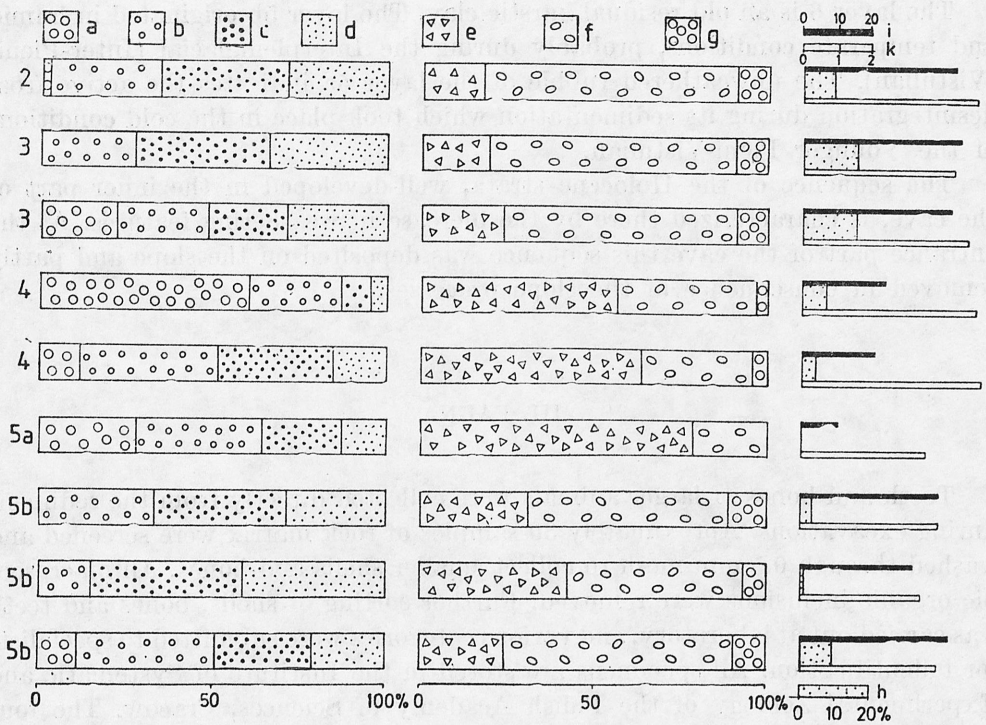

Fig. 5. Diagram showing the results of the limestone rubble analyses. Explanations: a—d: grain size analysis: a — particles bigger than 40 mm in diameter, b — 20—40 mm, c — 10—20 mm, d — 2—10 mm, e—g: morphology of the limestone debris bigger than 10 mm in diameter: e — sharp-edged particles, f — particles with smoothed edges, g — smoothed particles, h — particles with corrosive pit-like hollows, i — smoothing coefficient of the limestone particles, k — porosity of surfaces of limestone particles of 10—2 mm in the diameter

precipitations on the rubble particles of the layer 4 which gave an increase of the whole porosity. The corrosive pit-like hollows are poorly developed. In the layer 2 they are fewer than in layer 3. It is probably the result of the layers age only, because the hollows originated slowly in sediments after the time of debris, loam and humus deposition.

The sediments of the entrance part of the cave are composed mainly of a yellow loess-like loam with a small admixture of limestone rubble in the lower part (layer 5b) and abundant rubble in the upper part (layer 5a). The rubble in the upper part is sharp-edged, unweathered, while in the lower part the weathering features of the particles are similar to that of the upper layers inside the cave. Under the layer 5, small patches of clayey layer 6 fill the fissures in the rocky bottom.

Basing on this inconspicuous lithological data, and comparing them with the results of the investigations of sediments filling other caves and rock-shelters of the Cracow Upland (Madeyska 1982, 1988) it could be concluded as follows:

The layer 6 is an old residual karstic clay. The layer 5b originated in humid and temperate conditions, probably during the Interpleniglacial (Inter-Pleni--Vistulian). The unweathered rubble of the layer 5a indicates the active frost desintegration during its sedimentation which took place in the cold conditions of the Younger Pleni-Vistulian.

The sequence of the Holocene strata, well-developed in the inner part of the cave, is characterized there by the increase in weathering features. At the entrance part of the cave this sequence was deposited on the slope and partly removed in consequence of the slope processes.

III. FAUNA

Teeth and bones of larger animals were collected directly from the sediment during excavations. Aproximately 30 samples of rock matrix were screened and washed through 0.5 mm mesh to collect smaller shells and bones. All macroscopic organic inclusions were removed. Further sorting of shells, bones and teeth was carried out at laboratory, and various categories were submitted to specialists for indentification. All specimens are stored in the Institute of Systematic and Experimental Zoology of the Polish Academy of Sciences, Cracow. The four primary study objectives were:

(1) identification to species if possible,

(2) establishment of minimum number of individuals for each taxon and for each layer (based on the maximum number of either right or left skeleton elements),

(3) tests for faunal trends within the stratigraphic sequence utilizing statistical techniques to determine the significance of species proportions in each layer,

(4) assessment of climatic and environmental changes during the Holocene on the basis of faunal turnover.

The usually used measure of species diversity is the Shannon index of general diversity (cf. Odum 1971; Emlen 1973). This index is calculated from the equation $H = -\sum Pi \ln Pi$, where $Pi = ni/N$ = relative frequency for each species. This index takes into account both elements of diversity, species richness and evenness of importance of each taxon being reasonably independent of sample size (Avery 1982). Sometimes it may be important to distinguish which aspect of diversity is more significant. The index d, introduced to ecology by Odum (1971), tests the species richness. It is calculated from the equation $d = S-1/\ln N$, where S = number of species (taxa), N = number of individuals. For determination of species evenness (or equitability), the index $e = H/\ln S$ was employed. Indices mentioned above were used to establish the patterns of community structure in particular levels.

Table I lists the land snails and their common habitats (acc. to Ložek 1964; Wiktor 1974). Table II is a chronological check-list of the Late Pleistocene

(layer 5) and Holocene (layers 4—1) vertebrates. We follow the nomenclature and ordering of VAURIE (1959, 1965) for the birds and of PUCEK (1981) for the mammals.

