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Crocidura (Mammalia, Soricidae) remains from the late Early Pleistocene Somssich Hill 2 locality (Villány Hills, Southern Hungary)

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Abstract – Two species of the white-toothed shrews (*Crocidura kornfeldi* Kormos, 1934 and *Crocidura obtusa* Kretzoi, 1938) were found in the late Early Pleistocene vertebrate fauna of the Somssich Hill 2 locality. Most of the specimens could not be identified at the species level, therefore they are described here as *Crocidura* sp. indet. (*kornfeldi* or *obtusa*). Detailed morphological and morphometrical analyses were made on the remains of the two species. The biostratigraphical and palaeoecological relations of their occurrence are also given. With 14 figures and 5 tables.

Key words – *Crocidura kornfeldi*, *Crocidura obtusa*, Early Pleistocene, Somssich Hill, Soricidae

INTRODUCTION

The Somssich Hill 2 site is one of the most important Pleistocene vertebrate localities of Hungary. It was rediscovered by Dénes Jánossy and György Topál in 1974 (it was already mentioned by Kormos (1937) and Kretzoi (1956)). The excavation led by them between 1975 and 1984 yielded rich Pleistocene fauna, the preliminary lists of which are given in Jánossy (1983, 1986, 1990). The molluscan fauna of the locality was elaborated by Krolopp (2000), and some mammal groups were also described by János Hír (cricetids) and Dénes Jánossy (lemmings and arvicolids) (Hír 1998, Jánossy 1983, 1990). Most of the Somssich Hill 2 material is under elaboration in the Department of Palaeontology and Geology of the Hungarian Natural History Museum, by the cooperative research group of the Hungarian Academy of Sciences, the Hungarian Natural History Museum and the Eötvös Loránd University (OTKA K104506, project leader: Piroska Pazonyi). Some articles were recently published on the results of some fossil groups of the locality (Botka & Mészáros 2014*a*, 2015, Striczky & Pazonyi 2014, Szentesi 2014).

A great number of soricid fossils were found in the Somssich Hill 2 assemblage. Seven shrew species were mentioned by Botka & Mészáros (2014*b*) and Mészáros (2015). In the first description of the locality, Jánossy (1983) mentioned only one *Crocidura* species (*C. obtusa*). In the present study, we determined two species of this genus (*C. kornfeldi* and *C. obtusa*), which are discussed here in detail.

LOCALITY

The Somssich Hill 2 site is located ca. 500 m west from the city of Villány, on the top of the Somssich Hill (today named as Villány Hill) in Southern Hungary, Villány Hills (GPS coordinates: N 45° 52' 26.66", E 18° 26' 32.71"; EOVX = 58998, EOVY = 603025).

Detailed description of the locality is given in Hungarian by Botka & Mészáros (2015). Brief English overviews are shown in Botka & Mészáros (2014*a*) and in Striczky & Pazonyi (2014).

MATERIAL AND METHODS

The fossil material of the locality is stored in the Department of Palaeontology and Geology of the Hungarian Natural History Museum, Budapest (inventory numbers of the studied white-toothed shrews: VER 2015.247.–364.; VER 2015.305.–335.). Botka & Mészáros (2014*a*) mentioned that the *Beremendia* remains are poorly preserved, they are fragmentary and complete mandibles and maxillae are relatively rare. The *Crocidura* material is even less well-preserved, most of the remains are isolated teeth.

The 50 layers yielded 208 *Crocidura* remains, 12 specimens of which could have been identified with certainty as *C. kornfeldi* and 15 as *C. obtusa*. 181 specimens (isolated teeth, maxillary or mandible fragments) were not exactly identifiable, thus they are described as *Crocidura* sp. indet. (*kornfeldi* or *obtusa*). The presence of a third *Crocidura* species in the material is probably to be excluded.

During anatomical descriptions and measurements the method presented by Reumer (1984) was followed. The measurements were taken using the Delta Optical Smart Analysis Pro 1.0.0 software and were given in mm. The SEM photos were taken by a Hitachi S-2360N Environmental Scanning Electron Microscope (ESEM).

The abbreviations in the descriptions and in the measurements are used as follows: I = incisor, A = antemolar, P = premolar, M = molar, M^x = upper tooth, M_x = lower tooth, L = length, W = width, H = height, BL = buccal length, LL = lingual length, AW = anterior width, PW = posterior width, n = number of specimens, min. = minimum, max. = maximum, SD = standard deviation, MNI = minimum number of individuals, GMH = Geological Museum of Hungary (in the Hungarian Geological and Geophysical Institute). The numbers in the lists of "Studied material and measurements" are the collection and working numbers used during the elaboration of the material.

SYSTEMATIC DESCRIPTION

Phylum Vertebrata Linnaeus, 1758
Classis Mammalia Linnaeus, 1758
Order Eulipotyphla Waddell *et al.*, 1999
Family Soricidae Fischer von Waldheim, 1817
Subfamily Crocidurinae Milne-Edwards, 1874
Genus *Crocidura* Wagler, 1832

Dental formula is 143/123. The dental elements are not stained. The lower incisor is short to moderately long and is curving upward, its cutting edge is slightly serrate to smooth. The first upper antemolar is larger than the equal-sized second and third antemolars, all of them are unicuspid (after Repenning 1967). The genus is present in the European mainland from the Early Villányian (MN 16 zone, Pliocene) to present.

