Acta zoologica cracoviensia, **49A**(1-2): 83-118, Kraków, 30 June, 2006

Erinaceomorpha and Soricomorpha (Mammalia) from the Late Pleistocene and Holocene of Krucza Skała Rock Shelter and Komarowa Cave (Poland)

Barbara RZEBIK-KOWALSKA

Received: 10 Jan., 2006

Accepted: 21 March, 2006

RZEBIK-KOWALSKA B. 2006. Erinaceomorpha and Soricomorpha (Mammalia) from the Late Pleistocene and Holocene of Krucza Skała Rock Shelter and Komarowa Cave (Poland). *Acta zoologica cracoviensia*, **49A**(1-2): 83-118.

Abstract. 12 species of the insectivores, eight in Krucza Skała Rock Shelter and 10 in Komarowa Cave, were found in the Late Pleistocene and the Holocene layers of these localities. They are: *Erinaceus* sp., *Desmana moschata*, *Talpa* cf. *minor*, *Talpa europaea*, *Sorex minutus*, *Sorex runtonensis*, *Sorex araneus*, *Sorex* sp., *Neomys* sp., *Neomys* cf. *fodiens*, *Crocidura zorzii*, and *Crocidura leucodon*. Their descriptions, measurements, systematic position and illustrations are given. Two of them, *Desmana moschata* and *Crocidura zorzii* are new for the Polish Pleistocene fauna.

Key words: fossil insectivores, Mammalia, Late Pleistocene, Holocene.

B. RZEBIK-KOWALSKA, Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, 31-016 Kraków, Sławkowska 17, Poland.
E-mail: rzebik@isez.pan.krakow.pl

I. INTRODUCTION

The rock shelter itself (nine layers, 1-9) and the front entrance (six layers, I-VI) of Krucza Skała Rock Shelter were excavated in 1991 and 1992. The correlation of particular layers of the sediment profile in the rock shelter and front entrance are not clear in all cases (CYREK 1994). The deepest layers 1 and I and 2 and II as well as 9 and VI seem to be equivalent. The last two layers (9 and VI) are probably of a Holocene age, however species of a steppe-tundra environments occurred up to the surface (NADACHOWSKI et al. in press). Five samples were dated using the radiocarbon method (^{14}C). The oldest layer I is dated to 12 520±70 BP. According to BOCHEŃSKI and TOMEK (2004) all animal remains accumulated during a short time , i. e. the last 13 000 years. Rich archaeological artifacts and abundant animals remains were found at this locality (for more information see NADACHOWSKI et al. in press).

*This project was partly supported by grant 6 PO4C 097 20 awarded by the State Committee for Scientific Research of Poland.

Komarowa Cave is situated ca 10 km south to south-east of Częstochowa, in the northern part of the Częstochowa Uplands, and Krucza Skała Rock Shelter in the Kroczyce Roks, in the middle part of the Częstochowa Upland, both in central Poland.

Excavations inside the Komarowa Cave (layers K, J, G4, G, F, E, D/E, D, and C) and on the terrace in front of its entrance (layers Gtx, Ft, B/F', B, A/B, A' and A) took place between 1997 and 2001. Ten samples from various layers were dated using radiocarbon (^{14}C) and seven using the Thermoluminescence (TL) methods. The first (^{14}C) dates range from 46 100 ±900 BP to 24 550±220 BP and the second one (TL) are between 16 700±2000 BP and 9 900±1300 BP (NADACHOWSKI et al. in press). In most cases the dates agree with the sequence of the layers, and only those from the lower part of the uppermost layers A and A' indicate disturbance of sediments. Layer E (older than Middle Weichselian) was dated indirectly (for more information on the cave see TOMEK and BOCHEŃSKI 2005, NADACHOWSKI et al. in press).

Teeth: I^1, I_1 and A_1 were measured along the buccal side, the remaining teeth on the occlusal side. L = maximal length, W = maximal width, W (med.) = median width, and H = maximal height, DW – width of humerus diaphysis.

The material studied is housed in the collections of the Institute of Systematics and Evolution of Animals Polish Academy of Sciences in Kraków.

A c k n o w l e d g e m e n t s. The author is particularly grateful to Mr. Marek KAPTURKIEWICZ for the illustrations.

II. SYSTEMATIC PART

Family **Erinaceidae** FISCHER VON WALDHEIM, 1817

Subfalily **Erinaceinae** FISCHER VON WALDHEIM, 1817

Genus ***Erinaceus*** LINNAEUS, 1758

Erinaceus sp.

M a t e r i a l. One M^1 and one M_1 talonid. Minimal number of individuals = 1. Komarowa Cave, layers: D and A respectively, No. MF/3179.

D e s c r i p t i o n o f m a t e r i a l. The M^1 is large, subquadrate in occlusal outline. It is surrounded by a wide cingulum with the exeption of the region below the protocon and hypocon. The highest cusp is the metacon. The parastyle is present as well as the oval metaconule, which closes the trigon basin, and is distinct.

The talonid of the M_1 is devoid of a cingulum. Its entoconid is higher than the hypoconid. In the posterior part of the tooth the lower border of the crown is concave. The crista runs from the tip of the entoconid ends on the posterior wall of the tooth below to the tip of the hypoconid. The identification of this talonid as belonging to an M_1 and not to an M_2 results from its dimensions. In the M_1 of Recent *E. concolor* MARTIN, 1838 from Poland W of talonid = 3.35-4.03 mm (n = 12) and in M_2 = 2.88-3.55 mm (n = 12). As the width of the talonid present in Komarowa Cave = 3. 68 mm, it has been identificated as belonging to an M_1.

M e a s u r e m e n t s. M^1 L = 5.84 mm, W = 6.63 mm, talonid of M_1 W = 3.68 mm.

S y s t e m a t i c p o s i t i o n. The teeth described above do not differ in morphology from the same teeth of the Recent hedgehogs, *Erinaceus concolor* and *E. europaeus* LINNAEUS, 1758 living in Poland. They are, however, larger and more massive (see Table I and Fig. 1) than the teeth of the Recent species.

Two large species of hedgehogs have been described from the Pleistocene localities of Europe. These are: *E. praeglacialis* BRUNNER, 1933 from the Early Pleistocene of Windloch in Germany and *E. davidi* JAMMOT, 1973 from the Middle Pleistocene of La Fage in France. According to

Table I

Dimensions (in mm) of the M^1 in large Pleistocene and Recent species of the genus *Erinaceus* in Europe

		Erinaceus sp.	*E. praeglacialis*	*E.* cf. *praeglacialis*	*E. davidi*	*E. concolor*	*E. concolor*	*E. europaeus*
		Komarowa Cave	Windloch	Hundsheim	La Fage			
		(Poland)	(Germany)	(Austria)	(France)	(Poland)	(Europe)	
		L. Pleistocene and Holocene	E. Pleistocene	M. Pleistocene	M. Pleistocene	Recent	Recent	
			BRUNNER 1933 Holotype	RABEDER 1972	JAMMOT 1973		HOLZ and NIETHAMMER 1990	
M^1	L	5.84	5.15	5.00-5.50 *	4.90-5.40	4.89-5.50	4.70-5.50	4.60-5.50
		n=1	n=1	n=2* and 3**	n=7	n=13	n=20	
	W	6.63	6.32	5.80-6.50**	5.50-6.00	5.22-5.99	–	–

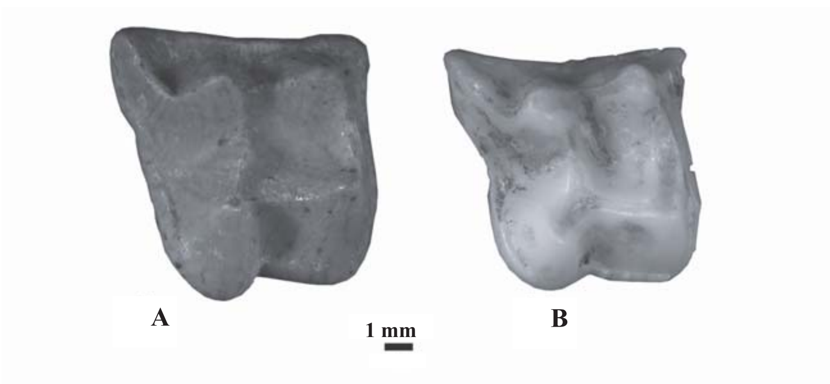

Fig. 1. Right M^1: A – *Erinaceus* sp. from Komarowa Cave, B – *Erinaceus concolor* (Recent) from Poland.

JAMMOT (1973) *E. davidi* is the largest of the Plio/Pleistocene hedgehogs. Its molars are identical to those in the Recent species but its upper premolars are more developed and the lower ones have slightly reduced talonids. The comparison of the M^1 measurements of *E. davidi* with the Recent M^1's of *E. concolor* and *E. europaeus* indicates that they lie in the range of variation of the Recent species (see Table I). Unfortunately there are no premolars in the material from Komarowa Cave and a morphological comparison is not possible.

As concerns *E. praeglacialis* it seems to be a larger than *E. davidi*, *E. concolor* and *E. europaeus* although RABEDER (1972) writes that its size lies in the range of variation of the Recent forms and only morphology (the position of P^3) and the size of M^3 allow one to distinguish the Recent and fossil species. As there is no the upper jaw in the Komarowa Cave material the identification of these specimens is difficult. Table I shows that the M^1 of *E. praeglaialis* is a little wider than in *E. concolor* . However the comparative material is limited (HOLZ and NIETHAMMER 1990 cited only the length of the tooth) and besides, we do not know the individual variation of the size of this tooth in *E. praeglacialis* and both Recent species. On the other hand, *E. praeglacialis* has never been found on a Late Pleistocene locality. So far, it is only known from the Early and Middle Pleistocene. As in case of Komarowa Cave the Pleistocene remains of hedgehogs are usually very scarce and badly preserved so it is difficult to assign them to species. We do not know when *E. praeglacialis* disappeared and when *E. concolor* appeared in Europe. This is especially important because for a long time the *E. concolor* was confounded with *E. europaeus*. In this case the teeth from Komarowa Cave are tentatively identified as *Erinaceus* sp.

Family **Talpidae** FISCHER VON WALDHEIM, 1817

Subfamily **Desmaninae** THOMAS, 1912

Genus ***Desmana*** GUELDENSTAEDT, 1777

Desmana moschata (LINNAEUS, 1758)

M a t e r i a l. One M^1, one P_4, two fragments of mandibles with P_4-M_2 and M_1 without processes, and two humeri, one almost entire, the second one damaged. Minimal number of individuals = 2. Komarowa Cave, layer: D, No. MF/3180.

D e s c r i p t i o n o f m a t e r i a l. The M^1 is massive and characterized by strong cusps. The highest one is the metacon. A strong mesostyle is deeply divided. The protoconule is smaller than the metaconule and connected to the parastyle and separated from the paracone and protocone by narrow grooves. A deep valley separates the protocone and metaconule. The posterior and antero-buccal (around the paracone) cingulum protrudes, the buccal, anterior and lingual cingula are absent.

The P_4 is almost flat in its lingual, convex in its buccal and concave in its posterior sides. The anterocristid ends near the antero-lingual corner of the tooth. The sharp posterocristid ends near the postero-buccal corner. A very small paraconid is present in the antero-lingual side of the tooth. A conspicious talonid basin is present which closed posteriorly by a continuation of the posterocristid. The entoconid and hypoconid are absent. Wide anterior and posterior cingula are also present.

The M_1 is large and very massive. Its oblique cristid ends against the protoconid – metaconid crest. In one specimen a strong parastylid and entostylid are present, in a second only the entostylid is visible. A strong anterior cingulum is present which continues on the bucal side, to the protoconid-hypoconid valley where it has the shape of a denticle.

The M_2 is similar but smaller.

The horizontal ramus in both mandibles are damaged in their anterior parts. In one of them a single mental foramen is ptresent situated below the talonid of M_1.

The humerus is very slender. The teres tubercle is rather long. It lies half way up the shaft and has an elliptical facet. The pectoral process is a protruding, wedge-shaped area and well developed. It lies in the center of the shaft, in a lateral position in relation to the teres tubercle. The entepicondyle is broken. The elliptical entepicondylar foramen is large. The supratrochlear fossa is large and deep. The ectepicondyle is rather long. The oleocranon fossa is shallow. The head and greater tuberosity are large.

M e a s u r e m e n t s. See Table II.

Table II

Dimensions of upper and lower teeth, the mandible and humerus (in mm) of *Desmana moschata* from Komarowa Cave and other European localities

No. of specimen		Komarowa Cave					RÜMKE 1985	
		Late Pleistocene					Recent	Recent*
		1	2	3	4	5		
M^1	L	4.81	–	–	–	–	4.18-4.74 (n=14)	4.64
	W	4.19	–	–	–	–	3.95-4.50	4.04
P_4	L	–	2.86	2.67	–	–	2.53-2.84 (n=14)	2.54
	W	–	2.05	1.92	–	–	1.77-2.05	2.01
M_1	L	–	3.65	–	3.61	–	3.58-3.98 (n=14)	3.72
	W	–	3.13	–	2.85	–	2.71-3.10	3.08
M_2	L	–	3.60	–	–	–	3.43-3.98 (n=14)	3.74
	W	–	2.93	–	–	–	2.57-2.96	2.95
H of mandible below M_1		–	5.99	–	5.32	–	–	6.01
H of mandible below M_2		–	5. 98	–	5.38	–	–	5.84
Humerus	L	–	–	–	–	23.10	–	24.50
	W	–	–	–	–	10.90	–	12.00
	DW	–	–	–	–	3.94	–	4.70

* specimen of the Institute of Systematics and Evolution of Animals collection

S y s t e m a t i c p o s i t i o n a n d d i s t r i b u t i o n. The presence of a divided mesostyle and well developed lingual parts of upper molars, the presence of the metaconal rib in P_4 and the oblique cristid of the lower molars ending against the protoconid-metaconid crest indicate that specimens from Komarowa Cave represent the subfamily Desmaninae. The large size (L of M_1 2.25 mm, L of M^1 2.75 mm; RÜMKE 1985) allow to identify them as the genus *Desmana*. Among *Desmana* such a large size features only *D. moschata*. The specimens from Komarowa Cave do not differ in morphology from the Recent form.

Today *D. moschata* lives in basins of the rivers: Volga, Don, Oka and Ural. In the Pleistocene its range was spread westwards in Europe.