Table I

Snails found at Nad Mosurem Starym Duża Cave representing various ecological categories and percentage representation of individuals in layers 3 and 2. 1 W — forest species; 2 — mesophilous forest species which may also occur in other biotopes: under bushes and shady, damp rocks W(M) as well as in forest-steppe W(s); 3 W(h) — forest species preferring moist habitats; 4 — species described generally as steppe — Sf — petrophilous xerothermic species and S(W) — living on bushes; 5—0 — species of open areas and Ws — xerothermic forest-steppe; 7 — eurytopic species which are only in a low degree dependent on damp conditions: M — mesophilous species, Mf — inhabiting open and wooded rocks of medium humidity, Wf — forests and rocks of medium humidity

Palaeoecological character		Species	Layer 3	Layer 2
1	W	*Aegopinella pura* (ALDER, 1830)	—	1.3
		Cochlodina laminata (MONTAGU, 1803)	3.8	4.6
		Cochlodina orthostoma (MENKE, 1830)	13.8	18.3
		Daudebardia rufa (DRAPARNAUD, 1805)	6.3	1.3
		Chilostoma faustinum (ROSSMÄSSLER, 1835)	—	0.6
		Macrogastra latestriata (A. SCHMIDT, 1857)	1.2	1.9
		Macrogastra plicatula (DRAPARNAUD, 1801)	—	3.3
		Isognomostoma isognomostoma (SCHRÖTER, 1784)	1.2	11.8
		Bulgarica cana (HELD, 1836)	—	4.6
		Oxychilus depressus (STERKI, 1880)	22.5	1.3
		Ruthenica filograna (ROSSMÄSSLER, 1836)	—	0.6
		Vestia elata (ROSSMÄSSLER, 1836)	—	0.6
2	W(M)	*Bradybaena fruticum* (O. F. MÜLLER, 1774)	3.8	4.6
		Discus rotundatus (O. F. MÜLLER, 1774)	22.5	4.6
		Alinda biplicata (MONTAGU, 1803)	—	3.9
		Oxychilus glaber (ROSSMÄSSLER, 1835)	2.5	0.6
		Vitrea crystallina (O. F. MÜLLER, 1774)	—	1.3
	W(s)	*Aegopinella minor* (STABILE, 1864)	1.2	2.5
		Helix pomatia LINNAEUS, 1758	10.0	5.2
3	W(h)	*Macrogastra ventricosa* (DRAPARNAUD, 1801)	—	1.9
4	Sf	*Chondrina clienta* (WESTERLUND, 1883)	1.2	3.9
	S(W)	*Cepaea vindobonensis* (FERUSSAC, 1821)	1.2	3.3
5	O	*Vallonia costata* (O. F. MÜLLER, 1770)	—	0.6
		Vallonia pulchella (O. F. MÜLLER, 1770)	—	0.6
	Ws	*Euomphalia strigella* (DRAPARNAUD, 1801)	7.6	0.6
7	M	*Cochlicopa lubrica* (O. F. MÜLLER, 1774)	—	0.6
	Mf	*Clausilia parvula* FERUSSAC, 1807	—	1.9
	Wf	*Clausilia dubia* DRAPARNAUD, 1805	1.2	11.8
		Laciniaria plicata (DRAPARNAUD, 1801)	—	1.9
Minimum number of individuals (N)			80	150
Total number of species (S)			15	29

Molluscs

In the material investigated, 31 species of terrestrial snails have been recognized. Snails are more frequent in the layers 3 and 2. In the layer 5 only fragments of shells of *Bradybaena fruticum* and *Arianta arbustorum* were found, while the sediments of the layer 4 have yielded single specimens of *Semilimax kotulai* and *Vitrea crystallina* as well as fragments of shells of *Bradybaena fruticum*. The palaeoecological analysis was carried out according to Ložek's schema (1964) and results were tabulated (Table I).

Specific constitution of the particular palaeoecological groups shows a predominance of woodland fauna. Twenty-one species belong to groups 1 and 2 which consist of woodland forms. The first group (W) includes 11 species definitely woodland in character, which very seldom occur in other biotopes and never appear in the open country. Group 2 consists of mesophile woodland species which may also occur in other biotopes: under bushes and shady, damp rocks (WM), as well as in woodland-steppe habitats (Ws). Of the discussed snail species, two representatives of the family *Clausiliidae* (*Vestia elata* and *Macrogastra latestriata*) are especially interesting. *Vestia elata* is a Carpathian species, very rare in Poland recently. In the Middle Holocene it was widely distributed and a few localities are known also from the Ojców region (Stworzewicz 1973, 1988). *Macrogastra latestriata* is another Carpathian species, but of widely extended distribution. It is also found sporadically in various parts of Poland and in the Southern Baltic coastal countries. It is known as a fossil from Ojców but is now probably extinct in this region. The remaining 10 species belong to groups 3, 4, 5 and 7. The group 7 is the most numerous (4 species) and consists of eurytopic species which are only dependent, to a low degree, on damp conditions. Of this group only *Laciniaria plicata* does not occur in the Ojców region at present.

Fishes

The fishes are too fragmentary and scarce to provide detailed evidence regarding age or depositional environment. Their occurrence does, however, confirm the presence of a stream in the vicinity. They could have been carried in by human occupants, being food remains.

Amphibians and reptiles

Sediments of the cave have yielded two species of amphibians and four species of reptiles (one lizard and three snakes). All of them, with the exception of *Elaphe longissima*, are native to the Cracow-Wieluń Upland. The most abundantly represented taxon is *Rana temporaria* known from several dozen bones. Reptiles and to a lesser degree, also amphibians, being animals dependent on external sources of heat, can be used to determine past climates (Szyndlar 1984). Of the discussed reptile species, *Elaphe longissima* seems to be of the

Table II

Percentage repretentation of vertebrate taxa at Nad Mosurem Starym Duża Cave calculated for each layer separately, and values of community composition indices. R — recently living species in the Prądnik River valley (for birds acc. to BOCHEŃSKI and OLEŚ, 1977; for mammals acc. to PUCEK and RACZYŃSKI, 1983) * The taxon belongs to one of aforementioned species and thus has not been considered in the calculation of the overall number of taxa

Taxon	Successive layers					R
	5	4	3	2	1	
Pisces		+	+	+		+
Amphibia et *Reptilia*						
Bufo bufo LINNAEUS, 1758		1.1	0.9	1.8	6.7	+
Rana temporaria LINNAEUS, 1758	4.3	2.3	1.5	1.8	10.1	+
Elaphe longissima (LAURENTI, 1768)					3.3	—
Anguis fragilis LINNAEUS, 1758					3.3	+
Coronella austriaca LAURENTI, 1768			0.3	0.4		+
Vipera berus (LINNAEUS, 1758)					3.3	+
Sub-total	0.3	3.4	2.7	4.0	26.7	
Aves						
Anas querquedula LINNAEUS, 1758		0.6	0.3			—
Anas querquedula/crecca juv			0.3			—
cf. *Spatula clypeata* LINNAEUS, 1758		0.6				—
Mergus merganser LINNAEUS, 1758	4.3		0.3			—
Anseriformes (goose?)			0.3			—
Accipiter gentilis (LINNAEUS, 1758)			0.3	0.4		+
Accipiter nisus (LINNAEUS, 1758)				0.4		+
Buteo buteo (LINNAEUS, 1758)			0.6			+
Falco cf. *tinnunculus* LINNAEUS, 1758		0.6		0.4		+
Lagopus sp.		0.6		0.4		—
Tetrastes bonasia (LINNAEUS, 1758)			0.3	0.4		—
Lyrurus tetrix (LINNAEUS, 1758)	4.3	1.1	0.6	0.4		—
Tetrao urogallus (LINNAEUS, 1758)			0.6	1.1		—
Galliformes (indet. juv)			0.3	0.4		?
Rallus aquaticus LINNAEUS, 1758		1.1	0.3			—
Crex crex (LINNAEUS, 1758)	8.8	0.6	0.3			—
Tringa hypoleucos LINNAEUS, 1758		0.6				—
Streptopelia turtur (LINNAEUS, 1758)		0.6				+
Asio otus LINNAEUS, 1758		0.6				+
Asio flammeus (PONTOPPIDAN, 1763)		0.6				—
Aegolius funereus (LINNAEUS, 1758)		0.6				—
Surnia ulula (LINNAEUS, 1758)			0.3			—
Strix aluco LINNAEUS, 1758		0.6		0.4		+
Strix uralensis PALLAS, 1771			0.3			—
Strix sp *			0.3			?
Strigiformes juv *			0.3			+
Apus apus (LINNAEUS, 1758)			0.3			+
Upupa epops LINNAEUS, 1758	4.3		0.3			—
Dendrocopos major (LINNAEUS, 1758)		0.6		0.4		+
cf. *Eremophila alpestris* (LINNAEUS, 1758)		0.6	0.3			—

