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Palaeoecology of the Early Pleistocene Somssich Hill 2 locality (Hungary) based on *Crocidura* and *Sorex* (Mammalia, Soricidae) occurrences

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Abstract

Two Crocidura and three Sorex species are reported from the Early Pleistocene Somssich Hill 2 locality (Villány Hills, Southern Hungary): *C. kornfeldi* Kormos, 1934; *C. obtusa* Kretzoi, 1938; *S. minutus* Linnaeus, 1766; *S. runtonensis* Hinton, 1911 and *S. margaritodon* Kretzoi, 1941. We compared the number of the *Crocidura* and *Sorex* occurrences in the 50 layers of the site and drew a sketch of the surrounding ecotypes. Layers 50–47 represent warmer climate with deciduous forests. From layer 46 cold climate and open grassland (steppe) appeared in the surroundings of the locality. In layers 33–4 mixed vegetation with forests and open grassland areas occurred varying in composition. Within this period layers 20–4 are characterized by the stronger dominance of the open vegetation. In layers 3–1 there are not enough remains to make a certain conclusion concerning the vegetation.

Keywords: Early Pleistocene, Crocidura, Palaeoecology, Somssich Hill, Sorex, Soricidae, Villány Hills

Introduction

The Somssich Hill 2 site (Villány Hills, Southern Hungary) is one of the most important Pleistocene vertebrate localities of Hungary. It was discovered by Dénes Jánossy and György Topál in 1974. The excavation led by them between 1974 and 1984 yielded rich Pleistocene fauna (approximately 1.0–0.9 Ma old).

The locality and the history of the excavation is described by Botka & Mészáros (2015, in Hungarian) and a brief English overview is given in Botka & Mészáros (2014a).

The preliminary lists of the fauna were given in Jánossy (1983, 1986, 1990). After the years of the excavations only some mammal groups were described by Hír (cricetids, 1998) and Jánossy (1983, 1990, lemmings and arvicolids). Moreover the molluscan fauna of the locality was completely elaborated by Krolopp (2000).

The rich material collected by the excavation team of Jánossy is kept in the Department of Palaeontology and Geology of the Hungarian Natural History Museum.

Most of the Somssich Hill 2 material is under elaboration by the cooperative research group of the Hungarian Academy of Sciences, the Hungarian Natural History Museum and the Eötvös Loránd University (OTKA K104506 research, project leader: Piroska Pazonyi). On the basis of their studies some preliminary results (Botka & Mészáros 2014b, Botka & Striczky 2014, Mészáros et al. 2013, Pazonyi et al. 2013a, b, Pazonyi & Virág 2013a, b, Pazonyi 2015, Szentesi 2013) and articles (Botka & Mészáros 2014a, 2015a, b; Striczky & Pazonyi 2014; Szentesi 2014) have been published.

In the present article a palaeoecological study is demonstrated based on the occurrence of the species of two Soricidae genera (*Crocidura* and *Sorex*) in the layers of the site.

Material and methods

Some of the shrew specimens from Somssich Hill 2 locality are more or less complete mandibles, but most of them are small mandibular and maxillary fragments or separated teeth. Due to this fact it would have been a hard task to settle the minimum number of the individuals. That is why an effective method of using soricid remains in the Palaeoecological reconstruction was suggested by Mészáros (2015). The number of *Crocidura* and *Sorex* teeth was compared layer by layer without species attribution. On the basis of the *Crocidura-Sorex* teeth rate a preliminary ecotype reconstruction of the site was given in the article.