Crocidura kornfeldi Kormos, 1934
(Figs 1–2)

1934 *Crocidura kornfeldi* n. sp. – Kormos, pp. 304–305, fig. 37.
1983 *Crocidura kornfeldi* Kormos – Fejfar & Horáček, pp. 134–136, tab. 2, pl. VI, figs 1–10, pl. VII, figs 7–10.
1984 *Crocidura kornfeldi* Kormos – Reumer, pp. 18–22, tabs 1–2, pl. 1, figs 1–6, pl. 2, figs 1–5.
1985 *Crocidura kornfeldi* Kormos – Reumer & Doukas, pp. 114–115, pl. 2, fig. 1.
1985 *Crocidura* sp. – Gil & Sesé, pp. 495–496, fig. 1.
2000 *Crocidura kornfeldi* Kormos – Rzebik-Kowalska, pp. 36–39, tabs XXXI–XXXIII, figs 13A, 14.
2001 *Crocidura kornfeldi* Kormos – Koufos *et al.*, pp. 53–55, tabs 3–4, fig. 2, pl. 2, figs 13a-22b.
2005 *Crocidura kornfeldi* Kormos – Masini *et al.*, pp. 82–83, tab. 1, fig. 4: 2–6.
2011 *Crocidura kornfeldi* Kormos – Rofes & Cuenca-Bescós, pp. 66–70, tabs 1–2, figs 2–3.
2013 *Crocidura kornfeldi* Kormos – Cuenca-Bescós *et al.*, fig. 4G.
2015 *Crocidura kornfeldi* Kormos – Furió *et al.*, p. 156, tab. 2, figs 3, 5a-b.

Holotype – A skull with partial dentition, GMH Ob. 3686.

Type locality – Villány 3 locality, Villány Hills, Hungary, Early Pleistocene (Villányian Stage, Kisláng Phase).

Studied material and measurements – For the overview of the measurements see Table 1. The measurement data of the following list are given in mm.

Layer 5 (VER 2015.247.)

2.5/12 – Right mandible fragment with M_2 and M_3; M_2: L=1.620, W=1.026; M_3: L=1.269, W=0.675
2.5/54, 55 – 2 right mandible fragments
2.5/71 – Right mandible fragment with M_2 and M_3; M_2: L=1.566, W=1.161; M_3: L=1.404, W=0.729

Layer 8 (VER 2015.248.)

2.8/4 – Left mandible fragment

Layer 12 (VER 2015.249.)

2.12/2 – Right mandible fragment with M_2 and M_3; M_2: L=1.242, W=0.942; M_3: L=1.026, W=0.648

Layer 14 (VER 2015.250.)

2.14/1 – Left mandible fragment with M_2 and M_3; M_2: L=1.485, W=1.031; M_3: L=1.161, W=0.675

Layer 30 (VER 2015.251.)

2.30/2 – Left mandible fragment with A_2, M_1 and M_2; M_1: L=1.544, W=1.296; M_2: L=1.525, W=1.004
2.30/3 – Left mandible fragment with M_1, M_2 and M_3; M_1: L=1.647, W=1.209; M_2: L=1.539, W=1.080; M_3: L=1.269, W=0.661

Layer 31 (VER 2015.252.)

2.31/2 – Right mandible fragment

Layer 45 (VER 2015.253.)