Table II (cont.)

Taxon	5	4	3	2	1	R
Motacilla alba LINNAEUS, 1758	4.3		0.3			+
Sturnus vulgaris LINNAEUS, 1758				0.4		+
Garrulus glandarius (LINNAEUS, 1758)			0.6	0.4		+
cf. *Corvus monedula* LINNAEUS, 1758				0.4		+
Cinclus cinclus (LINNAEUS, 1758)		0.6	0.3	0.4		+
Acrocephalus arundinaceus (LINNAEUS, 1758)		0.6				—
Phylloscopus sp.				0.4		+
Muscicapinae				0.4		+
cf. *Oenanthe oenanthe* (LINNAEUS, 1758)		0.6				+
Erithacus rubecula (LINNAEUS, 1758)				0.4		+
Turdus torquatus (LINNAEUS, 1758)			0.3	0.4		—
Turdus merula LINNAEUS, 1758			0.6	0.7		+
Turdus philomelos BREHM, 1831			0.3	0.4		+
Turdus viscisorus LINNAEUS, 1758		0.6	0.9	0.7		+
Turdus sp. *			0.3	0.4		+
Parus cf. *palustris* LINNAEUS, 1758			0.3			+
Parus major LINNAEUS, 1758			0.3	0.4		+
cf. *Sitta europaea* LINNAEUS, 1758				0.4		+
Carduelis spinus (LINNAEUS, 1758)			0.3			+
Carduelis cf. *chloris* (LINNAEUS, 1758)		0.6				+
Carduelis sp.			0.3			+
Fringilla coelebs LINNAEUS, 1758			0.3			+
Loxia curvirostra LINNAEUS, 1758				0.4		—
Pyrrhula pyrrhula (LINNAEUS, 1758)		1.1				+
Sub-total	26.0	14.1	11.7	10.5		
Mammalia						
Talpa europaea LINNAEUS, 1758		0.6	0.3	1.1	6.7	+
Sorex araneus LINNAEUS, 1758	4.3	9.4	0.6	2.2		+
Neomys fodiens (PENNANT, 1771)			0.6	0.4	3.3	+
Crocidura leucodon (HERMANN, 1780)			0.6	0.4		+
Rhinolophus hipposideros (BECHSTEIN, 1800)			3.5	1.1		+
Myotis myotis (BERKHAUSEN, 1797)				0.4		+
Myotis cf. *myotis* (BORKHAUSEN, 1797)			0.3			
Myotis bechsteini (KUHL, 1818)		0.6	5.6	5.5		+
Myotis nattereri (KUHL, 1818)			1.9			—
Myotis mystacinus (KUHL, 1819)		1.1	0.9	1.5	3.3	+
Myotis brandti (EVERSMANN, 1845)			1.5			—
Myotis daubentoni (KUHL, 1819)		0.6	2.2			+
Vespertilio murinus LINNAEUS, 1758			2.5	0.4		—
Eptesicus cf. *nilssoni* (KAYSERLING et BLASIUS, 1839)			0.6			+
Eptesicus cf. *serotinus* (SCHREBER, 1774)			2.8	1.1		+
Pipistrellus pipistrellus (SCHREBER, 1770)		0.6	4.1	0.4		+

Table II (cont.)

Taxon	5	4	3	2	1	R
Nyctalus cf. *leiseri* (KUHL, 1818)				0.4		+
Plecotus auritus (LINNAEUS, 1758)		2.3	11.8	3.6		+
Barbastella barbastellus (SCHREBER, 1774)			3.5	2.2		+
Lepus sp.	4.3	0.6		0.4		+
Sciurus vulgaris LINNAEUS, 1758			0.3	0.7		+
Cricetus cricetus (LINNAEUS, 1758)		2.9	5.6	0.7		+
Clethrionomys glareolus (SCHREBER, 1780)		19.9	5.2	23.6	10.1	+
Arvicola terrestris (LINNAEUS, 1758)	8.8	9.4	12.1	5.8	10.1	—
Pitymys subterraneus (de SELYS-LONGCHAMPS, 1836)			1.2	6.9	3.3	+
Dicrostonyx gulielmi (SANFORD, 1870)	21.8	1.1				—
Microtus sp.			5.2	1.5		+
Microtus oeconomus (PALLAS, 1776)		7.6	0.6	1.5		—
Microtus agrestis (LINNAEUS, 1761)		18.7	1.5	2.5		+
Microtus cf. *agrestis* (LINNAEUS, 1761) *	4.3		0.6			+
Microtus arvalis (PALLAS, 1779)				0.7	16.7	+
Microtus cf. *arvalis* (PALLAS, 1779)*	13.1	0.6	0.6	2.5		+
Microtus gregalis (PALLAS, 1779)	8.8	0.6	0.6			—
Apodemus (*Sylvaemus*) sp.		0.6	2.8	9.7	6.7	+
Sicista betulina (PALLAS, 1778)		1.1				+
Eliomys quercinus (LINNAEUS, 1766)			0.3	0.4		—
Glis glis (LINNAEUS, 1766)			0.9	1.1	3.3	+
Muscardinus avellanarius, (LINNAEUS, 1758)			0.3	0.4		+
Ursus arctos LINNAEUS, 1758		0 6				—
Vulpes vulpes (LINNAEUS, 1758)		0 6	0.3	0.4		+
Lutra lutra (LINNAEUS, 1758)				0.4		—
Martes martes (LINNAEUS, 1758)		0.6	0.9	1.8		+
Mustela putorius LINNAEUS, 1758		0.6	0.3			+
Mustela erminea LINNAEUS, 1758		0.6	0.3			+
Mustela nivalis LINNAEUS, 1766			0.3	0.4		+
Felis silvestris SCHREBER, 1777		0.6	0.6	0.7	3.3	—
Equus sp.	4.3					—
Sus scrofa domestica LINNAEUS, 1758			0.3	0.4		+
Capreolus capreolus (LINNAEUS, 1758)			0.3	0.4		+
Cervus elaphus LINNAEUS, 1758			0.3	0.4		—
Bos taurus LINNAEUS, 1758			0.6	1.1	3.3	+
Ovis sp./*Capra* sp.		0.6	0.3	0.4	3.3	+
Sub-total	69.7	82.5	85.6	85.6	73.4	
Minimum number of individuals (N)	23	171	325	274	30	
Total number of taxa (S)	14	48	78	67	17	
Shannon index of general diversity (H)	2.48	2.91	3.39	3.12	2.66	
Species diversity (d)	4.15	9.14	13.31	11.76	4.70	
Equitability (e)	0.93	0.75	0.78	0.74	0.94	