Later in 2015 a detailed elaboration of the *Crocidura* material was accomplished by Botka & Mészáros (2015b). This study provided a revision of previous taxonomical

Table 1. Ocurrence of *Crocidura* and *Sorex* teeth in the layers of Somssich Hill 2 locality

Layer	*Crocidura*	*Sorex*	% of *Crocidura*
1	–	–	–
2		4	0.00
3	–	3	0.00
4	33	123	21.15
5	97	172	36.06
6	19	50	27.54
7	4	10	28.57
8	24	68	26.09
9	10	17	37.04
10	32	27	54.24
11	15	31	32.61
12	29	70	29.29
13	13	116	10.08
14	12	59	16.90
15	2	82	2.38
16	6	31	16.22
17		8	0.00
18	4	4	50.00
19	–	35	0.00
20	3	12	20.00
21	–	25	0.00
22	6	215	2.71
23		4	0.00
24	2	90	2.17
25	9	166	5.14
26	4	45	8.16
27		122	0.00
28		186	0.00
29	4	30	11.76
30	6	56	9.68
31	6	133	4.32
32	–	87	0.00
33	4	148	2.63
34		62	0.00
35		212	0.00
36	1	189	0.53
37	5	133	3.62
38	7	157	4.27
39	–	65	0.00
40	–	134	0.00
41	4	211	1.86
42	1	404	0.25
43	1	364	0.27
44	4	486	0.82
45	4	202	1.94
46	4	326	1.21
47		313	0.00
48	–	4	0.00

attribution of some teeth formerly defined as "*Crocidura*". The preceding palaeoecological model settled by MÉSZÁROS (2015) needed modification in some points because of the new data which is shown in the present article.

Some alterations in the calculation methods were made considering the previous paper. The rate of the *Crocidura* teeth is figured out according to the formula given here:

$$\frac{N_{\text{Crocidura teeth}}}{N_{\text{Crocidura teeth}} + N_{\text{Sorex teeth}}} * 100$$

The ocurrence of *Crocidura* and *Sorex* teeth in the layers of Somssich Hill 2 locality is shown in Table 1.

Taxonomy

Phylum Vertebrata LINNAEUS, 1758
Classis Mammalia LINNAEUS, 1758
Order Eulipotyphla WADDELL et al., 1999
Family Soricidae FISCHER VON WALDHEIM, 1817

Seven shrew species from Somssich Hill 2 site were mentioned by BOTKA & MÉSZÁROS (2014b): *Beremendia fissidens* (PETÉNYI 1864), *B. minor* RZEBIK-KOWALSKA, 1976 and the here discussed two *Crocidura* and three *Sorex* species. However, the *Beremendia* species are not included in this palaeoecological research. They are described in detail by BOTKA & MÉSZÁROS (2014a).

Subfamily Crocidurinae MILNE-EDWARDS, 1874
Genus *Crocidura* WAGLER, 1832

Dental formula is 143/123. The teeth are not pigmented. The first upper antemolar is larger than the equal-sized second and third antemolars, all of them are unicuspid (after BOTKA & MÉSZÁROS 2015b, REUMER 1984, REPENNING 1967). It is present in the European mainland from the Early Villányian (MN 16) to Recent.

Crocidurinae prefer relatively milder and more arid climate compared to Soricinae (RZEBIK-KOWALSKA 1995). According to REUMER (1984) *Crocidura* prefer dry terrains. That is why these forms are good indicators of more-or-less open grasslands in the warmer phases of the Plio-Pleistocene (RZEBIK-KOWALSKA 1995). However, in this study we supposed that low temperature limited their occurrence, even if steppe areas appeared in the colder periods of the Pleistocene.

The Somssich Hill 2 *Crocidura* material is described in detail by BOTKA & MÉSZÁROS (2015b).

Crocidura kornfeldi Kormos, 1934
(Figure 1)

Morphology: the coronoid process of the mandible is blunt and low, the coronoid spicule is small, situated high and not distinct. The anterior part of the coronoid process

Figure 1. *Crocidura kornfeldi* KORMOS, 1934, left mandible fragment with M_1-M_3, Somssich Hill 2, layer 30. Scale bar = 1 mm

leans slightly backwards and the ramus sometimes has a widening in the middle part. The condyle reaches far backwards and is comparatively large in buccal view. The condyle is not high in posterior view, the interarticular area is short. The internal temporal fossa is large and open, reaching halfway up the coronoid process. The region underneath the internal temporal fossa (the subfossa) is excavated, separated from the fossa by a protuding ridge. The dental morphology of this species is very similar to that of *C. obtusa*, the only differential character is the higher position of the buccal re-entrant valley on M_1–M_2 (BOTKA & MÉSZÁROS 2015b).