2.45/1 – Right mandible fragment

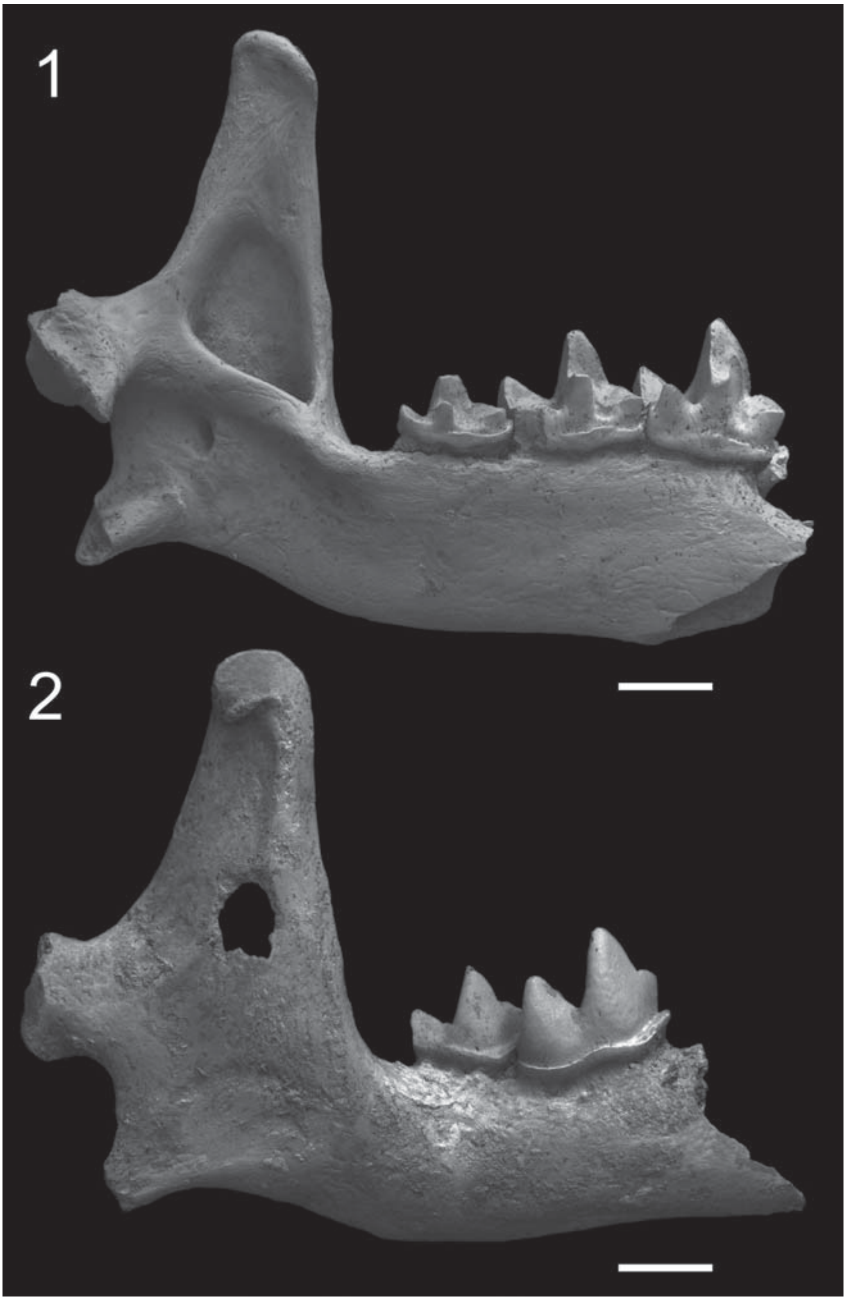
Layer 46 (VER 2015.254.)

2.46/3 – Right mandible with M_1; L=1.606, W=1.142

Original diagnosis – P^4, M^1 and M^2 are relatively short and broad, the molars have a short emargination; I_1 is acuspulate; A_1 and A_2 are broad; there is a thick bar

Table 1. Measurements of *Crocidura kornfeldi* teeth from the Somssich Hill 2 locality (for the abbreviations see "Material and methods")

		n (pcs)	min. (mm)	mean (mm)	max. (mm)	SD (mm)
M_1	L	1	–	1.61	–	–
	W	1	–	1.14	–	–
M_2	L	3	1.24	1.43	1.57	0.1686
	W	3	0.94	1.04	1.16	0.1101
M_3	L	5	1.03	1.23	1.40	0.1411
	W	5	0.65	0.68	0.73	0.0309



Figs 1–2. *Crocidura kornfeldi* Kormos, 1934, Somssich Hill 2, scale bar: 1 mm; **1.** left mandible fragment with M_1-M_3, layer 30, lingual view; **2.** right mandible fragment with M_1-M_2, layer 12, buccal view

between the anterior base of the coronoid process and the condyle, underneath the internal temporal fossa; a deep groove is present below this bar (after REUMER 1984).

Emended diagnosis – REUMER (1984) proposed an emended diagnosis, to which ROFES & CUENCA-BESCÓS (2011) added some further observations: P^4 and M^1 with strong posterior emargination; coronoid spicule either absent or small, poorly developed and situated high, near the tip of the coronoid process; condyle reaching far backwards. We emend the afore-described characters according to RZEBIK-KOWALSKA (2000, fig. 13A) and our observations on the Somssich Hill 2 material with the coronoid spicule being indistinct.

Anatomical description – Some detailed anatomical descriptions on *C. kornfeldi* were already published by several authors (REUMER 1984, RZEBIK-KOWALSKA 2000, KOUFOS *et al.* 2001, ROFES & CUENCA-BESCÓS 2011) coinciding with our observations.

Dentition – The dental morphology of *C. kornfeldi* is very similar to that of *C. obtusa*, the detailed description of the teeth is given at *C.* sp. indet. (*kornfeldi* or *obtusa*). In *C. kornfeldi*, the buccal re-entrant valley on M_1-M_2 opens high above the cingulum.

Mandible – The coronoid process is blunt and low. The coronoid spicule is small, situated high and indistinct. The anterior part of the coronoid process leans slightly backwards and the ramus sometimes is broadened at 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 to halfway up the coronoid process. The region below the internal temporal fossa (the subfossa) is excavated, separated from the internal temporal fossa by a protruding ridge.

Remarks – Many isolated teeth, fragmented maxillae and mandibles in the material may also belong to this species. However, we determine them as *C.* sp. indet. (*kornfeldi* or *obtusa*), because there is no clear evidence for their attachment to *C. obtusa*.

Crocidura obtusa Kretzoi, 1938
(Figs 3–4)

1938 *Crocidura obtusa* n. sp. – KRETZOI, p. 92, text-fig. 1a.
1969 *Crocidura obtusa* Kretzoi – JÁNOSSY, p. 601.
1971 *Crocidura obtusa* Kretzoi – KOENIGSWALD, p. 120.
2000 *Crocidura* cf. *obtusa* Kretzoi – RZEBIK-KOWALSKA, pp. 39–43, tabs XXXIV–XXXV, figs 13B, 14.