So far, the oldest, Early Pleistocene (Q1) remains of *D. moschata* are known from the locality of Mosbach 1 in Germany (KOENIGSWALD and TOBIEN 1987). At the Early/Middle Pleistocene boundary it appeared in England. BISHOP (1982) reported it from the locality of Westbury-Sub-Mendip and STUART (1988) from the West Runton Freswater Bed. In the Middle Pleistocene it was present in Germany at Mosbach 2 (KOENIGSWALD and TOBIEN 1987), in The Netherlands at Rhenen-Leccius de Ridder pit (KOLFSCHOTEN 1990) and at Nyaravai 2 in Lithuania (MOTUZKO

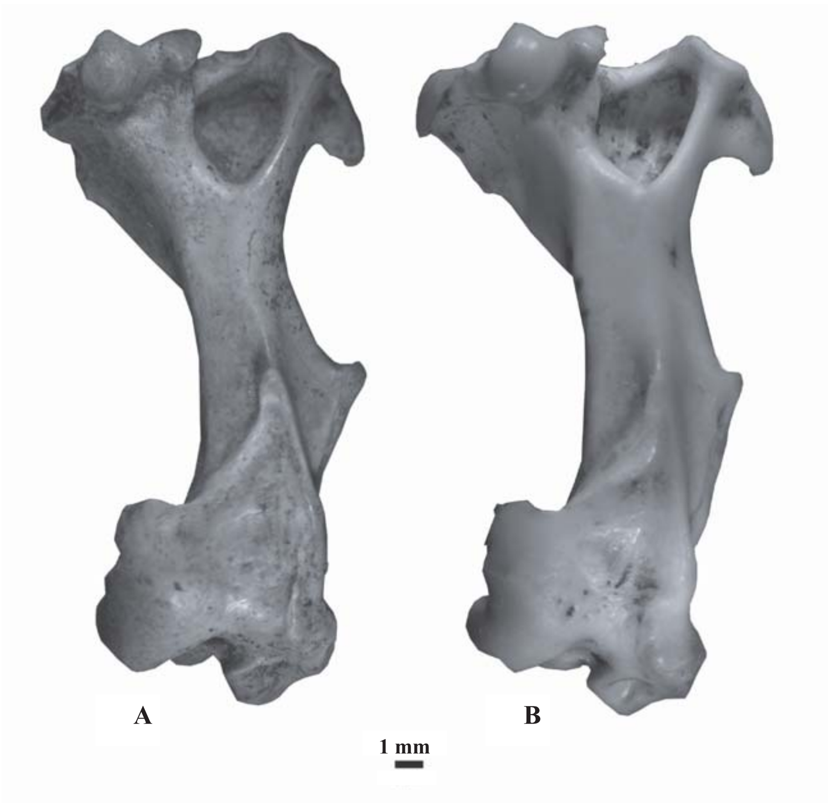

Fig. 2. Right humeri: A – *D. moschata* from Komarowa Cave, B – *D. moschata* (Recent) from Ukraine.

1990). Late Pleistocene remains of *D. moschata* are known from Nørre Lyngby in Denmark (AARIS-SØRENSEN 1995) and Early Holocene ones at Buroje in Byelorussia (MOTUZKO and IVANOV 1996). It is also known from Mosbach 3 (Germany), a locality with no precisely identified age.

Therefore, *D. moschata* was expected in the Polish territory and a finding in Komarowa Cave fulfills a gap between its Pleistocene range in Germany, Byelorussia and Lithuania. Its presence in Komarowa Cave is the first record of this species in Poland.

Subfamily **Talpinae** FISCHER VON WALDHEIM, 1817

Genus ***Talpa*** LINNAEUS, 1758

Talpa cf. ***minor*** FREUDENBERG, 1914

M a t e r i a l. Three humeri. Minimal number of individuals = 2. Krucza Skała Rock Shelter, layers: V?, and VI, No. MF/3189. Two strongly damaged humeri. Minimal number of individuals = 1. Komarowa Cave, layers: Gtx, No. MN/3181.

D e s c r i p t i o n o f m a t e r i a l. The humerus is small and its morphology is typical for the Recent *Talpa europaea* LINNAEUS, 1758.

M e a s u r e m e n t s. See Table III.

Table III

Dimensions of humeri (in mm) of *T.* cf. *minor* from Krucza Skała Rock Shelter and Komarowa Cave, *Talpa minor* from Betfia IX (Romania) and of *Talpa europaea* from Europe

		Krucza Skała Rock Shelter Late Pleistocene and Holocene	Komarowa Cave Late Pleistocene	*T. minor* Betfia IX Early Pleistocene RZEBIK-KOWALSKA 2000b	*T. europaea* Poland Europe* Recent NIETHAMMER* 1990
	L	12.80-13.10, n=2	–	10.50-11.40, n=13	13.30-15.10,n=5 13.10-18.20,n=63*
Humerus	W	8.30-8.80, n=2	–	7.50-8.20, n=14	9.50-10.60, n=5
	DW	2.80-2.90, n=3	2.83-3.03, n=2	2.40-3.10, n=67	3.30-4.00, n=5 3.30-4.70, n=63*

S y s t e m a t i c   p o s i t i o n   a n d   d i s t r i b u t i o n. As mentioned above the humeri from Krucza Skała Rock Shelter and from Komarowa Cave resemble that of *T. europaea* but are smaller. This suggests that they belong to *T. minor* FREUDENBERG, 1914, described from the early Middle Pleistocene of Hundsheim in Austria, as *T. europaea* var. *minor* n. subsp. The detailed description, history and synonymy of *T. minor* can be found in RABEDER (1972) and CLEEF-RODERS and VAN DEN HOEK OSTENDE (2001). According to RABEDER (1972) all small moles described from the Pliocene and Pleistocene belong to one species the name of which (taking into account the priority of name) should be *T. minor*. However, RĂDULESCU and SAMSON (1989) were of the opinion that the specimens described as *T. minor* from the Early Pliocene localities (e.g. from Podlesice and Węże 1 in Poland) most probably belong to *T. neagui* described by them from Bereşti (MN14) in Romania.

T. minor was present in the Pliocene, as well as the Early and Middle Pleistocene of Europe (RZEBIK-KOWALSKA 2000b, CLEEF-RODERS and VAN DEN HOEK OSTENDE 2001) but it has never been mentioned from Late Pleistocene and Holocene localities.

So far in Poland, besides Komarowa Cave and Krucza Skała Rock Shelter, it was found from the Pliocene (Podlesice, MN14, KOWALSKI 1956; Węże 1, MN15, SULIMSKI 1959, 1962a; Węże 2, N15/MN16, SULIMSKI 1962b; Rębielice Królewskie 1A, MN16, KOWALSKI 1960), the Pliocene/Pleistocene boundary (Kadzielnia, MN17/Q_1, KOWALSKI 1958), and Early Pleistocene locality (Żabia Cave, Q_1, BOSAK et al. 1982).

If the identification of the remains from Krucza Skała Rock Shelter and Komarowa Cave is good, the presence of *T. minor* in the Late Pleistocene (layer Gtx in Komarowa Cave and layer V? in Krucza Skała Rock Shelter) and Holocene (layer VI in Krucza Skała Rock Shelter) are the first such late findings of this species. The layer Gtx in Komarowa Cave is dated to the Late Eemian or Early Vistulian (Weichselian) and its presence there seems to be more probable than in the Holocene. In both caves deposits older than Late Pleistocene are lacking, so dislocation of sediments by ancient excavations or by the loose structure of some sediments (BOCHEŃSKI and TOMEK 2004) is not likely. The other possibility, that it was not *T. minor* but one of the smaller Recent European moles, e. g. *T. caeca* SAVI, 1822, is also improbable. Although, the last form has been considered by some authors (KURTÉN 1968, ROBERT 1983) to be the descendant of *T. minor*, later study has shown

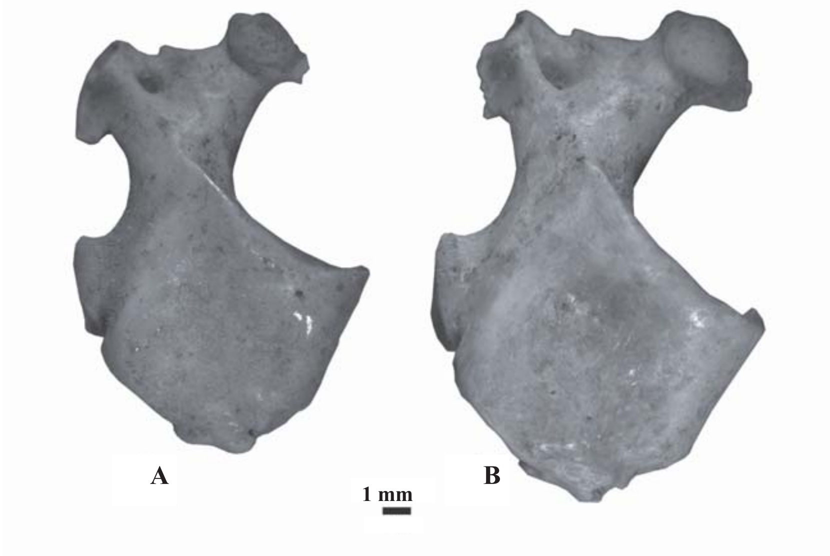

Fig. 3. Left humeri: A – *T. minor* from Krucza Skała Rock Shelter, B – *T. europaea* from Komarowa Cave.

some differences in their size and morphology. For example, the humeri and the mandibles of *T. caeca* and *T. minor* are more or less of the same size, but the molars of *T. caeca* are bigger, comparable in size with those of *T. europaea*. Unfortunately there are no teeth in the material from Krucza Skała Rock Shelter and Komarowa Cave. The presence of *T. caeca* in the record of Poland is, however, not probable. So far, *T. caeca* has not been mentioned in the fossil record (there is one mention in KURTÉN 1968 of its presence in the Late Pleistocene of Italy, but without any references), and besides, its Recent range lies much more to the south and west of Europe. The presence of other small Recent *Talpa* (e.g. *T. occidentalis* CABRERA, 1907, *T. stankovici* V. et E. MARTINO, 1931), endemics of Mediterranean peninsulae, are even more improbable. Therefore it is most probable that it was *T. minor*. It survived longer (up to the Holocene) in this part of Europe than in the west.

Talpa europaea LINNAEUS, 1758

M a t e r i a l. One P^4, three mandible fragments without teeth and processes, one M_1 and seven humeri. Minimal number of individuals = 6. Krucza Skała Rock Shelter, layers: 7, 9, V, and VI, No. MF?3190. One P^4, three M^1, 28 mandible fragments with P_1, P_4, M_1-M_2, and ten humeri mostly damaged in their proximal and distal parts. Minimal number of individuals = 9. Komarowa Cave, layers: GHH, F, A, Gtx, Ft, B, A/B, A', No. MF/3182.

D e s c r i p t i o n o f m a t e r i a l. The P^4 is characterized by a high and large paracone and a small, protruding parastyle. The parastyle lies in front of the paracone. The lingual extension is situated lingually in relation to the tip of the paracone. The posterocrista is sharp and long. The outline of the occlusal surface of the tooth is triangular. The buccal cingulum is well developed. Three roots, two buccal and one lingual, are present.

The M^1 has a low and large protocone and a weakly visible hypocone which appears as a swelling in the posterior arm of the protocone. The mesostyle is undivided. The posterior arm of the metacone is very long, about twice as long as the anterior arm. In two of the three teeth the parastyle is very well developed.

The P_1 is unicuspid with two strong roots. Its buccal side is a little convex, while its lingual side is straight. The anterocristid is short, and the posterocristid is long. They are sharp and the last one ends with a very small cusp. The cingulids are absent.

The P_4 is characterized by a high paraconid which is usually the only cusp of the tooth. Its buccal side is slightly convex. The parastylid protrudes. The talonid is present and bordered by a low posterior ridge. The long posterocristid runs from the lingual side of the paraconid to the posterolingual corner of the tooth. A wide, short cingulid is present along the posterolingual side of the tooth. The lingual cingulid is hardly visible.

In the M_1 the trigonid is narrower than the talonid. The trigonid basin is U-shaped, the talonid basin is wide and open. In the lingual side four cusps are visible because the entostylid is well developed. The oblique cristid ends against the middle of the protoconid-metaconid crest. The re-entrant valley is not very large. Cingulids are absent.

The M_2 has a trigonid which is wider its the talonid. The trigonid basin is wide. The talonid basin may be partly bordered by a low entocristid. In the lingual side five cusps are present because the parastylid and entostylid are developed. The oblique cristid ends more lingually than in the M_1, near the base of the metaconid. The re-entrant valley is open and wide. Cingulids are absent.

The coronoid process is large. Usually there are two mental foramina, under P_2 and M_1. The third one may be present under the P_4.

Humerus is very large and stout.

M e a s u r e m e n t s. See Table IV and V.

Table IV

Dimensions of upper and lower dentition and humeri (in mm) of *T. europaea* from Krucza Skała Rock Shelter

		Min.	X	Max.	n
P^4	L		1.74		1
	W	–	0.93	–	1
M_1	L	–	2.36	–	1
	W	–	1.31	–	1
H of mandible below P_2		1.70	1.72	1.75	2
H of mandible below M_1		1.94	1.95	1.97	2
Humerus	W	–	9.90	–	1
	DW	3.50	3.60	3.80	6

S y s t e m a t i c p o s i t i o n a n d d i s t r i b u t i o n. The size and morphology of the teeth agree with the size and morphology of *T. europaea* described by CLEEF-RODERS and VAN DEN HOEK OSTENDE (2001) as well as with these characters in the Recent *T. europaea* from Poland. Also the humeri are identical with those in the Recent species. In older deposits the remains of such a medium-sized *Talpa* are usually classified as *T. fossilis* PÉTENYI, 1864, but according to some authors (KOENIGSWALD 1970, RABEDEDER 1972 and others), the name *T. fossilis* indicates only the chronospecies. A revision of the material from the type locality (Beremend in Hungary) is needed to confirm if *T. fossilis* and *T. europaea* are indeed conspecific or if they are separate forms. However, the remains from the Late Pleistocene and Holocene layers of Krucza Skała Rock Shelter and Komarowa Cave can be surely included in *T. europaea*.