Crocidura obtusa KRETZOI, 1938
(Figure 2)

Morphology: the coronoid process of the mandible is high, its tip leans strongly backwards, the coronoid spicule is situated high and distinct. The upper part of the condyle reaches far backwards in buccal view. The condyle is high in

Figure 2. *Crocidura obtusa* KRETZOI, 1938, left mandible with I1 fragment, A2 and M_1-M_3, Somssich Hill 2, layer 12. Scale bar = 1 mm

posterior view, the interarticular area is long. The internal temporal fossa is large and open, reaching halfway up the coronoid process. The subfossa is sometimes present. The re-entrant valley of the first and the second lower molars opens closer to the buccal cingulum here than at *C. kornfeldi*.

Genus *Sorex* LINNAEUS, 1758

Teeth are pigmented with dark red to light orange colour. Fossa temporalis interna of the mandible is large and triangular. There is an entoconid crest on the lower first and second molars (REUMER 1984).

Dental formula is 1–6–3/1–2–3. M_3 talonid is basined. Lingual cingulum is well-developed on M_1–M_3, but it is straighter than on *Crocidura* forms. Articular facets of the mandibular condyle are slightly to moderately separated (REPENNING 1967).

The genus is present in Europe from the Late Miocene to Recent (RZEBIK-KOWALSKA 2003).

Sorex endure much colder temperature than *Crocidura* (RZEBIK-KOWALSKA 2015). *S. minutus*, the only *Sorex* species in the Somssich Hill 2 fauna that is still living is found even in the northernmost and coldest regions of Europe.

According to REUMER (1984) the fossil *Sorex* is indicative for a moist environment with well-developed (forest) vegetation and *Sorex minutus* suggests the presence of woody covering.

We accept REUMER's opinion, however, we cannot be sure in the ecological role of the genus in the site before the exact specific determination of *Sorex* specimens, because *S. runtonensis* is reported from some localities as a member of a steppe assemblage (OSIPOVA et al. 2006).

Nevertheless it will not be necessary to fully convert the model presented here, because *S. runtonensis* has its greatest abundance in layers 47–35, where steppe was supposed on the basis of the rodent species (see below).

Sorex margaritodon KRETZOI, 1941
(Figure 3)

It is a strongly built *Sorex* species with light orange pigmentation on the teeth.

Figure 3. *Sorex margaritodon* KRETZOI, 1941, right mandible fragment with M_1-M_2, Somssich Hill 2, layer 45. Scale bar = 1 mm

Sorex minutus LINNAEUS, 1766
(Figure 4)

This *Sorex* species is a very fragile built one, it has dark red pigmentation on the teeth.

Figure 4. *Sorex minutus* LINNAEUS, 1766, right mandible with I1 fragment, A2 and M_1–M_2, Somssich Hill 2, layer 38. Scale bar = 1 mm

Sorex runtonensis HINTON, 1911
(Figure 5)

It is a medium sized *Sorex* species, the cusps of the teeth are light to dark red-coloured.

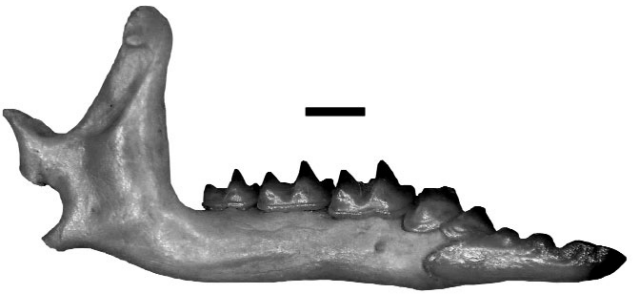

Figure 5. *Sorex runtonensis* HINTON, 1911, complex left mandible with the whole dentition, Somssich Hill 2, layer 45. Scale bar = 1 mm

Palaeoecological conclusions

Crocidura is used as an indicator of and open, grassy vegetation, while *Sorex* is regarded as the marker of forests in the ecotype changing model. In addition we considered environmental features shown by rodent occurrences in the different layers (Piroska PAZONYI, personal communication).