Holotype – The holotype described by KRETZOI (1938) was one right mandible but it was lost from the collection of the Hungarian Natural History Museum (it was probably destroyed in a devastating fire in 1956) (PÁLFY *et al.* 2008, p. 140). The original inventory number was Fa. 16.

Type locality – Gombasek (Gombaszög), Slovakia, Early Pleistocene.

Studied material and measurements – For the overview of the measurements see Table 2. The measurement data of the following list are given in mm.

Layer 4 (VER 2015.255.)

2.4/4 – Left mandible fragment with M_2; L=1.687, W=1.026
2.4/6 – Left mandible fragment with M_2; L=1.212, W=1.080
2.4/103 – Right mandible fragment

Layer 5 (VER 2015.256.)

2.5/3 – Left mandible fragment with M_1 and M_2; M_1: L=1.728, W=1.296; M_2: L=1.512, W=1.120
2.5/13 – Left mandible fragment with M_3; L=1.269, W=0.756
2.5/53 – Left mandible fragment

Layer 12 (VER 2015.257.)

2.12/1 – Left mandible fragment with I_1 fragment, A_2, M_1, M_2 and M_3; M_1: L=1.444, W=1.139; M_2: L=1.512, W=0.972; M_3: L=1.134, W=0.675

Layer 13 (VER 2015.258.)

2.13/4 – Left mandible fragment

Layer 25 (VER 2015.259.)

2.25/1 – Left mandible fragment with A_1, M_1 and M_2; M_1: L=1.363, W=0.985; M_2: L=1.220, W=0.904
2.25/4 – Left mandible fragment with M_2; L=1.447, W=0.877

Layer 30 (VER 2015.260.)

2.30/1 – Right mandible fragment

Layer 31 (VER 2015.261.)

2.31/1 – Left mandible fragment with eroded M_2

Table 2. Measurements of *Crocidura obtusa* teeth from the Somssich Hill 2 locality (for the abbreviations see "Material and methods")

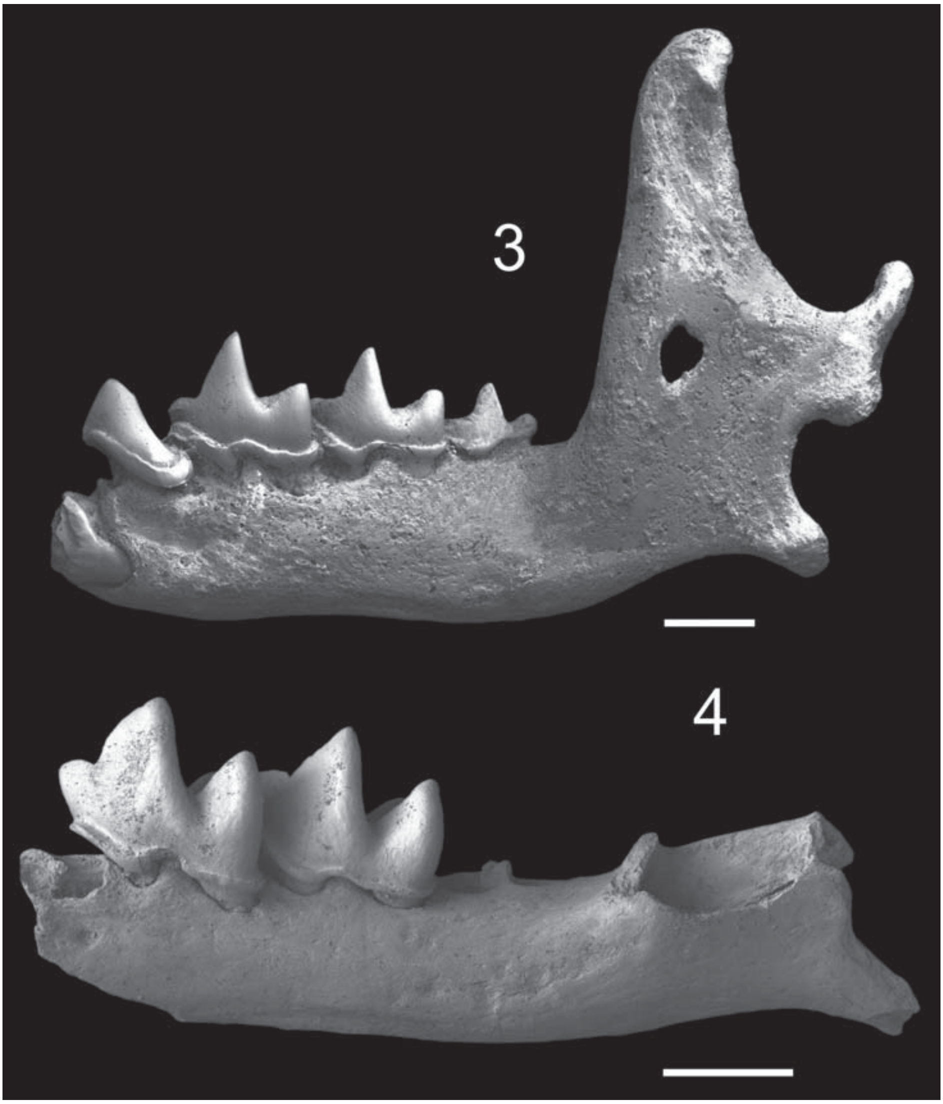
		n (pcs)	min. (mm)	mean (mm)	max. (mm)	SD (mm)
M_1	L	3	1.36	1.51	1.73	0.1947
	W	3	0.99	1.14	1.30	0.1555
M_2	L	6	1.21	1.43	1.69	0.1851
	W	6	0.88	1.00	1.12	0.0965
M_3	L	2	1.13	1.20	1.27	0.0995
	W	2	0.68	0.72	0.76	0.0573