Table V

Dimentions of upper and lower teeth and humeri (in mm) of *T. europaea* from Komarowa Cave

		Min.	X	Max.	n	sd	cv
P^4	L	–	1.70	–	1	–	–
	W	–	0.99	–	1	–	–
M^1	L	2.47	2.59	2.80	3	–	–
	W	1.70	1.75	1.78	3	–	–
P_1	L	1.34	1.40	1.50	3	–	–
	W	0.42	0.49	0.54	3	–	–
P_4	L	1.23	1.30	1.38	3	–	–
	W	0.56	0.61	0.67	3	–	–
M_1	L	2.09	2.22	2.36	6	–	–
	W	1.21	1.28	1.35	6	–	–
M_2	L	2.41	2.55	2.68	5	–	–
	W	1.31	1.39	1.48	6	–	–
H of mandible below M_2		1.71	1.77	1.88	6	–	–
H of mandible below M_1		1.88	2.04	2.28	10	0.13	6.37
H of ascending ramus		6.79	7.04	7.30	3	–	–
Humerus	L	14.50	15.07	15.60	3	–	–
	W	9.90	10.20	10.50	3	–	–
	DW	3.30	3.58	3.90	9	0.19	5.31

Family **Soricidae** FISCHER VON WALDHEIM, 1817

Subfamily **Soricinae** FISCHER VON WALDHEIM, 1817

Genus ***Sorex*** LINNAEUS, 1758

Sorex minutus LINNAEUS, 1766

M a t e r i a l. Four mandible fragments with teeth and processes, except the angular process. The minimal number of individuals = 3, Krucza Skała Rock Shelter, layers : 2/3, 7 and 8, No. MF/3191. One I^1 and 44 fragments of mandibles with all their teeth and processes, with the exception of I_1 and the angular process. The minimal number of individuals = 30, Komarowa Cave, layers: GHH, G, F, E, D, A, B/F',B, No. MF/3183.

D e s c r i p t i o n o f m a t e r i a l. I^1 is fissident, and its talon pointed. The buccal posterior edge is placed at a sharp angle to the dorsal margin. The buccal cingulum runs along the posterior edge of the tooth.

The I_1 is tricuspulate. A weak cingulum is present along its buccal posterior margin.

The A_1 is long on the buccal side, an essentially single-cusped.

The P_4 is two-cusped and its postero-lingual basin is well developed.

The M_1 and M_2 are sharply-cusped. Their buccal re-entrant valley opens at some distance above the buccal cingulum. This buccal cingulum is well-developed, narrow and usually undulate, the lingual cigulum is much broader, but less pronounced.

The M_3 has a well-developed talonid which is basined and provided with an entoconid and hypoconid.

The apex of the coronoid process is narrow. It bends towards the anterior. The anterior edge of the coronoid process is straight or more or less concave. The coronoid spicule is absent or hardly visible. The external temporal fossa is developed as a longitudinal groove to a medium depth, running parallel to the posterior edge of the coronoid process. The internal temporal fossa is high. It continues to the tip of the coronoid process.

The condyle is placed far to the back. It represents, in more than 90% of specimens, morphotype 1 (ZAITSEV and RZEBIK-KOWALSKA 2003) characterized by narrow (in its lower part) interarticular area. Its lower edge meets approximately the middle of the upper edge of the lower facet and its internal edge is more or less straight. The remaining specimens represent intermediate types between morphotypes 1 and 2. Morphotype 2 has a wide interarticular area in its lower part. Its lingual (lower) edge meets approximately the end of the upper edge of the lower facet and its internal edge is more or less concave.

The mental foramen is situated in more than 85 % of specimens, in the posterior position, below the trigonid of the M_1 (morphotype 2). The remaining specimens have it placed under the P_4 or a little backwards (morphotype 1) (ZAITSEV and RZEBIK-KOWALSKA 2003).

Mandibular and postmandibular foramina are present. In more than 70% of specimens both openings of approximately equal size are visible (morphotype 2) and in the remaining specimens the mandibular foramen is also present, but it is not easily visible from the lingual side (morphotype 3) (ZAITSEV and RZEBIK-KOWALSKA 2003.

M e a s u r e m e n t s. See Tables VI and VII.

Table VI

Dimensions of mandible and lower dentition (in mm) of *Sorex minutus* from Krucza Skała Rock Shelter

		Min.	X	Max.	n
I_1	L	–	2.48	–	1
	W	0.61	0.63	0.66	2
A_1	L	–	0.75	–	1
P_4	L	0.86	0.88	0.90	2
	W	0.49	0.51	0.54	2
M_1	L	1.10	1.13	1.15	2
	W	0.65	0.65	0.66	2
M_2	L	0.96	1.01	1.05	3
	W	0.60	0.61	0.63	3
M_3	L	0.80	0.84	0.89	2
	W	0.49	0.50	0.52	2
M-M_3	L	–	2.90	–	1
H of mandible below M_2		0.84	0.88	0.94	4
H of ascending ramus		2.56	2.77	2.98	2
W of coronoid process		0.45	0.48	0.52	2
H of condyloid process		1.23	1.35	1.48	2
W of interarticular area		0.45	0.45	0.46	2

Table VII

Dimensions of upper tooth, mandilble and lower dentition (in mm) of *Sorex minutus* from Komarowa Cave

		Min.	X	Max.	n	sd	cv
I^1	L	–	1.14	–	1	–	–
	L of talon	–	0.60	–	1	–	–
	H of talon	–	0.86	–	1	–	–
I_1	L	–	–	–	0	–	–
	W	–	0.52	–	1	–	–
A_1	L	0.71	0.73	0.76	2	–	–
P_4	L	0.74	0.81	0.90	6	–	–
	W	0.48	0.53	0.56	6	–	–
M_1	L	1.03	1.13	1.19	16	0.05	4.42
	W	0.56	0.66	0.74	16	0.04	6.06
M_2	L	0.96	1.03	1.08	14	0.03	2.91
	W	0.53	0.63	0.67	14	0.03	4.76
M_3	L	0.84	0.87	0.89	8	0.02	2.30
	W	0.40	0.49	0.53	9	0.04	8.16
M_1-M_2	L	3.02	3.05	3.09	5	–	–
H of mandible below M_2		0.76	0.87	1.01	29	0.06	7.69
H of ascending ramus		2.88	3.00	3.10	10	0.08	2.67
W of coronoid process		0.47	0.55	0.64	10	0.06	10.91
H of condyloid process		1.19	1.36	1.55	9	0.11	8.09
W of interarticular area		0.38	0.45	0.52	11	0.04	8.89

S y s t e m a t i c p o s i t i o n a n d d i s t r i b u t i o n. The very small size as well as the morphology described above allow one to attribute the specimens from Krucza Skała Rock Shelter and Komarowa Cave to the Recent species *S. minutus*. They do not differ in any aspect from *S. minutus* living today in the Polish territory. Recently *S. minutus* inhabits a large area from North Spain in Europe to Baikal Lake in Asia. It is the oldest specifically identified *Sorex* in Europe. It was found in the Early Pliocene (MN14) localities, dating back about five million years (RZEBIK-KOWALSKA 1998). It was therefore the first of the living *Sorex* species that appeared in the European fauna and persisted until Recent time. During the Late Pliocene and especially during the Pleistocene *S. minutus* was already very common in the fauna of Europe.

Other small species of *Sorex* described from the Pliocene and Pleistocene of Europe seemed to be identical to *S. minutus* and their names were considered the synonyms of the last species (RZEBIK-KOWALSKA 1991, 2006). Therefore they are not ancestral to *S. minutus*. According to STORCH et al. (1998) the supposed ancestor of *S. minutus* could be *S. minutoides*. It was described from Ertemte 2 in China, a locality dated to the Late Miocene and was more primitive than *S. minutus*. Some common features of *S. minutus* and *S. minutoides* suggest a close relationship of both forms and their divergence from other *Sorex* species in the Late Miocene.

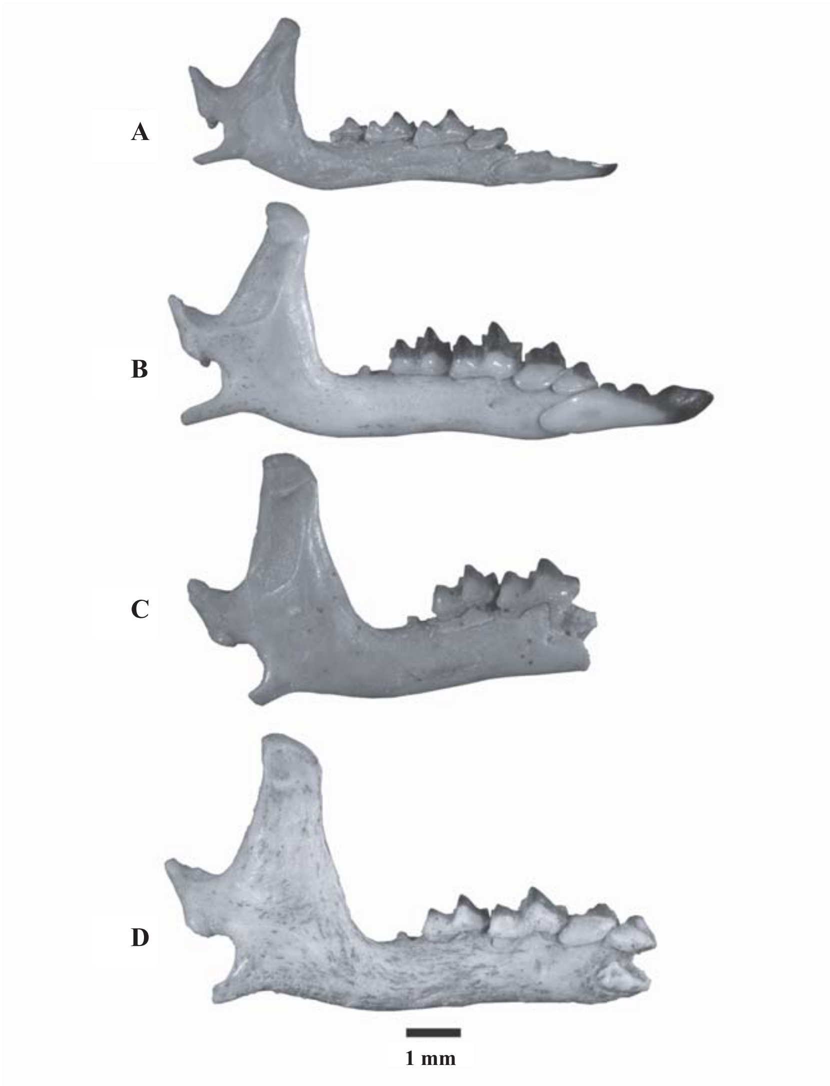

Fig. 4. Right mandibles: A – *S. minutus* from Krucza Skała Rock Shelter, B – *S. runtonensis* from Krucza Skała Rock Shelter, C – *S. araneus* from Komarowa Cave, and D – *Sorex* sp. from Krucza Skała Rock Shelter.

Sorex runtonensis HINTON, 1911

M a t e r i a l. One I^1 (damaged), one fragment of maxilla with A^4-M^2 and 21 mandible fragments with all teeth and processes, except of the angular process. The minimal number of individuals = 10, Krucza Skała Rock Shelter, layers: 1/2/3, 2/3, 6, 7, 8, 9, and VI, No. MF/3192. Five fragments of maxillae with A^3-M^2, and 153 fragments of mandible with all tooth types and processes with the exception of the angular process. The minimal number of individuals = 92, Komarowa Cave, layers: K, J, G4, G, G', F, E, D, C, D/E, Ftx, Ft, F', B/F', Z2, B, A, No. MF/3184.

D e s c r i p t i o n o f m a t e r i a l. Only three antemolars, A^3-A^5, are present. They are unicuspid. Their cusps are situated on the antero-buccal side of teeth. The teeth are surrounded by well-developed cingula on both sides. They decrease regularly in size posteriorly or A^4 is more or less the same size as A^5.

The P^4 has a prominent parastyle and a well-developed paracone and hypocone. The hypocone is individualized from the lingual cingulum. The anterior cingulum is absent, the buccal hardly visible, and the lingual and posterior ones better developed.

The M^1 and M^2 also have well-developed hypocones and indistinct metalophs. Their protocone/hypocone valleys are deep, the lingual and posterior cingula are well pronounced and, the buccal ones weak.

The posterior emargination of the P^4 and M^1-M^2 is moderate.

The I_1 is tricuspulate and its buccal cingulum narrow and not very pronounced. A_1 is single cusped and long and P_4 is bicuspid and relatively short and broad. Its postero-lingual basin is well developed. Both teeth are surrounded by strong cingula on both sides.

The M_1 and M_2 are similar in morphology, but the M_1 is larger. Their protoconids are the dominant cusps, the hypoconids are higher than the entoconids and the entoconid crests are high. The edostylids are present. The buccal cingula are narrow and protruding, the lingual ones larger but flat.

The M_3 is unreduced. It is provided with distinct basin, entoconid and hypoconid, but its talonid is narrower than the trigonid.

The mandibe is delicate and the coronoid process tall and narrow although some specimens are more robust, especially on the tips (for morphological variation of coronoid process in *S. runtonensis* see RZEBIK-KOWALSKA 2000a). The coronoid spicule is small. The external temporal fossa is deep and reaches the level of the upper sigmoid notch or a little lower. It is provided with a longitudinal bar parallel to the posterior border of the process. The internal temporal fossa is triangular and high and in about half the specimens is provided with a better or less developed horizontal bar. The condyloid process is high and in more than 90% of specimens it represents morphotype 1 (see *S. minutus*, p. 93). The mental foramen is in the posterior position and it represents morphotype 2. It lies below the trigonid of M_1, between its protoconid and the buccal re-entrant valley. More than 40% of specimens have it below the buccal re-entrant valley. About 90 % of specimens studied are characterized by the presence of two mandibular and postmandibular foramina (morphotype 2) (ZAITSEV and RZEBIK-KOWALSKA 2003).

M e a s u r e m e n t s. See below and Tables VIII, IX and X.

Dimensions of upper dentition (in mm) of *S. runtonensis* from Krucza Skała Rock Shelter. A^4 L = 0.48, W = 0.59; A^5 L = 0.44, W = 0.58; P^4 L = 1.33; M^1 L = 1.33, L (med.) = 1.02, W = 1.50; M^2 L = 1.27, L (med) = 0.98, W = 1.48.

S y s t e m a t i c p o s i t i o n a n d d i s t r i b u t i o n. The size is intermediate between the size of *S. minutus* and *S. araneus.* Also the morphology of the coronoid and condyloid process allow the identification of those specimens as *S. runtonensis*. According to some authors (e. g. VAN DER MEULEN 1973, JAMMOT 1977, HARRISON 1996) three other fossil *Sorex* species of medium size and similar morphology (*S. aranoides* HELLER, 1930, *S. helleri* KRETZOI, 1959 and *S. kennardi* HINTON, 1911) are identical with *S. runtonensis* and their names are only synonyms of the last species.