greatest importance. Since the present northern range of this snake lies in southernmost Poland, its more northern occurrence suggests that summer temperatures in layer 1 were higher or at least the same as nowadays. The remaining amphibians and reptiles with the present distribution reaching usually the Arctic Circle or at least southern Scandinavia (*Coronella austriaca*) are of less importance.

All the amphibians and reptiles are without exception terrestrial animals: the two amphibian species enter water exclusively during the breeding period. All of them can occur together in grasslands with more or less scattered dense tree and/or scrub areas. However, they also inhabit other types of land. It suggests that the amphibians and reptiles found in Nad Mosurem Starym Duża Cave are not good indicators of past vegetation.

Birds

The avian fauna is a very diverse one. Fifty-one taxa of birds have been reported from the cave deposits. Ducks (*Anas querquedula*, *Spatula clypeata* and *Mergus merganser*) would indicate the presence of stagnant water. The last species is palaeontologically recorded for the first time in Poland. Three species of hawks and one falcon (*Falco* cf. *tinnunculus*) were identified. They were poorly represented and the paucity of their remains possibly suggests that the cave entrance was not generally used as a roosting/feeding locale. Grouses are represented by four species (*Lagopus* sp., *Tetrastes bonasia*, *Lyrurus tetrix*, *Tetrao urogallus*) which are known from several different bones. These species were common enough in Poland during Late Pleistocene times to have appeared in more than one site. They are closely associated with coniferous and mixed forests. The recovery of *Lagopus* sp. was significant in light of the birds' present distribution and confirms the earlier opinion (Bocheński et al. 1983) that this bird survived in the southern part of the Cracow-Wieluń Upland up to the Late Holocene. Remains of two species of rails (*Rallus aquaticus* and *Crex crex* were identified. Presently, they inhabit neither the region of Nad Mosurem Starym Duża Cave nor the adjacent valley. Marshes, river flood plains, ponds, lakes with thick vegetation bordering waterside, are suitable nesting habitats for them. The Common Sandpiper *Tringa hypoleucos* found in the layer 4 has not been previously reported in the fossil state in Poland. It breeds on sandy and stony shores of lakes and river banks. The doves are represented only by *Streptopelia turtur*, while owls are common and differentiated (at least 6 species). Three of them (*Aegolius funereus*, *Surnia ulula*, *Strix uralensis*) occur mainly in coniferous forests, including thick forests and occasionally mixed forests. They nest mainly in tree holes. The Long-eared Owl *Asio otus* and the Tawny Owl *Strix aluco* prefer broadleaf and mixed forests. They are also present in other wooded areas, especially in broken forests with groups of trees. Of the discussed owl species only *Asio flammeus* is an open country species, nesting on the ground. It fre-

quently occurs in swampy localities and open marshes and bogs. Swifts are represented by *Apus apus* which breeds in cavities and crevices of rocks and cliffs. The Hoopoe *Upupa epops*, recorded for the first time as a fossil in Poland, requires open areas, especially of park landscape with groups of trees, as it nests in tree holes. Woodpeckers are represented only by *Dendrocopos major* (also the first record in Poland), an inhabitant of both coniferous and deciduous forests.

Passerines are numerous and they belong to at least 22 species. Larks, wagtails, starlings, nuthatches and dippers are represented by single species (*Eremophila alpestris*, *Motacilla alba*, *Sturnus vulgaris*, *Sitta europaea*, *Cinclus cinclus*, respectively). The last species has never been found in the fossil state in Poland. Its occurrence supports the proximity of running water, mainly with a stony or gravelly bed. The family *Corvidae* is represented by *Garrulus glandarius*, an inhibitant of forests of different type, and by *Corvus monedula*, which occurs in open areas but requires well-grown trees or rock outcrops for roosting and nesting. Among warblers only *Phylloscopus* sp. and *Acrocephalus arundinaceus* were identified, both described for the first time in Poland. The latter form mainly inhabits extensive reed marshes bordering on fresh waters. The family *Turdidae* is well represented (at least 6 species). Five taxa (*Erithacus rubecula*, *Turdus philomelos*, *T. viscivorus*, *T. torquatus*, *T. merula*) indicate the presence of rather thick forest with shrubby undergrowth, both broadleaf and coniferous and ground cover. *Oenanthe oenanthe* (first fossil record in Poland) inhabits open areas with short grasses and grassy slopes with rocks. Both tits (*Parus palustris* and *P. major*), forest species, were recognized palaeontologically for the first time in Poland. Finches are represented by dwellers of forests of different type (*Pyrrhula pyrrhula*, *Fringilla coelebs*, *Carduelis chloris*) or coniferous forests, especially spruce forests (*Carduelis spinus* and *Loxia curvirostra*). The two last species have not been found so far in fossil state in Poland.

Nad Mosurem Starym Duża Cave contains several new avian fossil records. Thirteen taxa are recovered palaeontologically for the first time in Poland. Seven further species (*Spatula clypeata*, *Surnia ulula*, *Strix uralensis*, *Eremophila alpestris*, *Turdus torquatus*, *Turdus viscivorus*, *Carduelis chloris*) were described from Late Pleistocene sites in Poland (Bocheński 1974, 1981; Bocheński et al. 1985; Madeyska 1981): however, they have never been found in Holocene sediments. Of the discussed species, 16 following taxa (*Anas querquedula*, *Spatula clypeata*, *Mergus merganser*, *Lagopus* sp., *Tetrastes bonasia*, *Lyrurus tetrix*, *Tetrao urogallus*, *Rallus aquaticus*, *Crex crex*, *Tringa hypoleucos*, *Asio flammeus*, *Aegolius funereus*, *Surnia ulula*, *Strix uralensis*, *Eremophila alpestris*, *Turdus torquatus*) do not occur at present in the Prądnik valley (cf. Bocheński and Oleś 1977).

The palaeoavifauna can be broken into severel groups, with each group playing a different role in palaeoecological interpretations. The first group, the most numerous one (26 taxa), consists of species found in forested or heavy scrub habitats, especially coniferous and mixed forests. Nine species require

substantial bodies of water, rivers, streams, marshes or swamps. The third group (11 species) consists of species associated with open areas, grassland, fields, sometimes meadows as well as rocky landscape.