Layer 39 (VER 2015.262.)

2.39/1 – Left mandible fragment

Layer 41 (VER 2015.263.)

2.41/1 – Left mandible fragment with eroded M_2 and M_3



Figs 3–4. *Crocidura obtusa* Kretzoi, 1938, Somssich Hill 2, scale bar: 1 mm; **3.** left mandible with I_1 fragment, A_2 and M_1-M_3, layer 12, buccal view; **4.** left mandible fragment with M_1-M_2, layer 5, buccal view

Layer 46 (VER 2015.264.)

2.46/1 – Left mandible fragment

Original diagnosis – Kretzoi (1938) distinguished the species from the other similar forms on the basis of the morphology and position of the lower incisor and antemolars.

Emended diagnosis – We emend this diagnosis according to Rzebik-Kowalska (2000, fig. 13B) and our observations on the Somssich Hill 2 material with the distinct coronoid spicule.

Anatomical description – Up to now mainly short presentations but no detailed descriptions have been born on *C. obtusa* (Kretzoi 1938, Jánossy 1969, Koenigswald 1971, Rzebik-Kowalska 2000).

Dentition – The morphological characters of the teeth are very similar to those of *C. kornfeldi*. They are only different in the position of the re-entrant valley of the first and the second lower molars. It opens closer to the buccal cingulum in *C. obtusa* than in *C. kornfeldi*.

Mandible – The coronoid process 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 posterior view, the interarticular area is long. The internal temporal fossa is large and open, reaching to halfway up the coronoid process. The subfossa is sometimes present.

Remarks – Some isolated teeth, maxillary and mandible fragments could be determined as *C.* sp. indet. (*kornfeldi* or *obtusa*) (see at *C. kornfeldi*).

Crocidura sp. indet. (*kornfeldi* or *obtusa*)
(Figs 5–9)

Studied material and measurements – For the overview of the measurements see Table 3. The measurement data of the following list are given in mm.

Layer 4 (VER 2015.305.)

2.4/2 – Left mandible fragment with A_2 fragment and M_1; M_1: L=1.498, W=1.147
2.4/3 – Left mandible fragment with M_1; L=1.539, W=1.174
2.4/8 – Left I_1; L=3.834, H=1.918
2.4/9, 10 – 2 left I_1 fragments
2.4/12 – Left mandible fragment with M_1 and M_2; M_1: L=1.525, W=1.215; M_2: L=1.512, W=1.080
2.4/13 – Right mandible fragment with fragmented M_2 and M_3; M_3: L=1.323, W=0.715
2.4/15 – Right M_1; L=1.660, W=1.215
2.4/16 – Right mandible fragment with M_2; L=1.687, W=1.026
2.4/18, 19 – 2 right I_1 fragments
2.4/21 – Right M^2 fragment
2.4/22 – Right I^1; L=1.701, H=1.323
2.4/23, 25, 32 – 3 right I^1 fragments

2.4/24 – Right I^1; L=2.160, H=1.458
2.4/28 – Left I^1 fragment
2.4/30 – Right mandible fragment with M_1; L=1.647, W=1.228
2.4/33 – Left I_1 fragment
2.4/37 – Left mandible fragment
2.4/39 – Left M^1; LL=1.593, BL=1.579, AW=1.755, PW=2.214
2.4/40 – Left mandible fragment with M_2; L=1.485, W=0.985
2.4/41, 42 – Left A^1 and A^2
2.4/101 – Left mandible fragment with M_1, M_2 and M_3; M_1: L=1.593, W=1.256; M_2: L=1.350, W=1.066; M_3: L=1.242, W=0.675
2.4/102 – Left mandible fragment with M_3; L=1.255, W=0.715

Layer 5 (VER 2015.306.)