The comparison of older, Early and Middle Pleistocene populations of *S. runtonensis* with those from the Late Pleistocene indicates that the species enlarged its size over time, e. g. the height of ascending ramus of specimens from eight Early and early Middle Pleistocene localities of Betfia (B-XIII, B-X, B-XI, B-IX, B-VII/1, B-V, B-VII/3 and B-VII/4) (Romania) equals 3.47-4.08 mm (n=205) (RZEBIK-KOWALSKA 2000a). The same dimension in the Early Pleistocene specimens from Zalesiaki 1A (Poland) equals 3.80-4.04 mm (n=7), in the early Middle Pleistocene Kozi Grzbiet (Poland) 3.70-4.02 mm (n=10) (RZEBIK-KOWALSKA 1991) and in the Middle Pleistocene West Runton (England) 3.78-4.29 mm (n=19) (HARRISON 1996). In his paper of 1911 HINTON only cited the height of ascending ramus of *S. kennardi* (3.85 mm , n = 1) because in two mandibles described as *S. runtonensis* these rami are a little damaged. However the mandible of *S. kennardi* was later included in *S. runtonensis* (HARRISON 1996). The same dimension of younger, Late Pleistocene specimens is on the average and maximally a little larger: in Obłazowa Cave (Poland) it equals 4.04-4.36 mm (n=17) (RZEBIK-KOWALSKA 2003), in Obłazowa Cave 2 – 3.71-4.22 mm (n=9) (HARRISON 1996), and in Krucza Skała Rock Shelter and Komarowa Cave 3.90-4.34 mm (n= 7) and 3.87-4.39 mm (n=70) respectively.

Table VIII

Dimensions of mandible and lower dentition (in mm) of *S. runtonensis* from Krucza Skała Rock Shelter

		Min.	X	Max.	n	sd	cv
I_1	L	3.40	3.52	3.64	2	–	–
	W	0.69	0.82	0.92	7	0.08	9.79
A_1	L	0.87	0.97	1.07	2	–	–
P_4	L	0.97	1.12	1.18	10	0.06	5.76
	W	0.66	0.73	0.77	10	0.04	5.50
M_1	L	1.35	1.43	1.51	10	0.05	3.50
	W	0.73	0.83	0.89	9	0.05	6.02
M_2	L	1.20	1.26	1.34	11	0.04	3.17
	W	0.66	0.74	0.81	10	0.04	5.40
M_3	L	0.96	1.02	1.06	5	–	–
	W	0.57	0.59	0.65	4	–	–
M_1-M_3	L	3.70	3.70	3.71	2	–	–
H of mandible below M_2		1.07	1.26	1.40	17	0.09	7.14
H of ascending ramus		3.90	4.11	4.34	7	0.18	4.38
W of coronoid process		0.73	0.84	1.02	10	0.10	11.90
H of condyloid process		1.53	1.71	1.96	9	0.15	8.77
W of interarticular area		0.54	0.59	0.67	9	0.05	8.47

On the other hand there are no size and morphological differences between the specimens from particular layers in Krucza Skała Rock Shelter and Komarowa Cave as well as between specimens from these two caves.

S. runtonensis was very common throughout Europe from the latest Pliocene to the Late Pleistocene (RZEBIK-KOWALSKA 1998). Lately it was also described as *S.* cf. *runtonensis* from Middle Pleistocene localities of the Caucasus (ZAITSEV and BARYSHNIKOV 2002, ZAITSEV and OSIPOVA 2004). The origin of *S. runtonensis* is unknown. The multivariate analysis indicates that *S. runtonensis* is similar to the widely distributed Eastern Palaearctic, extant *S. tundrensis* MERRIAM, 1900. In addition, these two species differ little from each other by morphological characters. It may well be that these two forms (fossil and Recent) are conspecific and their names should be considered as synonyms. However, a considerable spatial gap between the known ranges of these two forms (Western Palaearctic - *S. runtonensis* , Eastern Palaearctic – *S. tundrensis*) as well as our insufficient knowledge of the intraspecific taxonomy of *S. tundrensis* do not allow us, for the time being, to synonimized those two species (OSIPOVA et al., 2006).

Table IX

Dimensions of upper dentition (in mm) of *Sorex runtonensis* from Komarowa Cave

		Min.	X	Max.	n
A^3	L	–	0.65	–	1
	W	–	0.66	–	1
A^4	L	0.47	0.49	0.51	2
	W	0.59	0.61	0.64	2
A^5	L	0.47	0.47	0.48	2
	W	0.55	0.55	0.56	2
M^1	L	1.34	1.37	1.39	3
	L (med.)	1.12	1.16	1.19	3
	W	1.43	1.45	1.47	3
M^2	L	1.21	1.23	1.24	3
	L (med.)	1.04	1.05	1.06	3
	W	1.36	1.40	1.42	3

Table X

Dimensions of mandible and lower dentition (in mm) of *S. runtonensis* from Komarowa Cave

		Min.	X	Max.	n	sd	vc
I_1	L	3.50	3.58	3.65	3	–	–
	W	0.73	0.84	0.95	10	0.06	7.14
A_1	L	0.90	0.97	1.03	7	0.05	5.15
P_4	L	0.84	1.00	1.14	26	0.07	7.00
	W	0.59	0.72	0.78	26	0.04	5.56
M_1	L	1.31	1.40	1.53	65	0.05	3.57
	W	0.76	0.83	0.92	67	0.04	4.82
M_2	L	1.10	1.21	1.32	68	0.04	3.31
	W	0.69	0.76	0.84	68	0.03	3.95
M_3	L	0.89	1.00	1.13	40	0.05	5.00
	W	0.53	0.59	0.65	41	0.03	5.08
M_1-M_3	L	3.34	3.59	3.74	24	0.10	2.78
H of mandible below M_2		1.08	1.26	1.40	126	0.06	4.76
H of ascending ramus		3.87	4.15	4.39	70	0.13	3.13
W of coronoid process		0.72	0.88	1.07	82	0.08	9.09
H of condyloid process		1.67	1.84	2.01	51	0.08	4.35
W of interarticular area		0.48	0.59	0.81	73	0.06	10.17

S. tundrensis is one of the most eurytopic species of the genus *Sorex*. It inhabits biotopes of very different natural conditions, from arctic tundra to step, preferring more open and arid areas. Having in mind the great morphological similarity of both species one can assume that *S. runtonensis* had the same ecological requirements. It could therefore be the indicator of an arid and relatively open (tundra, forest-step) paleobiotope (OSIPOVA et al., 2006).

So far, the youngest remains of *S. runtonensis* were known only from Late Pleistocene localities of Europe. However, in Krucza Skała and Komarowa, they were also present in the Holocene layers: in 9 and VI in the first and in A in the second cave. In Krucza Skała Rock Shelter among 21 specimens recognized as *S. runtonensis* , only four (1 fragment of maxillae and 3 fragments of mandibles) were found in the Holocene layers. Taking into considerations the possibility of sediment dislocation by ancient excavations and the loose structure of some sediments the presence of these four remains in the Holocene could be accidental. However, among 155 fragments of *S. runtonensis* from Komarowa Cave 21 were found in the Holocene layer A. This fact seems to be less accidental and it may suggest that, as *T.* cf. *minor*, this species survived longer in this part of Europe.

Sorex araneus LINNAEUS, 1758

M a t e r i a l. Six fragments of maxillae with A^2-A^5 and P^4-M^2 and 18 mandible fragments with all teeth and processes except for the angular process. The minimal number of individuals = 9, Krucza Skała Rock Shelter, layers: 1/2/3, 2/3, 4, 5/6, 6, 7, 8, IV and a layer lacking stratigraphy, No. MF/3193. Three fragments of maxillae with P^4-M^3 and 71 mandible fragments with all teeth and processes with the exception of the angular process. Minimal number of individuals = 84, Komarowa Cave, layers: G, G', E, D, C, D/E, Ftx, Ft, B, and A, No. MF/3185.

D e s c r i p t i o n o f m a t e r i a l. I^1 is absent. As can be concluded from the number of alveolae five upper antemolars are present. Only A^2-A^5 are preserved, however A^4 and A^5 are pathological, because their crowns have grown together. The A^2 is unicuspid. Its cusp is situated in the antero-buccal part of the crown. Two crests run from the tip of the cusp: the main crest to the postero-buccal, and a shorter one to the antero-lingual cingulum. It divides the lingual depression into two parts: a shallow antero-lingual, and a much deeper postero-lingual. The A^3 is similar but smaller than the A^2. Both teeth have well-developed cingula all around.

The P^4 has a large parastyle, protocone and hypocone and a rather long parastylar crest. A deep valley separates the protocone and hypocone. The posterior cingulum is well-developed, the lingual and buccal ones weak and the anterior one absent.

The M^1 is characterized be very well-developed hypocon, only weakly developed metaloph and the lack of a parastyle. A wide valley is present between the protocon and hypocon. There is a cingulum on the lingual side of this valley. The posterior cingulum as well as the posterior emargination are rather well-developed. The anterior and buccal cingula are absent.

The M^2 is similar to the M^1 but smaller. It is more trapezoidal than rectangular in shape.

The M^3 is large in its lingual side. The paracone is the best developed cusp. The protocone and metacon are well developed but lower.

The I_1 is tricuspulate. The cuspules are separated by deep valleys and a faint buccal cingulum can be seen.

The A_1 is single-cusped and not very long. A broad, but not protruding cingulum is present on both sides of the tooth.

The P_4 has a shallow postero-lingual basin and a cingulum similar to that in A_1.

The M_1 and the M_2 are of a typical *Sorex* shape. In the M_1 a buccal re-entrant valley opens at some distance above the buccal cingulum. In the M_2 it opens low, directly above it. In both teeth the entoconid crest is high. The buccal cingulum is well developed, the lingual one is wider but less pronounced.

The M_3 is not reduced. The talonid is well-developed, basined and provided with both hypoconid and entoconid. The lingual cingulum is hardly visible or absent.

The anterior edge of the coronoid process is straight, its tip is wide and the coronoid spicule is rather well-developed. The external temporal fossa is large and pretty deep. It reaches the level of the upper sigmoid notch or a little lower. The internal temporal fossa is high and triangular. About 67% of specimens are provided with a more or less developed horizontal bar. In more than 90 % the condyloid process represents the morphotype 2 (see p. 93) with a wide interarticular area in its lower part. The remaining specimens are intermediate between morphotypes 1 and 2 (ZAITSEV and RZEBIK-KOWALSKA 2003). The mental foramen is situated in the posterior position (morphotype 2, see p. 93), more or less below the tip of the protoconid of the M_1, in 8% of specimens it lies a little more posteriorly almost reaching the buccal re-entrant valley of the M_1. In 75% of specimens two mandibular foramina are well visible (morphotype 2, see p. 93), in the remaining ones only one opening is externally present.

M e a s u r e m e n t s. See Tables XI, XII, XIII, and XIV.

Table XI

Dimensions of upper teeth (in mm) of *Sorex araneus* from Krucza Skała Rock Shelter

		Min.	X	Max.	n
A^2	L	–	0.92	–	1
	W	–	0.78	–	1
A^3	L	–	0.84	–	1
	W	–	0.69	–	1
$A^4 + A^5$ *	L	–	0.85	–	1
	W	–	0.65	–	1
P^4	L	1.57	1.61	1.65	5
M^1	L	1.41	1.48	1.53	5
	L (med.)	1.09	1.15	1.26	5
	W	1.55	1.60	1.63	5
M^2	L	1.28	1.29	1.31	5
	L (med.)	1.00	1.04	1.09	5
	W	1.50	1.53	1.56	5

* A^4 and A^5 grown together (common dimension)

S y s t e m a t i c p o s i t i o n a n d d i s t r i b u t i o n. The size of specimens described above approaches the size of the Recent *S. araneus* LINNAEUS, 1758 and *S. coronatus* MILLET, 1828. As concerns morphology they also resemble *S. araneus* and the fossil species *S. subaraneus* HELLER, 1958 described from the Middle Pleistocene of Erpfingen in Germany. They differ from *S. subaraneus*, known today from many European localities (RZEBIK-KOWALSKA 1998), however, by their great size and general robustness (see Table XV).

Table XII

Dimensions of mandible and lower teeth (in mm) of *Sorex araneus* from Krucza Skała Rock Shelter

		Min.	X	Max.	n	sd	cv
I_1	L	4.12	4.15	4.17	3	–	–
	W	0.84	0.95	1.04	5	–	–
A_1	L	1.00	1.12	1.24	2	–	–
P_4	L	1.16	1.22	1.31	12	0.04	3.28
	W	0.68	0.78	0.86	12	0.06	7.69
M_1	L	1.41	1.58	1.67	17	0.07	4.43
	W	0.85	0.92	1.00	17	0.04	4.35
M_2	L	1.26	1.32	1.37	16	0.03	2.27
	W	0.76	0.82	0.88	16	0.03	3.66
M_3	L	1.06	1.08	1.13	7	0.02	1.85
	W	0.57	0.63	0.66	7	0.03	4.76
M_1-M_3	L	3.93	3.98	4.06	7	0.05	1.26
H of mandible below M_2		1.31	1.40	1.56	17	0.07	5.00
H of ascending ramus		4.30	4.58	4.87	11	0.20	4.37
W of coronoid process		0.85	1.05	1.24	12	0.10	9.52
H of condyloid process		1.60	1.83	2.05	9	0.16	8.79
W of interarticular area		0.59	0.72	0.82	11	0.07	9.72

Table XIII

Dimensions of upper teeth (in mm) of *Sorex araneus* from Komarowa Cave

		Min.	X	Max.	n
P^4	L	1.50	1.51	1.53	2
M^1 (med.)	L	1.45	1.51	1.57	3
	L	1.12	1.19	1.29	3
	W	1.60	1.61	1.62	3
M^2 (med.)	L	1.27	1.32	1.37	3
	L	1.02	1.06	1.08	3
	W	1.44	1.52	1.58	3
M^3	L	–	0.63	–	1
	W	–	1.15	–	1

Table XIV

Dimensions of mandible and lower dentition (in mm) of *Sorex araneus* from Komarowa Cave

		Min.	X	Max.	n	sd	cv
I_1	L	3.70	3.82	3.99	10	0.11	2.88
	H	0.83	0.92	0.96	20	0.04	4.35
A_1	L	0.98	1.09	1.22	10	0.08	7.34
P_4	L	1.05	1.17	1.26	54	0.05	4.27
	W	0.69	0.79	0.88	53	0.05	6.33
M_1	L	1.40	1.52	1.65	105	0.05	3.29
	W	0.84	0.90	0.98	104	0.03	3.33
M_2	L	1.19	1.30	1.39	95	0.04	3.08
	W	0.74	0.82	0.92	95	0.03	3.66
M_3	L	0.95	1.04	1.14	35	0.05	4.81
	W	0.54	0.63	0.74	36	0.04	6.35
M_1-M_3	L	3.68	3.84	4.12	25	0.10	2.60
H of mandible below M_2		1.15	1.38	1.59	133	0.07	5.07
H of ascending ramus		4.30	4.60	4.93	63	0.14	3.04
W of coronoid process		0.78	1.03	1.21	69	0.08	7.77
H of condyloid process		1.59	1.80	2.01	48	0.11	6.11
W of interarticular area		0.52	0.67	0.85	69	0.07	10. 45

Table XV

Comparison of some dimensions (in mm) of M_1 and mandible of *S. araneus* and *S. subaraneus*

		S. araneus Komarowa Cave Late Pleistocene and Holocene	*S. araneus* Krucza Skała Rock Shelter Late Pleistocene	*S. araneus* Poland Recent	*S. subaraneus* Kadzielnia* Ręb. Królewskie 4** Kozi Grzbiet** Plio/Pleistocene* Middle Pleistocene** RZEBIK-KOWALSKA 1991
M_1	L	1.40-1.52-1.65 (n=105)	1.41-1.58-1.67 (n=17)	1.45-1.55-1.69 (n=39)	1.40-1.53 (n=65)
H of ascending ramus		4.30-4.60-4.93 (n=63)	4.30-4.58-4.87 (n=11)	4.45-4.72-4.94 (n=39)	4.15-4.61 (n=15)
H of condyloid process		1.59-1.80-2.01 (n=48)	1.60-1.83-2.05 (n=9)	1.65-1.88-2.05 (n=39)	1.60-1.85 (n=7)

In contrast to *S. subaraneus* the morphology of the fossils from our two caves seem to be more uniform. For example, in *S. subaraneus* the shape of the coronoid and condyloid processes is not very stable. According to JAMMOT (1977) this variety of forms is the reason why so many *Sorex* species have been described from the Pleistocene of Europe. He also thinks that *S. subaraneus* was an ancestral form of two Recent *Sorex* species: *S. araneus* and *S. coronatus*. Besides the morphology of their processes *S. araneus* and *S. subaraneus* differ also in the morphology of the A_1. In the latter species this tooth is provided with an additional small cusp (very rare in *S. araneus*). In contrast to *S. coronatus*, and similar to *S. araneus* , specimens from Komarowa Cave and Krucza Skała Rock Shelter have a straight anterior edge of the coronoid process (not bendind anteriorly). Also the upper sigmoid notch is narrow (not open), the posterior edge of the internal temporal fossa right (not oval), and the M_3 not reduced.