Mammals

Fifty mammal taxa have been recognized in the Nad Mosurem Starym Duża Cave assemblage. Rodents dominate the small-mammal component of the fauna. Larger mammals are poorly represented, usually only by isolated teeth and fragmentary postcranial elements.

Four species of insectivores are present. The European Mole *Talpa europaea* is a subterranean animal found in whole Holocene sequence. Shrews are represented by three species belonging to separate genera. Among them, *Sorex araneus* is relatively common and occurs in the whole section with the exception of the layer 1. It inhabits an extensive range, both grassland and woodland. The European Water Shrew *Neomys fodiens* is strictly associated with water. It occurs on moist meadows, banks of rivers and streams in shrubby habitats and seasonally flooded parts of forests. The genus *Crocidura* is represented by *C. leucodon*, and inhabitant of open country, at present usually associated with human settlements.

The fauna of bats is very diverse. Fourteen species have been recorded in the sediments. In the fossil assemblage all ecological groups of bats living now in Poland were recognized. The family *Rhinolophidae* is represented by *Rhinolophus hipposideros*, an inhabitant of rocky areas. It indicates a relatively warm climate and high temperature especially in summer. Five species of common bats *Vespertilionidae* are eurytopic species (*Myotis myotis*, *M. bechsteini*, *M. nattereri*, *M. mystacinus* and *M. brandti*). The mentioned species are associated both with mountain areas and lowlands; sometimes also with human settlements. In summer, small colonies can be found in hollow trees, less frequently in caves. They winter in caves and cellars, where they form small or large colonies, usually containing both sexes. One species, *Myotis daubentoni*, is strictly associated with water, indicating the presence of pools or small lakes in the vicinity of the cave. Five species (*Eptesicus nilssoni*, *Pipistrellus pipistrellus*, *Nyctalus* cf. *leisleri*, *Plecotus auritus* and *Barbastella barbastellus*) occur in forested areas of different type. In summer, they take refuge in hollow trees and rock fissures where single specimens or colonies can be found. In winter, they hide usually in rocky areas, in caves and various fissures. The only species associated with open areas is *Vespertilio murinus* usually found in steppe regions, while *Eptesicus serotinus* is primarily associated with human settlements (Wołoszyn 1987).

Lagomorphs are represented by very scarce remains of *Lepus* sp.

Rodents constitute the most common group of vertebrate remains (18 taxa). Squirrels are represented only by the forest species *Sciurus vulgaris*, while hamsters by *Cricetus cricetus*, an ihabitant of open country. Fauna of voles *Arvicolidae* is a relatively diverse one, consisting of representatives of different

ecological groups. Two species (*Clethrionomys glareolus* and *Microtus agrestis*) are inhabitants of woodland or bushy areas. The latter species and *Pitymys subterraneus* both live in the open country where they are found in moist fields and meadows. Two species (*Arvicola terrestris* and *Microtus oeconomus*) are associated with water. They inhabit swamps and moist meadows, and may also occur along streams, rivers and in damp forests. The Common Vole *Microtus arvalis* is an animal of open country. It primarily lives on cultivated fields at present. Two species (*Dicrostonyx gulielmi* and *Microtus gregalis*) found, first of all, in the Pleistocene layer 5, are indicative of steppe-tundra environment. Mice are represented by the specifically undetermined *Apodemus* (*Sylvaemus*) group, while the family *Zapodidae* by *Sicista betulina*, primarily a dweller of woodland areas or swampy meadows. All species of dormices (*Eliomys quercinus*, *Glis glis*, *Muscardinus avellanarius*) are associated with deciduous, coniferous or mixed forests.

Carnivores are represented by 8 species. Most of them inhabit at present large thick forests, both in lowlands and in mountains (*Ursus arctos*, *Martes martes*, *Felis silvestris*) or forested, bushy areas (*Mustela putorius*, *Mustela erminea*). One species (*Lutra lutra*) is associated with water environment, being highly adapted for amphibious life. The other carnivore species are eurytopic and occur both in woodland and open areas, fields and meadows (*Vulpes vulpes*, *Mustela nivalis*).

Ungulates are poorly represented. One bone of *Equus* sp. was found in the layer 5. Deers (*Capreolus capreolus* and *Cervus elaphus*) occur in all types of forests both in lowlands and in mountains. Pigs and bovids are represented only by domestic animals which were found, first of all, in the Neolithic and Bronze Age sediments (layer 3 and 2, respectively).

The mammal fauna complements the palaeoecological picture suggested by the birds. Of the discussed fauna the 12 following species (*Myotis nattereri*, *Myotis brandti*, *Vespertilio murinus*, *Arvicola terrestris*, *Dicrostonyx gulielmi*, *Microtus oeconomus*, *Microtus gregalis*, *Eliomys quercinus*, *Ursus arctos*, *Lutra lutra*, *Felis silvestris*, *Cervus elaphus*) do not occur in the Prądnik valley today (cf. Pucek and Raczyński 1983). The majority of species are associated with forested habitats (21 species), especially with coniferous and/or mixed forests. Further 9 species are eurytopic and occur both in woodland and open areas. The next group consists of taxa only found in open landscapes (9 species). Five species are strictly associated with water and 3 taxa belong to domestic animals.

IV. PALAEOENVIRONMENTAL AND PALAEOCLIMATIC RECONSTRUCTIONS BASED ON FAUNAL EVIDENCE

The faunal material has been examined in an attempt to extract information concerning vegetational and climatic change. For these purposes, at first, the analysis of the way of accumulation of the sediments and fossils should be un-

dertaken. In view of the small size of the cave and a system of fissures visible in the ceiling, it seems that the limestone rubble derived from the weathering walls and ceiling of the cave and the loam material got into the cave from the surface through fissures. Accumulation of the layer 5 probably originated from slope processes. The very rich and diverse faunal material accumulated is probably not homogeneous in origin. Mollusc shells as well as a part of vertebrate remains were washed into the cave from the nearest vicinity. A second hypothesis concerns owls and other raptors which feed on, particularly small mammals and birds, over a variety of habitats and return to digest and regurgitate their meals. The third possibility is that carcasses of larger mammals could have been carried in by human occupants or carnivores.

It seems very probable that the thanatocoenosis described is polygenic in nature, thus the represented fossil remains are good indicators of habitat differentiation in the vicinity of the site.

Faunal succession

For the purposes of palaeocological and palaeoenvironmental interpretations, the faunas from each layer were divided according to preferred habitat. The percent composition of minimum number of individuals for each constituent category (taxon) and for each habitat group were tabulated by level (Table I and III).