2.5/1 – Right mandible fragment with eroded $M_{1,}$ M_2 and M_3
2.5/2 – Right mandible fragment with eroded $A_{1,}$ M_1 and M_2

Table 3. Measurements of *Crocidura* sp. indet. (*kornfeldi* or *obtusa*) teeth from the Somssich Hill 2 locality (for the abbreviations see "Material and methods")

		n (pcs)	min. (mm)	mean (mm)	max. (mm)	SD (mm)
I^1	L	17	1.66	1.97	2.16	0.1634
	H	17	1.15	1.37	1.50	0.0895
P^4	LL	10	0.84	1.02	1.24	0.1284
	BL	10	1.78	1.94	2.13	0.1045
	W	10	1.65	1.93	2.13	0.1441
M^1	LL	13	1.32	1.54	1.70	0.1066
	BL	13	1.43	1.61	1.88	0.1384
	AW	13	1.73	1.85	1.97	0.0618
	PW	13	2.00	2.24	2.57	0.1444
M^2	LL	10	1.19	1.39	1.70	0.1440
	BL	10	1.30	1.39	1.49	0.0605
	AW	10	2.03	2.09	2.20	0.0720
	PW	10	1.65	1.75	1.81	0.0481
I_1	L	6	3.32	3.51	3.83	0.1798
	H	6	0.76	1.06	1.92	0.4309
M_1	L	57	1.32	1.56	1.72	0.0934
	W	57	0.93	1.17	1.30	0.0771
M_2	L	64	1.09	1.46	1.69	0.1277
	W	64	0.63	1.00	1.18	0.0985
M_3	L	33	1.03	1.20	1.32	0.0778
	W	33	0.59	0.67	0.78	0.0477

2.5/4 – Left mandible fragment with M_1; L=1.566, W=1.215
2.5/5 – Right mandible fragment with M_3; L=1.134, W=0.621
2.5/6 – Right mandible fragment with I_1 and A_2 fragments and M_1; M_1: L=1.620, W=1.174
2.5/7 – Left mandible fragment with M_2 and M_3; M_2: L=1.593, W=1.107; M_3: L=1.215, W=0.675
2.5/8 – Right mandible fragment with M_1; L=1.463, W=1.215
2.5/9 – Left mandible fragment with I_1, A_1, A_2, M_1 and M_2 fragments
2.5/11 – Right M_1 fragment
2.5/14 – Right mandible fragment with M_3; L=1.188, W=0.702
2.5/15 – Right mandible fragment with M_1, M_2 and M_3; M_1: L=1.647, W=1.228; M_2: L=1.498, W=1.107; M_3: L=1.269, W=0.594
2.5/16 – Left mandible fragment with M_1 and M_2; M_1: L=1.498, W=1.134; M_2: L=1.431, W=0.972
2.5/17 – Right mandible fragment with A_2 and M_1; M_1: L=1.620, W=1.161
2.5/18 – Right mandible fragment with M_2 and M_3; M_2: L=1.431, W=0.877; M_3: L=1.161, W=0.621
2.5/31 – Left I^1; L=2.052, H=1.458
2.5/32 – Right I^1; L=2.079, H=1.404
2.5/33 – Right I^1; L=2.052, H=1.323
2.5/34 – Left I^1 fragment
2.5/35 – Right I^1; L=2.106, H=1.404
2.5/36 – Left I^1; L=2.079, H=1.431
2.5/37 – Right I^1; L=2.160, H=1.431
2.5/38 – Left I^1; L=1.944, H=1.323
2.5/39 – Left mandible fragment with M_2; L=1.566, W=1.066
2.5/40 – Left mandible fragment with M_1; L=1.620, W=1.161
2.5/41 – Left mandible fragment with M_3; L=1.201, W=0.783
2.5/42 – Left mandible fragment with M_1; L=1.593, W=1.228
2.5/43 – Left maxillary fragment with P^4, M^1 and M^2; P^4: LL=0.918, BL=1.971, W=1.998; M^1: LL=1.539, BL=1.674, AW=1.890, PW=2.241; M^2: LL=1.296, BL=1.350, AW=2.079, PW=1.620
2.5/44 – Right maxillary fragment with P^4, M^1 and M^2; M^1: LL=1.593, BL=1.647, AW=1.849, PW=2.268; M^2: LL=1.363, BL=1.444, AW=2.065, PW=1.741
2.5/45 – Left maxillary fragment with P^4 and M^1; P^4: LL=1.161, BL=2.133, W=2.133; M^1: LL=1.647, BL=1.647, AW=1.836, PW=2.295
2.5/46 – Left maxillary fragment with eroded A^3 and P^4
2.5/47 – Right maxillary fragment with eroded I^1 and A^1
2.5/48 – Left M^2 fragment
2.5/49 – Right M^2; LL=1.485, BL=1.485, AW=2.160, PW=1.768
2.5/50 – Left maxillary fragment with P^4; LL=0.945, BL=1.890, W=1.863
2.5/51 – Right M^2; LL=1.323, BL=1.350, AW=2.025, PW=1.647
2.5/52 – Eroded right M^2
2.5/56 – Right mandible fragment with M_1 and M_2; M_1: L=1.404, W=1.188; M_2: L=1.431, W=1.053
2.5/61 – Left mandible fragment with M_1, M_2 and M_3; M_1: L=1.431, W=1.269; M_2: L=1.431, W=1.053; M_3: L=1.188, W=0.756
2.5/62 – Right mandible fragment with M_1, M_2 and M_3; M_1: L=1.485, W=1.161; M_2: L=1.431, W=1.080; M_3: L=1.215, W=0.729
2.5/63 – Right mandible fragment with M_2 and M_3; M_2: L=1.404, W=1.053; M_3: L=1.134, W=0.729
2.5/64 – Right mandible fragment with M_1, M_2 and fragment of M_3; M_1: L=1.620, W=1.188; M_2: L=1.539, W=1.053
2.5/65 – Right mandible fragment with M_1; L=1.647, W=1.188
2.5/66 – Left mandible fragment with A_1 and A_2