Today *S. araneus* lives in a large part of Europe and continental Asia. Its different populations show a great variability of the karyotypes. This variability was the basis to recognition of several dozen chromosomal races. Some of these races were later recognized as different species (e. g. *S. coronatus*, *S. arunchi* LAPINI and TESTONE, 1998).

According to palaeontological data *S. araneus* appeared in Europe as early as the Early Pleistocene and specimens described as *S.* cf. *araneus* were listed even earlier, at for instance the early Late Pliocene (MN16) locality of Schernfeld in Germany (DEHM 1962). On the other hand, *S. subaraneus*, which is considered to be the ancestor of *S. araneus*, is cited for the first time from the late Late Pliocene (MN17) of Montousse 5 in France (CLOT et al. 1976). If *S. subaraneus* was really the ancestor of *S. araneus*, the Late Pliocene and also maybe the Early Pleistocene remains of *Sorex* were probably erroneously identified as *S. araneus* and belong to *S. subaraneus*. A revision of fossils attributed to *S. subaraneus* and *S. araneus* is needed.

The origin of fossil *S. subaraneus* is not clear. ZAITSEV and BARYSHNIKOV (2002) wrote that the extinct Middle Pleistocene *S. satunini* OGNEV, 1922 from Treugolnaya Cave in Caucasus did not differ in morphology from *S. subaraneus*. The fossil form and European *S. subaraneus* differ from the Recent *S. satunini* only in their smaller size (DOLGOV 1985). This indicates that the ancestor of *S. araneus* (*S. subaraneus* or *S. satunini*, the question of their synonymy requiring additional studies) most probably was a Pleistocene immigrant from Asia.

Sorex sp.

M a t e r i a l. Right mandible with teeth except the I_1 and M_3 and processes except of the angular process. Minimal number of individuals = 1. Krucza Skała Rock Shelter, layer VI/V, No. MF/3194.

D e s c r i p t i o n o f m a t e r i a l. The specimen is morphologically similar to *S. araneus* present in the assemblage as well as to the Recent specimens of *S. araneus* from Poland. In addition the majority of measurements of this specimen lie in the range of variation of *S. araneus* with the exception of the height of the ascending ramus and width of the coronoid process which are larger (see Table XVI).

M e a s u r e m e n t s. A_1 L = 1.13 mm, P_4 L = 1.30 mm, W = 0.91 mm, M_1 L = 1.61 mm, W = 0.95 mm, M_2 L = 1.31 mm, W = 0.86 mm, H of mandible below M_2 = 1.55 mm, H of ascending ramus = 5.15 mm, W of coronoid process = 1.29 mm, H of condyloid process = 1.90 mm, W of interarticular area = 0.63 mm.

S y s t e m a t i c p o s i t i o n. As mentioned above the morphology and size of the *Sorex* specimen from Krucza Skała Rock Shelter agree with these characters in *S. araneus* except the size of the ascending ramus and the coronoid process. Such large dimensions are characteristic of some species of *Sorex* belonging to the subgenus *Drepanosorex* KRETZOI, 1941 and to the largest *Sorex* species described from the Middle and Late Pleistocene, *S. macrognathus* JÁNOSSY, 1965 and *S. thaleri* JAMMOT, 1989 respectively.

Table XVI

Dimensions of ascending ramus and coronoid process (in mm) of *S. araneus* and *S.* cf. *thaleri*

	Sorex sp. Krucza Skała Rock Shelter	*S. araneus* Krucza Skała Rock Shelter	*S. araneus* Poland	*S. araneus* Europe	*S.* cf. *thaleri* Obłazowa Cave (Poland)
	Late Pleistocene		Recent	Recent HAUSER et al. 1990	Late Pleistocene RZEBIK-KOWALSKA 2003
H of ascending ramus	5.15	4.30-4.87, n=11	4.45-4.94, n=39	4.45-4.81, n=24	4.80-5.21, n=35
W of coronoid process	1.29	0.85-1.24, n=12	0.95-1.24, n=39	–	1.04-1.48, n=44

However, the species of the subgenus *Drepanosorex* are characterized by the exoadaenodont teeth, light (yellow) color of tooth pigment, an anteriorly (below P_4) placed mental foramen etc. In the specimen from Krucza Skała Rock Shelter the teeth are not bulbous, the pigment is red and the mental foramen is placed more posteriorly, below the protoconid of the M_1.

On the other hand according to JAMMOT (1989), *S. thaleri* described from La Baume de Gigny in France is morphologically similar to S. *araneus* but more massive in the posterior part of the mandible, especially in the posterior part of the horizontal ramus and the condyloid process. The condyloid process of *S. thaleri* is low, its interarticular area is comparatively wide and the lower facet very long. In *S. araneus* and the specimen from Krucza Skała the condyloid process is relatively higher and its lower facet is shorter.

S. macrognathus was described from Uppony I in Hungary. According to RABEDER (1992), who revised the material from the type locality and changed its subspecies to species status, the morphology of this form is also similar to that in *S. araneus* but its measurements are about 13% larger.

A comparison of the height (4.87 mm) of the ascending ramus of *S. araneus* from Krucza Skała Rock Shelter with the same dimension of the studied specimen (5.15 mm) indicates that the latter is larger by only about 5.5 %. Therefore, the identification of Krucza Skała Rock Shelter mandible as *S. macrognathus* would seems to be baseless. As we still know little on the number and specific position of the large Pleistocene *Sorex* species only revision of all *Sorex araneus* – like forms and larger Pleistocene *Sorex* in Europe will resolve the problem.

Genus ***Neomys*** KAUP, 1829

Neomys* cf. *fodiens (PENNANT, 1771)

M a t e r i a l. One fragment of upper jaw with A^2-A^3 and P^4-M^2 and 27 mandible fragments with all teeth and processes except of the angular process. The minimal number of individuals = 16, Komarowa Cave, layers: E, D, B, and A, No. MF/ 3186.

D e s c r i p t i o n o f m a t e r i a l. The unicuspid antemolar A^2 is long and narrow, surrounded by a strong cingulum. Its cusp is situated in the anterior part of the tooth. The A^3 is similar but a little smaller.

The P^4 has a well developed parastyle which protrudes anteriorly. The protocone is placed relatively far buccaly. It is L-shaped and separated from the large hypocone by a deep valley. The cingular cusp is developed on the ridge surrounding the hypoconal flange. The buccal and posterior cingula are present.

The M^1 and M^2 have the strongly developed hypocones, separated from the protocones by a deep valleys. Their metalophs are not very high.

The I_1 is monocuspulate and its buccal cingulum is well developed.

The A_1 is long and essentially (in unworn specimens) two-cusped. The cingulum is present on both (lingual and buccal) sides.

The P_4 has also two cusps but it is rather short and high. Clear cingula occur on both sides of the tooth.

The M_1-M_2 are of a typical *Neomys* shape. In M_1 the protoconid and the metaconid are close together, causing the trigonid to be narrow. On both teeth the buccal re-entrant valley opens low, directly above the broad, well-pronounced, undulate buccal cingulum. The lingual cingulum is also well developed.

The M_3 has a well developed talonid and strong cingula present on both sides.

The coronoid process is broad and its anterior edge slightly concave to almost straight. The external temporal fossa is rather deep, especially in its upper (above the coronoid spicule) part. The coronoid spicule is very well developed. The low internal temporal fossa and high condyloid process are of a typical *Neomys* shape. The condyle is characterized by the interarticular area narrow and the lower facet long. The mental foramen is situated below the re-entrant valley or below the hypoconid of the M_1. One mandibular foramen lies bellow the middle of the internal temporal fossa.

M e a s u r e m e n t s. See below and Table XVII.

Dimensions of upper dentition (in mm) of *N.* cf. *fodiens* from Komarowa Cave. A^2 L = 1.35, W = 0.85; A^3 L = 1.13, W = 0.78; P^4 L = 1.88; M^1 L = 1.82, L(med.) = 1.39, W = 2.06; M^2 L = 1.48, L(med.) = 1.27, W = 1.83; n = 1.

Table XVII

Dimensions of mandible and lower dentition (in mm) of *N.* cf. *fodiens* from Komarowa Cave

		Min.	X	Max.	n	sd	cv
I_1	L	–	4.55*	–	1	–	–
	W	–	1.03	–	1	–	–
A_1	L	1.57	1.58	1.60	2	–	–
P_4	L	1.34	1.39	1.45	6	–	–
	W	0.96	0.99	1.03	6	–	–
M_1	L	1.75	1.79	1.85	11	0.03	1.68
	W	1.07	1.14	1.21	11	0.04	3.51
M_2	L	1.47	1.59	1.64	9	0.06	3.77
	W	0.90	1.05	1.20	9	0.08	10.00
M_3	L	1.34	1.35	1.37	2	–	–
	W	0.77	0.80	0.83	2	–	–
M_1-M_3	L	–	4.74	–	1	–	–
H of mandible below M_2		1.60	1.69	1.85	14	0.07	4.14
H of ascending ramus		4.78	4.93	5.18	10	0.13	2.64
W of coronoid process		0.95	1.00	1.11	12	0.04	4.00
H of condyloid process		2.35	2.56	2.75	7	0.17	6.64
W of interarticulae area		0.41	0.52	0.60	14	0.05	9.61

* a little damaged

S y s t e m a t i c p o s i t i o n a n d d i s t r i b u t i o n. A composition of such morphological characters as long upper unicuspids, strong hypocones in the P^4 and upper molars, monocuspulate I_1's, small internal temporal fossa and high condyle with a very narrow interarticular area allow the identification of these remains as *Neomys.*

So far, three to four fossil and three Recent species of the genus *Neomys* are known in Europe. Among fossil species there are: *N. newtoni* HINTON, 1911 described from West Runton in England and dated from the Early to the Middle Pleistocene, *N. browni* HINTON, 1911 described from the Grays Thurrock (Middle Pleistocene) in England and known only from its type locality, *N. hintoni* ZAITSEV and BARYSHNIKOV, 2002 described from Treugolnaya Cave in Northern Caucasus in Russia and dated to the Middle Pleistocene and also found in other Caucasus cave Mezmaiskaya (ZAITSEV and OSIPOVA 2004) dated to the Late Pleistocene. A fourth species, *N. intermedius* BRUNNER, 1952 described from Margrabenhöhle in Germany and dated to the Middle or Late Pleistocene was called into question by JAMMOT (1977) because of a laconic diagnosis (dimensions intermediate between those of the Recent *N. anomalus* and *N. fodiens*) given by BRUNNER in 1952. The species was, however, supported by HELLER in his paper of 1983 (RZEBIK-KOWALSKA 1998).

The Recent species are represented by *N. anomalus* CABRERA, 1907, *N. teres* MILLER, 1908 and *N. fodiens* (PENNANT, 1771).

N. anomalus lives today in the Iberian Peninsula and the Pyrenees, in the Jura, and the Central Massif in France, in Belgium, Germany, the Appenine Peninsula, the Alps, the Sudetes, the Western Carpathians, the Balkan Peninsula, and the lowlands of Eastern Europe up to 46° longitude. Isolated populations are also present in the mouth of Dnieper, in Crimea, in virgin forest of Białowieża, in Byelorussia, the upper part of Don River etc. Such distribution suggests a relictual character of its range. According to the palaeontological data its first appearance is dated to the Middle Pleistocene.

N. teres, formerly known as *N. shelkownikovi* SATUNIN, 1913 (ZAITSEV and OSIPOVA 2004) is a Caucasian endemic. As a fossil it was found in one Middle and one Late Pleistocene locality of the Northern Caucasus.

N. fodiens lives in the whole of the Northern and Middle (Central) Palaearctic. It is known from the Middle Pleistocene onwards.

The large size of the Komarowa Cave remains, larger than in other fossil and Recent species except in *N. fodiens* , allow the belief that they represent this last species.

However, in comparison with the Recent *N. fodiens*, the specimens from Komarowa Cave are more robust, the anterior edge of their coronoid process is almost straight (in the Recent species it is concave) and larger both, on the top and on the level of the condyloid process. Besides, the coronoid spicule in Komarowa Cave specimens is more developed, and the lower P_4 wider. In the Recent *N. fodiens* from Poland W of P_4 = 0.72-0.84-0.94 (n=15), while in Komarowa Cave the same dimension = 0.96-0.99-1.03 mm (n=6).

In this situation the specimens from Komarowa Cave has been tentatively described as *N.* cf. *fodiens.*

Neomys sp.

M a t e r i a l. Two fragments of mandible with A_1, P_4, M_1-M_2 and coronoid and condyloid processes. The minimal number of individuals = 2. Komarowa Cave, layers: B and A, No. MF/3187.

D e s c r i p t i o n o f m a t e r i a l. The A_1 is elongated, provided with broad cingula on both sides.