Investigation of changes in faunal diversity and community structure (Table II) shows great difference between the lowest layer 5 and the upper part of the section. The faunal assemblage from the layer 5 is generally poor, containing 2 species of snails, 1 amphibian, 5 species of birds and 8 mammal taxa. Its characteristic feature is a high content of open country species, including taxa inhabiting steppe-tundra environment. The most abundant species, *Dicrostonyx gulielmi* and *Microtus gregalis* are indicative of a cold, moderately humid climate and a steppe-tundra landscape. Hydrophilous species, inhabiting ponds, rivers or marshes (e. g. *Mergus merganser*, *Crex crex*) are also relatively numerous. The content of forest species is insignificant. Such species community corresponds to the well known faunal assemblages of the Pleni-Vistulian age in the region (Bocheński 1974; Madeyska 1981; Nadachowski 1982).

The layer 4 shows a pronounced change in the composition of faunal assemblage. The thanatocoenosis comprises 3 species of snails, 2 anurans, 21 birds and 24 mammals. The characteristic feature is a marked increase in the content of the typical forest species (Table III). The predominant taxa are: *Clethrionomys glareolus* and *Microtus agrestis*. Relatively abundant are eurytopic species: *Sorex araneus* and *Arvicola terrestris* as well as *Microtus oeconomus*, an inhabitant of marshes and other aquatic habitats. On the other hand, the frequency of steppe and open country species decreased markedly, and there are very scarce remains of *Dicrostonyx gulielmi* and *Microtus gregalis*. Species of

Table III

Species of vertebrates found in sediments of successive layers of Nad Mosurem Starym Duża Cave representing various habitat categories and percentage representation of categories for individuals (N) and for species (S). Ecological groups: A — species inhabiting pools, rivers, streams, including reed-beds; B — species of very moist environment, inhabiting marshes, river flood plains etc.; C — typical forest species; D — eurytopic species; E — species of open country and steppe, including rocky areas; F — species of steppe-tundra environment; G — domestic animals or species strictly associated with human settlements

Ecological groups	Successive layers									
	5		4		3		2		1	
	N	S	N	S	N	S	N	S	N	S
A	4.3	7.1	3.5	10.4	1.6	6.8	0.4	1.6	—	—
B	17.4	14.3	19.4	12.5	16.0	6.8	8.2	6.3	13.3	11.8
C	7.8	14.3	52.4	41.6	42.3	48.0	56.4	49.3	26.7	29.4
D	13.0	21.4	16.6	16.7	21.0	17.8	23.8	22.2	30.0	35.2
E	26.2	28.6	5.8	12.5	14.4	13.7	8.2	14.3	23.3	11.8
F	30.4	14.3	1.7	4.2	0.6	1.4	—	—	—	—
G	—	—	0.6	2.1	4.1	5.5	3.0	6.3	6.7	11.8
Minimum number of individuals (N)	23		171		319		268		30	
Total number of species (S)		14		48		73		63		17

very moist environments are another major component especially among the birds (e. g. *Anas querquedula*, *Spatula clypeata*, *Rallus aquaticus*, *Crex crex*, *Tringa hypoleucos*, *Acrocephalus arundinaceus*). Domestic animals (*Ovis* or *Capra*) appeared in the assemblage for the first time.

The assemblage of layer 3 is the richest and the most varied. The sediment has yielded 15 species of snails, 2 amphibians, 1 snake, 32 birds and 43 mammals. The Shannon index and species diversity is markedly higher (Table III). The thanatocoenosis is different as compared to the previous one. Forest species are still dominant both in the snail and vertebrate communities; however, the total number of individuals associated with woodland areas slightly decreased. The most frequent are the following species: *Cochlodina orthostoma*, *Oxychilus depressus*, *Discus rotundatus*, *Plecotus auritus* and *Clethrionomys glareolus*. Noteworthy is the increase of the number of species connected with open country (e. g. *Asio flammeus*, *Motacilla alba*, *Cricetus cricetus*). A Pleistocene relic form, *Dicrostonyx gulielmi* disappeared definitively from the study area, while *Microtus gregalis*, another component of steppe-tundra environment, has survived. On the other hand, gradual disappearance of aquatic birds and mammals associated with very moist environments is observed. A feature deserving a note is the presence of a very diverse fauna of bats which comprises 13 taxa. In the layer, *Pitymys subterraneus* makes its appearance for the first time in the profile.

The layer 2 contains an assemblage similar to the previous one. The fossil community consists of 29 species of snails, 2 amphibians, 1 snake, 25 birds and 39 mammals. Woodland species are still the predominant elements of the fauna. Among snails, quantitatively prevalent are especially *Cochlodina orthostoma* and *Isognomostoma isognomostoma*. Among vertebrates, the predominance of *Clethrionomys glareolus* is observed. Relatively abundant are also *Myotis bechsteini*, *Arvicola terrestris*, *Pitymys subterraneus* and *Apodemus* (*Sylvaemus*) sp. The characteristic feature is the disappearance of the majority of hydrophilous species. The level provides the last appearance dates for a lot of species, including forms which are not found near the cave today. To the latter category belong the following taxa: *Vestia elata*, *Macrogastra latestriata*, *Laciniaria plicata*, *Lagopus* sp., *Tetrastes bonasia*, *Lyrurus tetrix*, *Tetrao urogallus*, *Turdus torquatus*, *Loxia curvirostra*, *Vespertilio murinus*, *Arvicola terrestris*, *Microtus oeconomus*, *Eliomys quercinus*, *Felis silvestris* and *Cervus elaphus*.

The youngest layer 1 differs distinctly from the previous Holocene levels as far as the fauna is concerned: the assemblage is very poor and does not contain snail shells and bird remains. The fauna consists of 2 species of amphibians, 3 reptiles (including 1 lizard and 2 snakes), and 12 mammals. The frequency of forest species decreases markedly. The characteristic feature of the community is a higher content of species typical of open country (e. g. *Microtus arvalis*). Species which inhabit rivers, streams or ponds disappeared entirely. Noteworthy is the presence of *Elaphe longissima*, which is not found in the region today.

Environmental and climatic changes

The presented succession of the snail and vertebrate faunas from Nad Mosurem Starym Duża Cave reflects the changes in ecological environment and climate over a period of the Pleni-Vistulian (layer 5) and, after a long gap, from the close of the Atlantic episode to recent times (Tab. IV). The composition of the faunal assemblage from the layer 4 suggests the wide expansion of coniferous and mixed forests with shrubby undergrowth in a relatively humid climate. In the region there occurred marshes, small ponds or lakes with thick vegetation bordering waterside. Meadows, steppes or grassy slopes were relatively scarce and limited to small areas. The assemblage from the layer 3 indicates that the range of forests became slightly limited, while open environments played a more important part in the Ojców region. The composition of the thanotocoenosis of the layer 2 testifies once more the wide expansion of forests. The humidity of the climate decreased distinctly due to the disappearance of moist habitats. The environment during the deposition of layer 1 changed markedly. Fields, meadows, grassy areas and other open habitats have become widespread due to the deforestation connected with human activity.