2.5/67 – Left mandible fragment with M_2 and M_3; M_2: L=1.458, W=1.026; M_3: L=1.188, W=0.675
2.5/68 – Left mandible fragment with M_1 fragment, M_2 and M_3; M_2: L=1.404, W=1.039; M_3: L=1.282, W=0.702
2.5/69 – Left mandible fragment with M_1 and M_2; M_1: L=1.485, W=1.242; M_2: L=1.390, W=1.026
2.5/72 – Right mandible fragment with M_1 and M_2; M_1: L=1.714, W=1.269; M_2: L=1.593, W=1.161
2.5/73 – Left mandible fragment with M_1, M_2 and M_3; M_1: L=1.633, W=1.161; M_2: L=1.458, W=1.053; M_3: L=1.296, W=0.729
2.5/74 – Left mandible fragment with A_2, M_1 and M_2; M_1: L=1.687, W=1.188; M_2: L=1.566, W=1.053

Layer 6 (VER 2015.307.)

2.6/1 – Right mandible fragment with $A_{2,}$ M_1 and M_2; M_1: L=1.647, W=1.155; M_2: L=1.390, W=0.985
2.6/2 – Left mandible fragment with M_2 and M_3; M_2: L=1.571, W=1.066; M_3: L=1.242, W=0.742
2.6/3 – Right mandible fragment with $A_{2,}$ M_1 and M_2; M_1: L=1.606, W=1.120; M_2: L=1.436, W=1.031
2.6/5 – Left mandible fragment with M_2; L=1.323, W=0.896
2.6/6 – Right mandible fragment with M_2 and M_3; M_2: L=1.487, W=1.053; M_3: L=1.293, W=0.675
2.6/7 – Left I_1; L=3.391, H=0.866
2.6/8 – Left I_1 fragment
2.6/9 – Left maxillary fragment with P^4 and M^1; P^4: LL=1.080, BL=2.052, W=2.049; M^1: LL=1.647, BL=1.679, AW=1.890, PW=2.362
2.6/10 – Left M^2; LL=1.379, BL=1.409, AW=2.203, PW=1.795
2.6/11 – Left I^1; L=2.052, H=1.428
2.6/12 – Eroded left I^1
2.6/13 – Left I^1; L=2.146, H=1.385

Layer 7 (VER 2015.308.)

2.7/1 – Right mandible fragment with eroded M_2 and M_3
2.7/3 – Right I^1; L=1.922, H=1.339
2.7/4 – Fragmented right M_3

Layer 8 (VER 2015.309.)

2.8/1 – Left mandible fragment with M_1 and M_2; M_1: L=1.606, W=1.215; M_2: L=1.539, W=1.053
2.8/2 – Left mandible with complete dentition; I_1: L=3.685, H=1.026; M_1: L=1.728, W=1.242; M_2: L=1.512, W=0.999; M_3: L=1.296, W=0.680
2.8/5 – Right mandible fragment with $A_{2,}$ M_1, M_2 and M_3; M_1: L=1.377, W=1.215; M_2: L=1.571, W=1.080; M_3: L=1.255, W=0.677
2.8/6 – Left maxillary fragment with A^2, A^3, P^4, M^1 and M^2; P^4: LL=0.999, BL=1.922, W=1.957; M^1: LL=1.458, BL=1.471, AW=1.890, PW=2.025; M^2: LL=1.474, BL=1.330, AW=2.052, PW=1.728
2.8/11 – Left mandible fragment with M_1, M_2 and M_3 fragment; M_1: L=1.660, W=1.239; M_2: L=1.485, W=1.082
2.8/12 – Right I^1 fragment
2.8/13 – Right M^1; LL=1.525, BL=1.498, AW=1.860, PW=2.268
2.8/14 – Left I_1 fragment

Layer 9 (VER 2015.310.)

2.9/1 – Left mandible fragment with M_2 and M_3; M_2: L=1.517, W=0.945; M_3: L=1.212, W=0.672
2.9/2 – Right mandible fragment with I_1, A_1, A_2 fragment and M_1; M_1: L=1.498, W=1.066
2.9/3 – Left mandible fragment with I_1, A_1 and A_2; I_1: L=3.469, H=0.891
2.9/4 – Left I^1; L=1.660, H=1.147

Layer 10 (VER 2015.311.)