The P_4 is massive, its postero-lingual basin is rather deep, reaching almost the postero-lingual corner of the tooth. Both cingula (buccal and lingual) are broad.

The M_1 and M_2 are also massive, and their large cingula are very well developed. The M_2 is much smaller than the M_1.

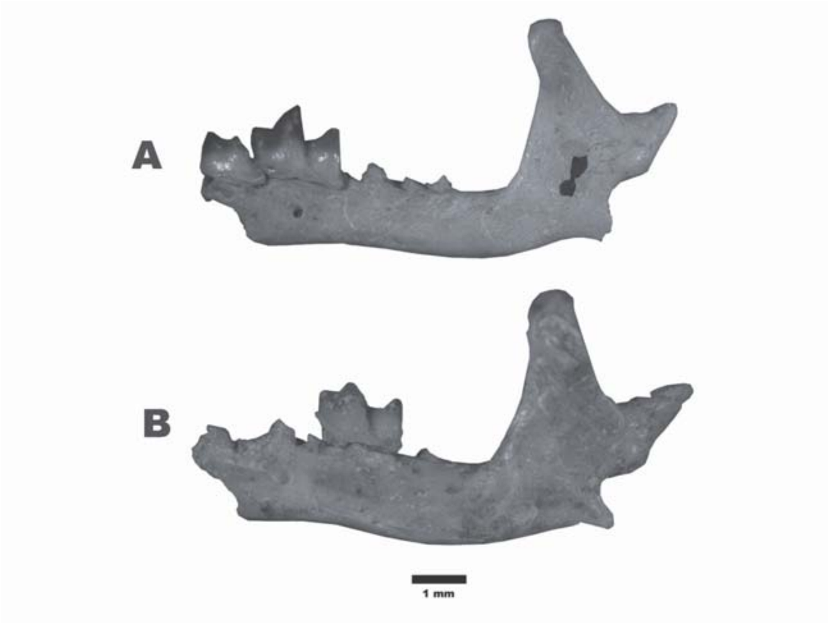

Fig. 5. Left mandibles: A – *Neomys* sp. from Komarowa Cave, B – *N. fodiens* from Komarowa Cave.

The tip of the coronoid process is narrow, its anterior margin is concave and the posterior one straight. The coronoid spicule is well developed. The external temporal fossa is shallow, deeper above the coronoid spicule. The internal temporal fossa is very small. The condyloid process is high, its lower facet long and its interarticular area very narrow.

There is only one mandibular foramen and the mental foramen is situated under the re-entrant valley of the M_1.

Dimensions (in mm). Specimens No. 1. A_1 L = 1.08; P_4 L = 1.11, W = 0.82; M_1 L = 1.62, W = **; M_2 L = 1.30*, W = **; H of mandible below M_2 = 1.43.

Specimen No. 2. P_4 L = 1,19, W = 0.83; M_1 L = 1.70, W = 0.97; H of mandible below M_2 = 1.31, H of ascending ramus = 4.40; W of coronoid process = 2.28*; W of interarticular area = 0.39.

* – damaged, ** – slightly damaged.

S y s t e m a t i c p o s i t i o n a n d d i s t r i b u t i o n. The morphology of the coronoid and condyloid processes as well as the position of the mental formen indicate that both specimens represent the genus *Neomys*. Its size, however, smaller than the size of the remaining *Neomys* specimens from Komarowa Cave exclude their membership of *N. fodiens*.

As mentioned above (p. 106), so far, besides *N. fodiens*, three to four fossil and three Recent species of *Neomys* were described. However, the fossil species are always rare in the material, and if present, they are always in small numbers. They are difficult to identify, because little is known about their morphological variability and no evident size differences have been found between them.

N. teres, the endemic of the Causasus, and the fossil *N. intermedius* seems to be somewhat larger than both Komarowa Cave specimens. The remaining species, fossil *N. hintoni*, *N. newtoni* and *N. browni* as well as the Recent *N. anomalus* are, more or less, of the same size as the specimen from Komarowa Cave.

The fossil *N. hintoni*, known so far only from the Caucasus, differs from other species by the buccal depression situated on the ascending ramus, below the external temporal fossa. In comparison with Komarowa Cave specimens its lower molars are devoid of lingual cingula.

The Komarowa Cave specimens differ from *N. browni* by having a narrower interarticular area of the condyle and a longer, and narrower lower facet.

N. newtoni, like the specimens from Komarowa Cave, is characterized by amassive P_4 and the lower molars are provided with very well developed buccal and lingual cingula. The width (W) of P_4 in *N. newtoni* = 0.84-0.90 mm (n = 3) and in specimens from Komarowa Cave W = 0.82-0.83 mm (n = 2) while in the Recent species of *N. anomalus* from Poland W of P_4 = 0.70-0.75 mm (n = 6). However, in comparison to the M_1, the M_2 of *N. newtoni* seems to be as long as in the Recent *N. anomalus*, while in specimens from Komarowa Cave it is much shorter. The ratio (M_1/M_2) in 6 specimens of *N. anomalus* from Poland = 1.07-1.14, while in one specimen from Komarowa Cave with M_1 and M_2 present in the mandible it equals = 1.25. Unfortunately due to the very limited comparative material of *N. newtoni* from Kozi Grzbiet (Poland, early Middle Pleistocene) and from West Runton (England, Middle Pleistocene) accessible to the author, there are no comparative specimens with M_1 and M_2 present together in the mandible. However, the absolute length (L) of M_1 in this species = 1.65-1.71 mm (n=2), and L of M_2 = 1.54 mm (n=1), while in the Komarowa specimens absolute L of M_1 is similar and = 1.62-1.70 mm (n=2), while L of M_2 = only 1.30 mm (n=1). As the number of specimens present in Komarowa Cave as well as those used for comparison is very limited it is difficult to say if this character is diagnostic. Nevertheless the presence of *N. newtoni* in the Late Pleistocene [Interplenivistulian and/or Early Vistulian (Weichselian) age] and in the Holocene sediments (layers) of Komarowa Cave seems to be unlikely. So far, the youngest localities with *N. newtoni* found in Europe are dated to the Middle Pleistocene.

N. anomalus differs from the Komarowa Cave *Neomys* by having slender teeth (especially P_4). Besides, in comparison with the Komarowa Cave specimens its M_2 is long and its lingual cingula in the lower molars, if present, are hardly visible.

Untill more material is found the two small specimens of *Neomys* from Komarowa Cave have only been identified as *Neomys* sp.

Subfamily **Crocidurinae** MILNE-EDWARDS, 1874

Genus **Crocidura** WAGLER, 1832

Crocidura zorzii PASA, 1942

M a t e r i a l. One fragment of right mandible with ascending ramus (without the condyloid process), and M_1. The minimal number of individuals = 1, Krucza Skała Rock Shelter, layer: 1/2/3, No. MF/3195.

D e s c r i p t i o n o f m a t e r i a l. The horizontal ramus is wide and stout, slightly concave below the M_2. The ascending ramus is high, its posterior edge is slightly concave. The apex of the coronoid process is wide and bend inwards. The coronoid spicule protrudes. The external temporal fossa is rather deep and it runs down to the level of the upper sigmoid notch. The internal temporal fossa is triangular with rounded angles and not very high, the internal apical fossa is moderately deep. The mental foramen is situated below the root of the P_4, the mandibular foramen lies in a deep depression in the middle of the lower border of the internal temporal fossa. The M_1 is very broad, its re-entrant valley opens high above the cingulum. The anterior cingulum is broad and protruding, the buccal one is a little narrower, protruding and extremely undulating, the lingual one is flat and hardly visible. The lower edge of the lingual cingulum is almost straight.

M e a s u r e m e n t s. See Tables XVIII.

S y s t e m a t i c p o s i t i o n a n d d i s t r i b u t i o n. The large size, the stout horizontal ramus of the mandible as well as the massive M_1 distinguish this specimen from other specimens of *Crocidura* found in this locality as well as from specimens from Komarowa Cave, all described as *C. leucodon* (HERMANN, 1789).

Table XVIII

Some dimensions of mandible and lower teeth (in mm) of *C. zorzii* and *C.* cf. *zorzii* from Krucza Skała Rock Shelter and other European localities

		C. zorzii	*C. zorzii*	*C. zorzii*	*C. zorzii*	*C. zorzii*	*C.* cf. *zorzii*
		Krucza Skała Rock Shelter	Soave	Spessa 2	Breitenberghöhle	La Fage	Morovitsa Cave 2
			Italy	Italy	Germany	France	Bulgaria
		L. Pleistocene	E. Pleistocene PASA 1947	M. Pleistocene BARTOLOMEI 1964	M. Pleistocene BRUNNER 1957	M. Pleistocene JAMMOT 1973	L. Pleistocene POPOV 1989
M_1	L	1.68	–	–	–	–	–
	W	1.21	–	–	–	–	–
H of ascending ramus		5.42	5.40-5.50 (n=?)	5.00	5.30	5.40-5.51-5.70 (n=6)	5.28-5.36-5.45 (n=3)
W of coronoid process		1.16	–	–	–	–	–
H of mandible below M_2		1.86	1.70-1.80 (n=?)	1.80	1.80	1.75-1.82-1.92 (=8)	1.62-1.76-1.99 (n=4)

In the Pleistocene of Europe three species of *Crocidura*, bigger than *C. leucodon*, are cited: *C. zorzii* PASA, 1942 described from the Early Pleistocene of Soave in Italy, *C. obtusa* KRETZOI, 1938 described from the Early Pleistocene of Gombasek in Slovakia, and *C. robusta* HELLER, 1960 described from the Late Pleistocene of Lobsing in Germany (RZEBIK-KOWALSKA 1998).

According to KRETZOI (1938) the size and most morphological characters of *C. obtusa* and *C. leucodon* are identical, with the exception of the A_1 and P_4, which are different in both species. However, the quality of drawings which show these differences is so bad that JAMMOT (1977) decided to recognize the name *C. obtusa* as invalid and considered it a synonym of the extant *C. leucodon*. Some authors, (KOENIGSWALD 1971, MAIS and RABEDER 1977, TERZEA 1983, JÁNOSSY 1986, 1996, RZEBIK-KOWALSKA 2000a), however, recognized it among fossil *Crocidura* species. It was cited in localities dated from the Late Pliocene to the Middle Pleistocene of Germany, Austria, Hungary and Romania (RZEBIK-KOWALSKA 1998).

The diagnosis of *Crocidura robusta* given by HELLER (1960) indicated that this species was a little larger than *C. leucodon* and the ascending ramus of its mandible was situated perpendicularly to the horizontal one, whereas in *C. leucodon* they form an obtuse angle. This species was mentioned from the Middle and Late Pleistocene in Germany, France, and Hungary by such authors as KOENIGSWALD and SCHMIDT-KITTLER (1972), CLOT et al. (1976), JAMMOT (1977), and JÁNOSSY (1986).

Crocidura zorzii is characterized by an ascending ramus of the mandible which is high and massive and that leans slightly backwards, massive condyloid process and robust teeth (PASA 1942, 1947). It was cited from the Early to Late Pleistocene in Italy, Germany, France, and Bulgaria by PASA (1952), BRUNNER (1957), BARTOLOMEI (1964), BARTOLOMEI and PASA (1970), JAMMOT (1973), and POPOV (1989).

The characters of this largest mandible of *Crocidura* found in Krucza Skała (see description and measurements in Tables XVIII) agree best with characters of *C. zorzi* living in Europe during the Pleistocene, including the Late Pleistocene. It was found in such Late Pleistocene localities as Montorio (PASA 1952) and Zovencedo (BARTOLOMEI 1964) in Italy and Morovitsa Cave 2 in Bulgaria (POPOV 1989). For the taxonomic position of the fossil species of the genus *Crocidura* see also RZEBIK-KOWALSKA (2000a).

C. zorzii was found in the deepest (mixed 1/2/3) layers of Krucza Skała Rock Shelter dated to the Bölling Interstadial. As mentioned above, it was already known from the Late Pleistocene, but from localities of southern Europe, in Bulgaria and Italy. If the identification is correct the Krucza Skała Rock Shelter in Poland is the most northeastern situated locality of this species. It is probably also the youngest one because the oldest layer of Krucza Skała Rock Shelter is equal to 12 520±70 BP. The presence of *C. zorzii* in this locality seems possible, because it was already mentioned from neighbouring Germany. It is a new element in the Polish fossil fauna of shrews.

C. leucodon (HERMANN, 1780)

M a t e r i a l. One fragment of skull with I^1, A^1 and P^4-M^2 and one mandible fragment with M_1-M_3, without processes. The minimal number of individuals = 2. Krucza Skała Rock Shelter, layers: 7 and 9, No. MF/3196. One fragment of maxilla with A^3 and P^4-M^3 and five fragments of mandible with P_4-M_3 and processes. The minimal number of individuals = 3. Komarowa Cave, layers: E, D, B, A, No. MF/3188.

D e s c r i p t i o n o f m a t e r i a l. The I^1 has the broad two-lobed talon, and rather narrow apex. Its cingulum, along the posterior buccal margin, is narrow but well pronounced.

Of the three upper antemolars, the first one is the largest, the posterior one considerably smaller. They are provided with cingula on both sides.

The parastyle of the P^4 is protruding and separated from the paracone by a valley. The protocone is well developed and situated a little buccally of the antero-lingual corner of tooth. The hypocone is hardly individualized on the lingual cingulum and separated from the protocone by a wide valley. The hypoconal flange and the posterior side of this tooth are bordered by a cingulum.

The M^1 and the M^2 are relatively broad and short, and their hypocones are very strong.

The posterior emargination of the P^4, M^1 and M^2 is rather strong.

The M^3 has individualized protocone and hypocone and its paracone is the best developed cusp.

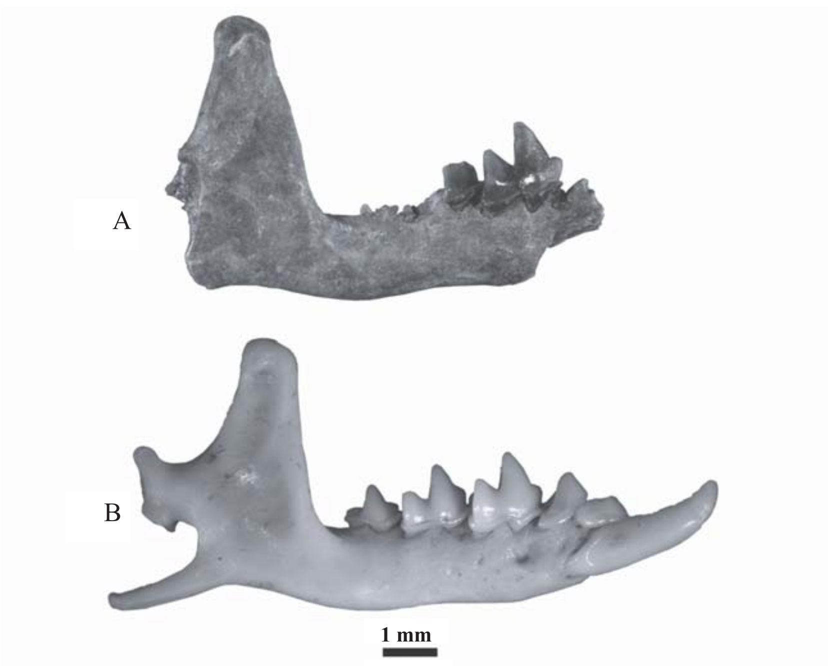

Fig. 6. Right mandibles: A – *C. zorzii* from Krucza Skała Rock Shelter, B – *C. leucodon* (Recent) from Poland.