The Nad Mosurem Starym Duża Cave snail and bone assemblage has expanded our knowledge of the Holocene fauna of the southern part of the Cracow-Wieluń Upland, and has introduced new questions on Holocene zoogeography

Table IV

Stratigraphy and faunal trends in the Holocene sediments of Nad Mosurem Starym Duża Cave. Explanations: SR — Sub-Recent, SA — Sub-Atlantic, SB — Sub-Boreal, EA — Epi-Atlantic, AT — Atlantic, BO — Boreal, PB — Pre-Boreal, YD — Younger Dryas

Ty BP	Climatic stages: Ložek 1973	Climatic stages: Starkel 1977	Layer	Sediment	Prehistoric stages	Settlement horizons	Last appearance dates	First appearance dates
-1	SR	SA	1	black humus	Iron Age	Historic settlements		Elaphe longissima
-2	SA		2	humus with small amount of rubble		Lusatian Culture	Iphigena latestriata, Vestia elata, Laciniaria plicata, Lagopus sp., Microtus oeconomus	
-3	SB	SB			Bronze Age			
-4	EA		3	greyish-yellow or brown loam with humus		Bošaca Culture Radial Decorated Pottery Culture	majority of aquatic birds Microtus gregalis	Pitymys subterraneus
-5			4	yellowish loam with rubble	Neolithic		Dicrostonyx gulielmi	domestic animals
-6								
-7	AT	AT						
-8					Mesolithic			
-9	BO	BO						
-10	PB	PB						
	YD	YD						

of the region. The topographic diversity of the Ojców region is responsible for a mosaic of different biotopes and habitats during the Holocene. Especially, the faunal evidence for the former presence of thick forests during the Sub-Boreal phase, although not as exstensive as these obtained from pollen analysis, is highly suggestive.

Teresa Madeyska
Institute of Geological Sciences
Polish Academy of Sciences
Żwirki i Wigury 93
02-098 Warszawa
Poland

Ewa Rook
Archaeological Museum
Senacka 3
31-002 Kraków
Poland

Adam Nadachowski
Barbara Rzebik-Kowalska
Ewa Stworzewicz
Zbigniew Szyndlar
Teresa Tomek
Mieczysław Wolsan
Bronisław W. Wołoszyn
Institute of Systematic
and Experimental Zoology
Polish Academy of Sciences
Sławkowska 17
31-016 Kraków
Poland

REFERENCES

Alexandrowicz S. W. 1983. Malacofauna of Holocene calcareous sediments of the Cracow Upland. Acta geol. pol., **33** (1—4): 117—158.

Alexandrowicz S. W., Stworzewicz E. 1983. Fauna mięczaków martwicy holoceńskiej z doliny Racławki koło Krzeszowic. Acta zool. cracov., **26** (8): 243—250.

Avery A. D. 1982. Micromammals as palaeoenvironmental indicators and an interpretation of the late Quaternary in the Southern Cape province, South Africa. Annals South Afr. Mus., **85** (2): 183—374.

Bocheński Z. 1974. Ptaki młodszego czwartorzędu Polski. PWN, Warszawa—Kraków, 212 pp.

Bocheński Z. 1981. Szczątki kopalne ptaków z Jaskini Mamutowej. Folia quatern., **54**: 1—24.

Bocheński Z., Ginter B., Kozłowski J. K., Mook W. G., Muszyński M., Nadachowski A., Stworzewicz E., Szyndlar Z. 1985. Badania osadów schronisk podskalnych w Zalasie koło Krakowa. Folia quatern., **56**: 3—56.

Bocheński Z., Młynarski M., Nadachowski A., Stworzewicz E., Wołoszyn B. W. 1983. Górnoholoceńska fauna z Jaskini Dużej Sowy (doniesienie wstępne). Przegl. zool., **27** (4): 437—456.

Bocheński Z., Oleś T. 1977. Ptaki Ojcowskiego Parku Narodowego. Acta zool. cracov., **22** (8): 319—371.

Chmielewski W. 1961. Civilization de Jerzmanowice. IHKM, PAN, Wrocław—Warszawa—Kraków, 92 pp.

Chmielewski W. 1975. Paleolit środkowy i górny. (in.): Chmielewski W., Hensel W. (eds). Prahistoria Ziem Polskich: Paleolit i mezolit. Wrocław—Warszawa—Kraków—Gdańsk, pp. 9—158.

Chmielewski W., Kowalski K., Madeyska-Niklewska T., Sych L. 1967. Wyniki badań osadów Jaskini Koziarni w Sąspowie, pow. Olkusz. Folia quatern., **26**: 1—67.

Emlen J. M. 1973. Ecology: An Evolutionary Approach. Addison-Wesley Publ. Comp., Reading-Menlo Park—London—Don Mills, 493 pp.

Kowalski K., Kozłowski J. K., Krysowska M., Wiktor A. 1965. Badania osadów schroniska w Puchaczej Skale w Prądniku Czajowskim powiat Olkusz. Folia quatern., **20**: 1—42.

Kozłowski K. 1922. Starsza epoka kamienna w Polsce (paleolit). Pr. Kom. Archeol. Pozn. Tow. Przyj. Nauk, **1** (1): 1—53.

Ložek V. 1964. Quartärmollusken der Tschechoslowakei. Rozpr. Ustř. Ustavu Geol., **31**: 1—374.

Ložek V. 1973. Příroda ve Čtvrtohorach. Akademia. Praha, 372 pp.

Madeyska T. 1981. Środowisko człowieka w środkowym i górnym paleolicie na ziemiach polskich w świetle badań geologicznych. Studia Geol. Pol., **69**: 1—125.

Madeyska T. 1982. The stratigraphy of Palaeolithic sites of the Cracow Upland. Acta Geol. Pol., **32** (3—4): 230—242.

Madeyska T. 1988. Osady jaskiń i schronisk Doliny Sąspowskiej (in): Jaskinie Doliny Sąspowskiej. Tło przyrodnicze osadnictwa pradziejowego. Pr. Inst. Archeol. Uniw. Warszawskiego, 1: 77—173.

Nadachowski A. 1982. Late Quaternary rodents of Poland with special reference to morphotype dentition analysis of voles. PWN Warszawa—Kraków, 109 pp.

Odum E. P. 1971. Fundamentals of ecology. W. B. Saunders, Philadelphia.

Pucek Z. (ed.). 1981. Keys to vertebrates of Poland. Mammals. Pol. Acad. Sci. Publ., Warszawa, 367 pp.

Pucek Z., Raczyński J. (eds). 1983. Atlas of Polish mammals. Pol. Acad. Sci. Publ., Warszawa, 188 pp.

Rook E. 1970a. Wyniki prac wykopaliskowych w jaskini "nad Mosurem Starym, dużej" w Grodzisku pow. Olkusz, w latach 1967 i 1968. Spraw. Archeol., **22**: 57—65.

Rook E. 1970b. Sprawozdania z badań w jaskini nad Mosurem Starym, dużej w Grodzisku, pow. Olkusz. Mat. Archeol., **11**: 271—274.