While rodents indicate warm temperature, *Crocidura* species are totally missing from layers 50–47. That is why we supposed warmer climate and deciduous forests with complete *Sorex* dominance.

In the time of the deposition of the layers 46–34 steppe vegetation is marked by the rodent fauna. However the abundance of *Crocidura* species is not high. The explanation of this fact is that their spread is usually limited by low temperature, even if the ecosystem would be adequate to their preference.

This is supported by the European occurrence of the living *Crocidura* species, the diversity of which is decreasing toward the northern areas – where they are missing from the cold grasslands (RZEBIK-KOWALSKA 1995). So we may suppose that cold climate and open grassland (steppe) appeared in the surroundings of the locality in this period. *Sorex* species tolerating low temperature well were significant here.

In the interval represented by layers 33–4 there are frequent *Crocidura* forms as well. On the basis of the alternating frequency of the two genera we conclude mixed vegetation with forests and open grassland areas occurring varying in relation.

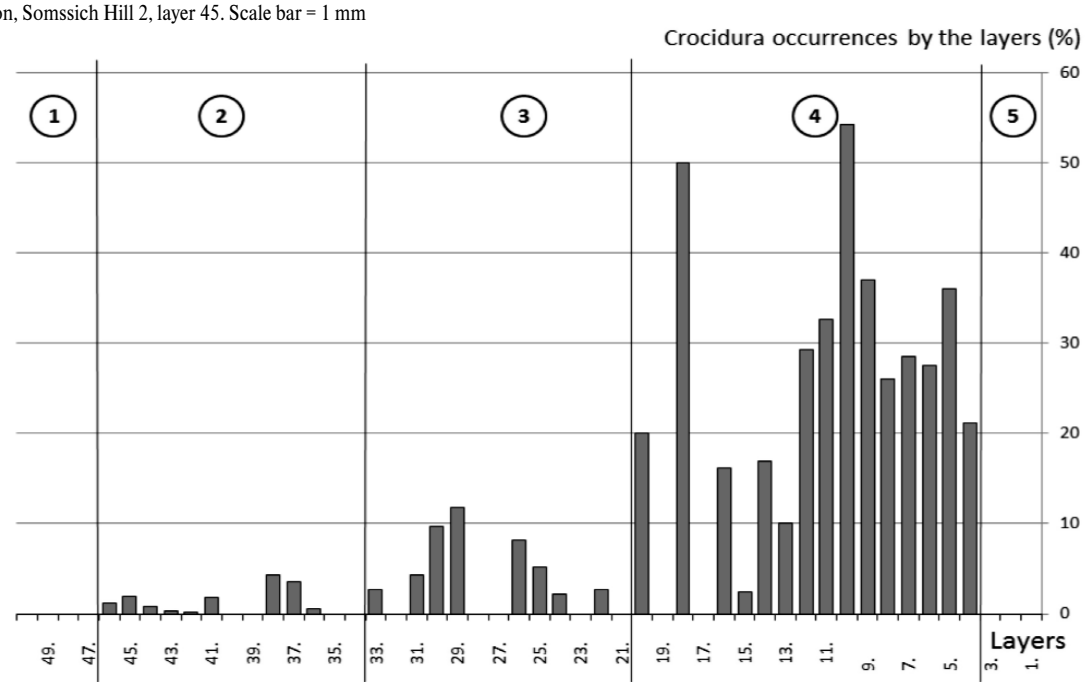

Figure 6. The number of the Crocidura teeth relatively to the whole *Crocidura* and *Sorex* teeth material in the layers of Somssich Hill 2 locality with the supposed ecotypes: 1 – warmer climate with deciduous forests, 2 – cold climate and open grassland (steppe), 3 – forest-steppe with less grassy areas, 4 – forest steppe with greater grassy areas, 5 – not enough remains for the ecotype-reconstruction

Within this period grassy areas became larger in size from layer 20. This is indicated by the greater significance of *Crocidura* forms beside *Sorex* ones.

The remains found in layers 3–1 were not enough for drawing a well-founded outline on the vegetation (Figure 6).

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