The P_4 is typical for *Crocidura*, a high, pointed, tetrahedron-shaped tooth. Its narrow cingulum is equally strong on both sides.

The M_1 and the M_2 have low entoconid crests. Their buccal re-entrant valleys open high above the cingulum. The buccal cingula are narrow but well pronounced and undulate, particularly in the M_1. Lingual cingula are weak.

The talonid of the M_3 is reduced to a single cusp. The cingula are similar to these in M_1 and M_2.

The coronoid process of the mandible is blunt and the coronoid spicule moderately developed. The external pterygoid fossa is moderately excavated and the internal temporal fossa is large and open, reaching halfway up the coronoid process. The condyloid process is comperatively large. The mental foramen is situated underneath the P_4/M_1 transition.

M e a s u r e m e n t s. See Table XIX and XX.

Table XIX

Dimensions of upper teeth (in mm) of *Crocidura leucodon* in Krucza Skała Rock Shelter and Komarowa Cave

		Krucza Skała Rock Shelter				Komarowa Cave				Poland (Recent)			
		Min.	X	Max.	n	Min.	X	Max.	n	Min.	X	Max.	n
I^1	L		1.68		1		–		0		–		0
	L of talon		0.64		1		–		0		–		0
	H of talon		1.42		1		–		0		–		0
A^1	L		1.41		1		–		0	1.21	1.26	1.31	7
	W		0.86		1		–		0	0.77	0.83	0.86	7
A^3	L		–		0		0.75		1	0.72	0.76	0.78	3
	W		–		0		–		1	0.67	0.71	0.75	3
P^4	L (bucc.)		2.09		1		1.88		1	1.88	1.96	2.03	11
M^1	L		1.58		1		1.51		1	1.45	1.56	1.62	11
	L (med.)		1.07		1		1.08		1	0.99	1.08	1.16	11
	W		2.20		1		2.14		1	2.03	2.12	2.25	11
M^2	L		1.35		1		1.38		1	1.25	1.30	1.38	11
	L (med.)		1.00		1		1.06		1	0.94	1.01	1.06	11
	W		2.04		1		1.92		1	1.85	1.95	2.00	11
M^3	L		–		0		0.66		1	0.54	0.59	0.65	10
	W		–		0		1.24		1	1.22	1.30	1.36	10

S y s t e m a t i c p o s i t i o n a n d d i s t r i b u t i o n. The measurements of Krucza Skała Rock Shelter and Komarowa Cave specimens are very similar and they lie in the range of variation of Recent *C. leucodon* (see Tables XIX and XX). Their morphology is also similar and it does not differ from the morphology of the Recent species.

According to palaeontological data, *C. leucodon* appeared in Europe in the Middle Pleistocene (RZEBIK-KOWALSKA 1998). According to CATZEFLIS (1984) and REUMER (1986) however, it came to Europe from the Middle East only after the last interglacial. Further study is needed to resolve this problem.

Table XX

Dimensions of mandible and lower teeth (in mm) of *C. leucodon* in Krucza Skała Rock Shelter and Komarowa Cave

		Krucza Skała Rock Shelter				Komarowa Cave				Poland (Recent)			
		Min.	X	Max.	n	Min.	X	Max.	n	Min.	X	Max.	n
P_4	L	–	–	–	0	–	1.17	–	1	1.17	1.27	1.33	11
	W	–	–	–	0	–	0.98	–	1	0.86	0.93	1.00	11
M_1	L	–	1.49	–	1	–	1.57	–	1	1.44	1.49	1.56	11
	W	–	1.09	–	1	–	1.20	–	1	1.08	1.13	1.17	11
M_2	L	–	1.51	–	1	1.45	1.48	1.51	3	1.37	1.42	1.49	11
	W	–	0.97	–	1	0.97	1.02	1.08	3	0.92	0.96	1.00	11
M_3	L	–	1.20	–	1	1.25	1.27	1.30	2	1.17	1.23	1.28	10
	W	–	0.67	–	1	0.68	0.74	0.80	3	0.65	0.68	0.73	10
M_1-M_3	L	–	4.15	–	1	–	4.27	–	1	3.96	4.09	4.23	10
H of mandible below M_2		–	1.42	–	1	1.42	1.57	1.66	5	1.37	1.54	1.75	11
H of ascending ramus		–	–	–	0	–	4.67	–	1	4.49	4.71	4.93	11
W of coronoid process		–	–	–	0	–	1.01	–	1	0.88	1.00	1.14	11

Table XXI

Some mandible dimensions (in mm) of *C. leucodon, C. obtusa* and *C. robusta* in Krucza Skała Rock Shelter, Komarowa Cave and other localities in Europe

	C. leucodon Krucza Skała Rock Shelter L. Pleistocene	*C. leucodon* Komarowa Cave L. Pleistocene	*C. leucodon* Poland Recent	*C. obtusa* Weissenburg 7 Germany E. Pleistocene (KOENIGSWALD 1971)	*C.* cf. *obtusa* Betfia IX Romania E. Pleistocene (RZEBIK-KOWALSKA 2000)	*C. robusta* Lobsing Germany L. Pleistoene (HELLER 1960)
H of ascending ramus	–	4.67	4.49-4.71-4.93 (n=11)	5.30	4.82-4.99-5.30 (n=4)	5.30
W of coronoid process	–	1.01	0.88-1.00-1.14 (n=11)	–	1.00-1.06-1.12 (n=5)	–
H of mandible below M_2	1.42	1.42-1.54-1.66 (n=5)	1.37-1.54-1.75 (n=11)	1.70	1.65-1.69-1.77 (n=6)	1.70

However, so far, the representatives of the genus *Crocidura* (also the Recent *C. leucodon*) were never found in Polish territory (on the northern part of Carpathians) earlier than in the Holocene. The presence of a single specimens (one specimen of *C. zorzii* in mixed layers 1/2/3, and one of *C. leucodon* in layer 7 in Krucza Skała Rock Schelter as well as one in layers E, D, and two in layer B of *C. leucodon* in Komarowa Cave) in the Late Pleistocene sediments may be accidental.

III. FAUNA OF ERINACEOMORPHA AND SORICOMORPHA IN KRUCZA SKAŁA ROCK SHELTER AND KOMAROWA CAVE AND ITS ENVIRONMENT

Insectivores from Krucza Skała Rock Shelter consist of 69 remains. They represent at least 34 individuals belonging to three genera (*Talpa*, *Crocidura* and *Sorex*) and eight species (*T*. cf. *minor*, *T*. *europaea*, *C. zorzii*, *C. leucodon*, *S. minutus*, *S. runtonensis*, *S. araneus* and *Sorex* sp.). Four of the eight species found in Krucza Skała Rock Shelter belong to the Recent insectivore fauna of Poland, and further four (*T*. cf. *minor*, *C. zorzii*, *S. runtonensis*, and *Sorex* sp.) are extinct. Species excavated in particular layers and percentage of remains of particular species are shown in Tables XXII, XXIII, and XXVI.

Table XXII

Species present in particular layers inside Krucza Skała Rock Shelter Layer

Species	Layer							
	1/2/3	2/3	4	5/6	6	7	8	9
Talpa europaea	–	–	–	–	–	+	–	+
Sorex minutus	–	+	–	–	–	+	+	–
Sorex runtonensis	+	+	–	–	+	+	+	+
Sorex araneus	+	+	+	+	+	+	+	–
Crocidura zorzii	+	–	–	–	–	–	–	–
Crocidura leucodon	–	–	–	–	–	+	–	+

Table XXIII

Species present in particular layers in front of Krucza Skała Rock Shelter

Species	Layer				
	IV	V	V?	V/VI	VI
Talpa cf. *minor*	–	–	+	–	+
Talpa europaea	–	+	–	–	+
Sorex runtonensis	–	–	–	–	+
Sorex araneus	+	–	–	–	–
Sorex sp.	–	–	–	+	–

In Komarowa Cave 469 remains and at least 239 individuals of insectivores were present. They belong to six genera (*Einaceus*, *Desmana*, *Talpa*, *Sorex*, *Neomys*, and *Crocidura*) and ten species (*Erinaceus* sp., *D. moschata*, *T*. cf. *minor*, *T. europaea*, *S. minutus*, *S. runtonensis*, *S. araneus*, *N*. cf. *fodiens*, *Neomys* sp., and *C. leucodon*). In Komarova Cave five species (*T. europaea*, *S. minutus*, *S. araneus*, *N*. cf. *fodiens* and *C. leucodon*) live today in Polish territory. *D. moschata* is still living but its range has shifted eastwards. Another four species (*Erinaceus* sp., *T*. cf. *minor*, *S. runtonensis* and *Neomys* sp.) are extinct. Species excavated in particular layers and percentage of remains of particular species are shown in Tables XXIV, XXV, and XXVII respectively.

Table XXIV

Species present in particular layers inside Komarowa Cave

Species	Layer								
	K	J	G4	G	F	E	D/E	D	C
Erinaceus sp.	–	–	–	–	–	–	–	+	–
Desmana moschata	–	–	–	–	–	–	–	+	–
Talpa europaea	–	–	–	–	+	–	–	–	–
Sorex minutus	–	–	–	–	–	+	–	+	–
Sorex runtonensis	+	+	+	+	+	+	+	+	+
Sorex araneus	–	–	–	+	–	+	+	+	+
Neomys cf. *fodiens*	–	–	–	–	–	+	–	+	–
Crocidura leucodon	–	–	–	–	–	+	–	–	–

Table XXV

Species present in particular layers of the terrace in front of Komarowa Cave

Species	Layer						
	Gtx	Ft	B/F’	B	A/B	A’	A
Erinaceus sp.	–	–	–	–	–	–	+
Talpa cf. *minor*	+	–	–	–	–	–	–
Talpa europaea	+	+	–	+	+	+	+
Sorex minutus	–	–	+	+	–	–	+
Sorex runtonensis	–	+	+	+	–	–	+
Sorex araneus	–	+	–	+	–	–	+
Neomys cf. *fodiens*	–	–	–	+	–	–	+
Neomys sp.	–	–	–	+	–	–	+
Crocidura leucodon	–	–	–	+	–	–	+

In general, the presence of the abundant remains of the *Sorex* species indicates a humide wooded environment in the vicinity of caves.

However, the recent study of OSIPOVA et al. (2006, see p. 97) showed that *S. runtonensis* as a close relative of the Recent *S. tundrensis* MERRIAM, 1900 prefered more open area and more arid landscapes (e. g. forest-steppe regions). Therefore, in Krucza Skała Rock Shelter the fauna represents both woodland as well as grassland, because besides *S. runtonensis* some moles and white-toothed shrews, which are present, also prefer more open areas.

Table XXVI

Percentage of remains of particular species in Krucza Skała Rock Shelter

Species	% of remains
“Forest” species	
S. araneus	34.78
S. minutus	5.80
Sorex sp.	1.45
∑	42.03
“Open country” species	
T. cf. *minor*	4.35
T. europaea	17.39
C. leucodon	2.90
C. zorzii	1.45
S. runtonensis	31.88
∑	57.97
∑	100.00

Table XXVII

Percentage of remains of particular species in Komarowa Cave

Species	% of remains
“Forest” species	
Erinaceus sp.	0.43
S. araneus	36.89
S. minutus	9.54
∑	46.91
“Open country” species	
T. europaea	9.17
T. cf. *minor*	0.43
S. runtonensis	33.47
C. leucodon	1.28
∑	44.35
„Wet“ species	
D. moschata	2.13
N. cf. *fodiens*	6.18
Neomys sp.	0.43
∑	8.74
∑	100.00

The same is true in the case of Komarowa Cave, where *Sorex*, *Crocidura*, and *Talpa* species were found. The presence of hedgehog also suggests a forest environment. Additionally *Desmana moschata* and two species of *Neomys* indicate the presence of freshwater. In the Late Pleistocene and the Holocene a mosaic of woodland and grassland prevailed in the vicinity of both caves. In the same periods open water bodies were also present near Komarowa Cave.

REFERENCES

AARIS-SØRENSEN K. 1995. Palaeoecoloy of a Late Weichselian vertebrate fauna from Nørre Lyngby, Denmark. *Boreas*, **24**: 355-365.

BARTOLOMEI G. 1964. Mammiferi di brecce pleistoceniche dei Colli Berici (Vicenza). *Memorie del Museo Civico di Storia Naturale di Verona*, **12**: 221-290.

BARTOLOMEI G., PASA A. 1970. La breccia ossifera di Boscochiesanuova nei Monti Lessini(Verona): I depositi e la fauna. *Memorie del Museo Civico di Storia Naturale di Verona*, **17**: 475-494.

BISHOP M. J. 1982. The mammal fauna of the early Middle Pleistocene cavern infill site of Westbury-Sub-Mendip, Somerset. *Special Papers in Palaeontology*, **28**: 1-108.

BOCHEŃSKI Z., TOMEK T. 2004. Bird remains from a rock-shelter in Krucza Skała (Central Poland). *Acta zoologica cracoviensia*, **47**(1-2): 27-47.

BOSÁK P., GŁAZEK J., HORÁCEK I., SZYNKIEWICZ A. 1982. New locality of Early Pleistocene vertebrates – Żabia Cave at Podlesice , Central Poland. Acta *Geologica Polonica*, **32**: 217-226.

BRUNNER G. 1933. Eine Präglaziale Fauna aus dem Windloch bei Sackdilling (Oberpfalz). *Neues Jahrbuch für Mineralogie*, *Geologie und Paläontologie, Beilagebände*, Abteilung B, **71**: 303-327.

BRUNNER G. 1952. Die Markgrabenhöhle bei Pottenstein (Oberfranken). *Neues Jahrbuch für Geologie und Paläontologie, Monatshefte*, **1952**: 457- 471.

BRUNNER G. 1957. Breitenberghöhle bei Gössweinstein/Ofr. *Neues Jahrbuch für Geologie und Paläontologie, Monatshefte*, **1957**: 352-378.