Rook E. 1980. Osadnictwo neolityczne w jaskiniach Wyżyny Krakowsko-Częstochowskiej. Mat. Archeol., **20**: 5—114.

Römer F. 1883. Die Knochenkohle von Ojców in Polen. Paleontographica, **29**: 1—41.

Starkel L. 1977. Paleogeografia holocenu. PWN, Warszawa, 362 pp.

Stworzewicz E. 1973. Kopalna fauna ślimaków *(Gastropoda)* ze Schroniska nad Jaskinią Niedostępną w okolicach Ojcowa. Acta zool. cracov., **18** (12): 301—310.

Stworzewicz E. 1988. Fauna mięczaków jaskin i schronisk Doliny Sąspowskiej. (in.): Jaskinie Doliny Sąspowskiej. Tło przyrodnicze osadnictwa pradziejowego. Pr. Inst. Archeol. Univ. Warszawskiego, 1: 39—45.

Szyndlar Z. 1984. Fossil Snakes from Poland. Acta zool. cracov., **28** (1): 1—156.

Vaurie C. 1959. The Birds of the Palearctic Fauna. Passeriformes. H. F. & G. Witherby Ltd., London, XII+762 pp.

Vaurie C. 1965. The Birds of the Palearctic Fauna. Non-Passeriformes. H. F. & G. Witherby Ltd., London, XX+763 pp.

Wiktor A. 1974. Fauna mięczaków subfosylnych rezerwatu Muszkowicki Las Bukowy w powiecie ząbkowickim. Ochrona Przyr., **40**: 269—290.

Wołoszyn B. W. 1987 [1988]. Pliocene and Pleistocene bats of Poland. Acta Palaeontol. Pol., **32** (3—4): 207—325

Zawisza J. 1874. Jaskinia Mamutowa w dolinie Wierzchowskiej (oraz Jaskinia Wierzchowska i ogólny pogląd na jaskinie tej okolicy). Wiad. Archeol., **2**: 1—22.

STRESZCZENIE

Badania wykopaliskowe przeprowadzone w Jaskini nad Mosurem Starym Dużej w latach 1967—1969 dostarczyły bogatych materiałów archeologicznych i paleontologicznych. Wyróżniono 6 warstw, z których najgłębsza (warstwa 6) była jałowa. Kolejna warstwa 5, występująca jedynie na stoku przed jaskinią, osadzała się w okresie ostatniego zlodowacenia. Pozostała seria osadów (warstwy od 4 do 1) tworzyła się najprawdopodobniej od schyłkowej części fazy atlantyckiej holocenu po czasy historyczne. W osadach, szczególnie okresu holoceńskiego, odkryto bogatą faunę ślimaków lądowych (31 gatunków) i kręgowców (nieliczne szczątki ryb, 2 gatunki płazów, 4 gatunki gadów, 51 taksonów ptaków i 50 taksonów ssaków). Ślimaki występowały głównie w warstwach 3 i 2 i należały przede wszystkim do form leśnych. Trzy gatunki, a mianowicie *Vestia elata*, *Macrogastra latestriata* i *Laciniaria plicata* nie występują współcześnie w rejonie Ojcowa. Wśród gadów najciekawszym gatunkiem jest *Elaphe longissima* odnaleziony w warstwie 1, co świadczy, że występował do niedawna w tej części Jury Krakowsko-Wieluńskiej. Wśród ptaków stwierdzono po raz pierwszy w stanie kopalnym dla Polski 13 następujących taksonów: *Mergus merganser*, *Tringa hypoleucos*, *Upupa epops*, *Dendrocopos major*, *Cinclus cinclus*, *Acrocephalus arundinaceus*, *Phyloscopus* sp., *Muscicapinae*, *Oenanthe oenanthe*, *Parus palustris*, *Parus major*, *Carduelis spinus* i *Loxia curvirostra*. Szesnaście taksonów ptaków nie gnieździ się obecnie w okolicach Ojcowa (*Anas querquedula*, *Spatula clypeata*, *Mergus merganser*, *Lagopus* sp., *Tetrastes bonasia*, *Lyrurus tetrix*, *Tetrao urogallus*, *Rallus aquaticus*, *Crex crex*, *Tringa hypoleucos*, *Asio flammeus*, *Aegolius funereus*, *Surnia ulula*, *Strix uralensis*, *Eremophila alpestris* i *Turdus torquatus*). Awifauna jest zdominowana przez ptaki gnieżdżące się w lasach różnego typu (26 gatunków). Wykazano ponadto 9 gatunków wodnych-błotnych i 9 gatunków związanych z polami, łąkami lub terenami skalistymi. Wśród ssaków również dominują formy leśne (21 gatunków); 9 gatunków występuje w terenach otwartych i tyle samo jest form eurytopowych. Obecność cieków lub zbiorników wodnych jest konieczna do życia dalszym 5 gatunkom, a 3 ssaki to zwierzęta domowe. Dwanaście gatunków ssaków nie jest wykazywanych obecnie z doliny Prądnika (*Myotis nattereri*, *Myotis brandti*, *Vespertilio murinus*, *Arvicola terrestris*, *Dicrostonyx gulielmi*, *Microtus oeconomus*, *Microtus gregalis*, *Eliomys quercinus*, *Ursus arctos*, *Lutra lutra*, *Felis silvestris* i *Cervus elaphus*). Materiał faunistyczny został użyty do odtworzenia środowiska i warunków klimatycznych panujących podczas tworzenia się osadów. Zbadano następstwo zespołów faunistycznych w poszczególnych poziomach stosując ekologiczne współczynniki: różnorodności Shannona (H), różnorodności gatunkowej (d) i jednorodności zespołu faunistycznego (e). Zespół z warstwy 5 był najuboższy w gatunki z dominacją form tundrowych (*Dicrostonyx*, *Microtus gregalis*), co świadczy o tym, że reprezentuje on okres zimnego klimatu i otwartego środowiska stepowo-tundrowego. Kolejne trzy zespoły z warstw 4, 3 i 2 wskazują na klimat dość ciepły i silny rozwój lasów, głównie iglastych lub mieszanych. W kolejnych warstwach spada li-

czebność gatunków związanych z wodą, co świadczyłoby o stopniowym zanikaniu środowisk wodnych różnego typu w okolicach Krakowa w okresie subborealnym, a także o osuszaniu klimatu. Dane z Jaskini nad Mosurem Starym Dużej wskazują, że niektóre plejstoceńskie relikty (*Dicrostonyx*) przetrwały na badanym terenie do początku późnego holocenu, lub jeszcze dłużej (np. *Lagopus*, *Microtus gregalis*, *Microtus oeconomus*). Wiele gatunków leśnych (szczególnie wśród ptaków), obecnie nie występujących w okolicach Ojcowa, przetrwało do końca okresu subborealnego. Najmłodsza warstwa 1, uboga faunistycznie, wskazuje na postępujące odlesienie badanego terenu, co ma prawdopodobnie związek z działalnością człowieka.

Redaktor pracy: mgr Z. Bocheński