CATZEFLIS F. 1984. Systématique Biochimique, Taxonomie et Phylogénie des Musaraignes d'Europe (Soricidae, Mammalia). Ph. D. dissertation, University of Lausanne, Lausanne.

CLEEF-RODERS J. T. VAN, HOEK OSTENDE L. VAN DEN. 2001. Dental morphology of *Talpa europaea* and *Talpa occidentalis* (Mammalia: Insectivora) with a discussion of fossil *Talpa* in the Pleistocene of Europe. *Zoologische Mededelingen*, Leiden, **75**: 51-67.

CLOT A., CHALINE J., JAMMOT D., MOURER-CHAUVIRÉ C., RAGE J. C. 1976. Les poches ossifères du Pléistocène moyen et inférieur de Montoussé (Hautes-Pyrénées). *Bulletin de la Société d'Histoire Naturelle de Toulouse*, **112**: 146-161.

CYREK K. 1994. Die Jungpaläolitische Höhlenfundplatz Krucza Skała in Mittelpolen. *Archäologisches Korrespondenzblatt*, **24**(4): 367-374.

DEHM R. 1962. Altpleistocäne Säuger von Schernfeld bei Eichstätt in Bayern. *Mitteilungen der Bayerischen Staatssammlung für Palälaontologie und Geologie*, **2**: 17-61.

DOLGOV V. A. 1985. Burozubki Starogho Sveta (The long-tailed shrews of the Old World). Izdanie Moskovskogho Universiteta, Moskva: 1-221.

HARRISON D. L. 1996. Systematic status of Kennard's shrew (*Sorex kennardi* HINTON, 1911, Insectivora, Soricidae): a study based on British and Polish material. *Acta zoologica cracoviensia*, **39**(1): 201-212.

HAUSER J. VON, HUTTERER R., VOGEL P. 1990. *Sorex araneus* LINNAEUS, 1758 – Waldspitzmaus. [In:] J. NIETHAMMER, F. KRAPP (eds) – Handbuch der Säugetiere Europas, AULA-Verlag Wiesbaden: 237-278.

HELLER F. 1960. Würmeiszeitliche und letztinterglaziale Faunenreste von Lobsing bei Neustadt/Donau. *Erlanger geologische Abhandlungen*, **34**: 19-33.

HELLER F. 1983. Die Höhlenruine Hunas bei Hartmannshof (Landkreis Nürnberger Land). Eine pälaontologische und urgeschichtliche Fundstelle aus dem Spät-Riss. *Quartär-Bibliothek*, **4**: 1-407.

HINTON M. A. C. 1911. The British fossil shrews. *The Geological Magazine*, **8**: 529-539.

HOLZ H. VON, NIETHAMMER J. 1990. *Erinaceus europaeus* LINNAEUS, 1758 – Braunbrustigel, Westigel. [In:] J. NIETHAMMER, F. KRAPP (eds) – Handbuch der Säugetiere Europas, AULA-Verlag Wiesbaden: 26-49.

HOLZ H. VON, NIETHAMMER J. 1990. *Erinaceus concolor* MARTIN, 1838 – Weissbrustigel, Ostigel. [In:] J. NIETHAMMER, F. KRAPP (eds) – Handbuch der Säugetiere Europas, AULA-Verlag Wiesbaden: 50-64.

JAMMOT D. 1973. Les insectivores (Mammalia) du gisement Pléistocène moyen des abimes de La Fage á Noailles (Corrèze). *Nouvelles Archives du Muséum d'Histoire Naturelle de Lyon*, **11**: 41-51.

JAMMOT D. 1977. Les musaraignes (Soricidae – Insectivora) du Plio-Pléistocène d'Europe. Ph. D. dissertation, University of Dijon, Dijon.

JAMMOT D. 1989. Les insectivores. [In:] M. CAMPY, J. CHALINE, M. VUILLEMEY (eds) – La Baume de Gigny (Jura). *Galia Préhistoire*, **27**: 111-120.

JÁNOSSY D. 1986. Pleistocene Vertebrate Faunas of Hungary. Akadémiai Kiadó, Budapest.

KOENIGSWALD W. VON. 1970. Mittelpleistozäne Kleinsäugerfauna aus der Spaltenfüllung Petersbuch bei Eichstätt. *Mitteilungen der Bayerischen Staatssammlung für Paläontologie und Historische Geologie*, **10**: 407-432.

KOENIGSWALD W. VON. 1971. Die altpleistozäne Wirbeltierfaunula aus der Spaltenfüllung Weissenburg 7 (Bayern). *Mitteilungen der Bayerischen Staatssammlung für Paläontologie und Historische Geologie*, **11**: 117-122.

KOENIGSWALD W., SCHMIDT-KITTLER N. 1972. Eine Wirbeltierfauina des Riss/Würm-Interglazials von Erkenbrechtsweiler (Schwäbische Alb, Baden-Württemberg). *Mitteilungen der Bayerischen Staatssammlung für Paläontologie und Historische Geologie*, **12**: 143-147.

KOENIGSWALD W. VON, TOBIEN H. 1987. Bemerkungen zur Altersstellung der plaistozänene Mosbach-Sande bei Wiesbaden. *Geologisches Jahrbuch*, **115**: 227-237.

KOLFSCHOTEN T. VAN 1990. The evolution of the mammal fauna in the Netherlands and the Middle Rhine area (Western Germany) during the late Middle Pleistocene. *Mededelingen Rijks Geologische Dienst*, **43**(3): 1-69.

KOWALSKI K. 1956. Insectivores, bats and rodents from the Early Pleistocene bone breccia of Podlesice near Kroczyce (Poland). *Acta Palaeontologica Polonica*, **1**: 331-394.

KOWALSKI K. 1958. An Early Pleistocene fauna of small mammals from the Kadzielnia Hill in Kielce (Poland). *Acta Palaeontologica Polonica*, **3**(1): 1-47.

KOWALSKI K. 1960. Pliocene insectivores and rodents from Rębielice Królewskie (Poland). *Acta zoologica cracoviensia*, **5**(5): 155-201.

KRETZOI M. 1938. Die Raubtiere von Gombaszög nebst einer Übersicht der Gesamtfauna. (Ein Beitrag zur Stratigraphie des Alquartaers). *Annales Historico-naturales Musei Nationalis Hungarici,* **31**(1937-1938): 88-157.

KURTÉN B. 1968. Pleistocene mammals of Europe. The World Naturalist, Weidenfeld and Nicolson, London: 1-304.

MAIS K., RABEDER G. 1977. Eine pliozäne Höhlenfüllung im Pfaffenberg bei Bad Deutsch-Altenburg (Niederösterreich). *Die Höhle*, **28**: 84-86.

MEULEN VAN DER A. J. 1973. Middle Pleistocene smaller mammals from the Monte Peglia (Orvieto, Italy), with special reference to the phylogeny of *Microtus* (Arvicolidae, Rodentia). *Quaternaria*, **17**: 1-144.

MOTUZKO A. N. 1990. Evolution of the genus *Arvicola* and its importance for stratigraphy of the Likhvin section. [In:] O. FEJFAR, W.-D. HEINRICH (eds) – International Symposium Evolution, Phylogeny and Biostratigraphy of Arvicolids (Rodentia, Mammalia), Rohanov (Czechoslovakia), May 1987, Geological Survey, Prague: 347-352.

MOTUZKO A. N., IVANOV D. L. 1996. Holocene micromammal complex of Belarus: A model of faunal development during Interglacial epochs. *Acta zoologica cracoviensia*, **39**(1): 381-386.

NADACHOWSKI A., WOJTAL P., MIĘKINA B., LIPECKI G., ŻARSKI M., URBANOWSKI M., OCHMAN K., KRAWCZYK M., JAKUBOWSKI G., TOMEK T. (in press). Late Pleistocene environment of Częstochowa Upland (Poland) estimated from faubistic evidence of the archaeological cave sites. Institute of Systematics and Evolution of Animals, Polish Academy of Sciences,

NIETHAMER J. 1990. *Talpa europaea* LINNAEUS, 1758 – Maulwurf. [In:] J. NIETHAMMER, F. KRAPP (eds) – Handbuch der Säugetiere Europas, AULA-Verlag Wiesbaden: 99-133.

OSIPOVA V. A., RZEBIK-KOWALSKA B., ZAITSEV M. V. 2006. Intraspecific variability and phylogenetic relationship of the Pleistocene shrew *Sorex runtonensis* (Soricidae). *Acta Theriologica*, **51**(2): 129-138.

PASA A. 1942. I depositi ossiferi di Soave nel Veronese. Atti della Reale Accademia di Agricoltura, *Scienze e Lettre di Verona*, Serie 5, **20**: 37-50.

PASA A. 1947. I mammiferi di alcune antiche brecce Veronesi. *Memorie del Museo Civico de Storia Naturale di Verona*, **1**: 1-111.

PASA A. 1952. Mammiferi fossili della breccia di Montorio presso Verona. *Atti dell'Accademia di Agricoltura, Scienze e Lettre di Verona*, Serie 6, **2**: 1-20.

POPOV V. V. 1989. Middle Pleistocene small mammals (Insectivora, Lagomorpha, Rodentia) from Morovitsa Cave (North Bulgaria). *Acta zoologica cracoviensia*, **32**: 561-588.

RABEDER G. 1972. Die Insectivoren und Chiropteren (Mammalia) aus dem Altpleistozän von Hundsheim (Niederösterreich). *Annalen des Naturhistorischen Museums*, **76**: 375-474.

RABEDER G. 1992. Die Soriciden (Insectivora, Mammalia) aus dem jüngsten Pleistozän des Nixlochs bei Losenstein-Ternberg (Oberösterreich). *Mitteilungen der Kommission für Quartärforschung der Österreichischen Akademie der Wisenschaften*, **8**: 143-151.

RĂDULESCU C., SAMSON P. 1989. Contributions to the knowledge of the mammalian faunas from Măluşteni and Bereşti (Romania). *Miscellanea Speologica Romanica*, **1**: 303-311.

REUMER J. W. F. 1986. Note on Soricidae (Insectivora, Mammalia) from Crete. I. The Pleistocene species *Crocidura zimmermani*. *Bonner Zoologische Beiträge*, **37**: 161-171.

ROBERT C. 1983. Recherches sur les taupes (*Talpa*, Insectivora) de quelques gisements quaternaires de France. *Thesis Université de Bordeaux*, **I** : 1-170.

RÜMKE C. A. 1985. A review of fossil and recent Desmaninae (Talpidae, Insectivora). *Utrecht micropaleontological bulletins*. *Special publication*, **4**: 1-264.

RZEBIK-KOWALSKA B. 1991. Pliocene and Pleistocene Insectivora (Mammalia) of Poland. VIII. Soricidae: *Sorex* LINNAEUS, 1758, *Neomys* KAUP, 1829, *Macroneomys* FEJFAR, 1966, *Paenelimnoecus* BAUDELOT, 1972 and Soricidae indeterminata. *Acta zoologica cracoviensia*, **34**: 323-424.

RZEBIK-KOWALSKA B. 1998. Fossil history of shrews in Europe. [In:] J. M. WÓJCIK, M. WOLSAN (eds.) – Evolution of shrews, Mammals Research Institute, Polish Academie of Sciences, Białowieża: 23- 92.

RZEBIK-KOWALSKA B. 2000a. Insectivora (Mammalia) from the Early and early Middle Pleistocene of Betfia in Romania. I. Soricidae FISCHER VON WALDHEIM, 1817. *Acta zoologica cracoviensia*, **43**(1-2): 1-53.

RZEBIK-KOWALSKA B. 2000b. Insectivora (Mammalia) from the Early and early Middle Pleistocene of Betfia in Romania. II. Erinaceidae BONAPARTE, 1838 and Talpidae GRAY, 1825. *Acta zoologica cracoviensia*, **43**(1-2): 55-77.

RZEBIK-KOWALSKA B. 2003. Insectivores (Insectivora). [In]: P. VALDE-NOWAK, A. NADACHOWSKI, T. MADEYSKA (eds) – Obłazowa Cave, human activity, stratigraphy and palaeoenvironment, Institute of Archaeology and Ethnology Polish Academy of Sciences, Kraków: 113-118.

RZEBIK-KOWALSKA B. 2006. Paleontological relationship of European *Sorex*. [In:] J. F. MERRIT, S. CHURCHFIELD, R. HUTTERER, B. J. SHEFTEL (eds) – Advances in the biology of shrews II, Special Publication of International Society of Shrew Biologists, New York: 1-8.

STORCH G., QIU Zh., ZAZHIGIN V. S. 1998. Fossil history of shrews in Asia. [In:] J. M. WÓJCIK, M. WOLSAN (eds) – Evolution of shrews, Mammals Research Institute, Polish Academy of Sciences, Białowieża: 93-120.

STUART A. J. 1988. The vertebrate faunas from West Runton (Crag and Freshwater Bed). [In:] P. L. GIBBARD, J. A. ZALASIEWICZ (eds) – Pliocene - Middle Pleistocene of East Anglia, Field Guide, *Quaternary Research Association*, Cambridge: 152-157.

SULIMSKI A. 1959. Pliocene insectivores from Węże. *Acta Palaeontologica Polonica*, **4**: 119-173.

SULIMSKI A. 1962a. Supplementary studies on the insectivores from Węże 1 (Poland). *Acta Palaeontologica Polonica*, **7**: 441-489.

SULIMSKI A. 1962b. O nowym znalezisku kopalnej fauny kręgowców w okolicy Działoszyna. *Przegląd Geologiczny*, **10**: 219-223. (In Polish with English summary).

TERZEA E. 1983. *Pliomys „lenki*" (HELLER, 1930) (Rodentia, Mammalia) dans le Pléistocène de Roumanie. *Travaux de l'Institut de Spéologie „Émile RACOVITZA"*, **22**: 65-80.

TOMEK T., BOCHEŃSKI Z. 2005. Weichselian and Holocene bird remains from Komarowa Cave, Central Poland. *Acta zoologica cracoviensia*, **48A**(1-2): 43-65.

ZAITSEV M. V., BARYSHNIKOV G. F. 2002. Pleistocene Soricidae (Lipotyphla, Insectivora, Mammalia) from Treugolnaya Cave, Northern Caucasus, Russia. *Acta zoologica cracoviensia*, **45**(2): 283-305.

ZAITSEV M. V., OSIPOVA V. A. 2004. Insectivorous mammals (Insectivora) of the Late Pleistocene in the Northern Caucasus. *Zoologicheskij Zhurnal*, **83**(7): 851-868.

ZAITSEV M. V., RZEBIK-KOWALSKA B. 2003. Variation and taxonomic value of some mandibular characters in red-toothed shrews of the genus *Sorex* L. (Insectivora: Soricidae). *Russian Journal of Theriology*, **2**(2): 97-104.