2.10/11 – Left mandible fragment with A_2, M_1, M_2 and M_3; M_1: L=1.474, W=1.163; M_2: L=1.201, W=0.904; M_3: L=1.188, W=0.704
2.10/12 – Left mandible fragment with M_1, M_2 and M_3; M_1: L=1.674, W=1.212; M_2: L=1.597, W=1.088; M_3: L=1.269, W=0.702
2.10/13 – Right mandible fragment with M_1 fragment, M_2 and M_3; M_2: L=1.437, W=1.026; M_3: L=1.026, W=0.599
2.10/14 – Left mandible fragment with M_1 and M_2; M_1: L=1.544, W=1.120; M_2: L=1.296, W=0.972
2.10/15 – Right mandible fragment with M_1 and M_3; M_1: L=1.722, W=1.085; M_3: L=1.190, W=0.648
2.10/16 – Right mandible fragment with I_1, A_1 and A_2; I_1: L=3.577, H=1.053
2.10/17 – Right mandible fragment with M_1 and M_2; M_1: L=1.674, W=1.212; M_2: L=1.490, W=1.080
2.10/18 – Right mandible fragment with M_2 and M_3 fragment; M_2: L=1.593, W=1.177
2.10/19 – Right mandible fragment with M_1 and M_2; M_1: L=1.409, W=1.188; M_2: L=1.471, W=1.080
2.10/20 – Right mandible fragment with M_2; L=1.552, W=1.080
2.10/21 – Left maxillary fragment with P^4 and M^1 fragment and M^2; M^2: LL=1.296, BL=1.444, AW=2.030, PW=1.757
2.10/22 – Left maxillary fragment with P^4 and M^1; P^4: LL=0.837, BL=1.895, W=1.647; M^1: LL=1.458, BL=1.876, AW=1.906, PW=2.173
2.10/23 – Left maxillary fragment with M^1 and M^2; M^1: LL=1.701, BL=1.512, AW=1.944, PW=2.322; M^2: LL=1.377, BL=1.458, AW=2.187, PW=1.757
2.10/24 – Right I^1 fragment

Layer 11 (VER 2015.312.)

2.11/1 – Right mandible fragment with M_1, M_2 and M_3; M_1: L=1.512, W=1.209; M_2: L=1.539, W=1.004; M_3: L=1.131, W=0.645
2.11/2 – Left mandible fragment with A_2, M_1 and M_2 fragment; M_1: L=1.593, W=1.215
2.11/3 – Left mandible fragment with M_1, M_2 and M_3 fragments
2.11/4 – Right mandible fragment with M_1 and M_2; M_1: L=1.620, W=1.236; M_2: L=1.485, W=1.080
2.11/5 – Left mandible fragment with A_2 and M_1, M_2 fragments
2.11/6 – Right I^1 fragment

Layer 12 (VER 2015.313.)

2.12/3 – Right mandible fragment with A_1, A_2, M_1 and M_2; M_1: L=1.660, W=1.215; M_2: L=1.660, W=0.945
2.12/4 – Skull fragment with left I^1 fragment, A^1, A^2, A^3, P^4 fragment, right A^2, A^3, P^4 and M^1 fragment; P^4: LL=1.053, BL=2.030, W=1.998
2.12/6 – Right mandible fragment with M_3; L=1.215, W=0.675

2.12/7 – Left mandible fragment with M_2 and M_3; M_2: L=1.566, W=0.985; M_3: L=1.188, W=0.675
2.12/8 – Left mandible fragment with M_2 and M_3 fragments
2.12/9 – Right I_1 fragment
2.12/10 – Right I_1; L=3.321, H=0.756

Layer 13 (VER 2015.314.)

2.13/2 – Left maxillary fragment with P^4, M^1 and M^2; P^4: LL=0.864, BL=1.849, W=1.755; M^1: LL=1.431, BL=1.485, AW=1.728, PW=2.165; M^2: LL=1.185, BL=1.298, AW=2.025, PW=1.809
2.13/3 – Right maxillary fragment with M^1 and M^2; M^1: LL=1.593, BL=1.566, AW=1.809, PW=2.565; M^2: LL=1.701, BL=1.377, AW=2.025, PW=1.701
2.13/5 – Left maxillary fragment with M^1 and M^2; M^1: LL=1.593, BL=1.566, AW=2.106, PW=2.268; M^2: LL=1.458, BL=1.390, AW=2.254, PW=1.755
2.13/6 – Right mandible fragment with M_2 and M_3; M_2: L=1.323, W=0.864; M_3: L=1.053, W=0.594
2.13/7 – Right mandible fragment with M_2 and M_3; M_2: L=1.458, W=0.931; M_3: L=1.107, W=0.621
2.13/8 – Eroded right M_2
2.13/9 – Eroded right I^1

Layer 14 (VER 2015.315.)

2.14/2 – Right mandible fragment with M_1 and M_2; M_1: L=1.323, W=0.945; M_2: L=1.444, W=0.810
2.14/3 – Right mandible fragment with M_2 and M_3 fragment; M_2: L=1.593, W=1.026
2.14/4 – Right mandible fragment with A_2 fragment, eroded M_1 and M_2
2.14/5 – Left mandible fragment with A_1, A_2 and M_1; M_1: L=1.582, W=1.201

Layer 15 (VER 2015.316.)

2.15/1 – Right maxillary fragment with M^1 and M^2; M^1: LL=1.539, BL=1.620, AW=1.849, PW=2.214; M^2: LL=1.323, BL=1.431, AW=2.133, PW=1.782

Layer 16 (VER 2015.317.)

2.16/1 – Left mandible fragment with M_1; M_1: L=1.647, W=1.174
2.16/2 – Right mandible fragment with I_1 fragment, A_1, A_2 and M_1; M_1: L=1.552, W=1.174
2.16/4 – Right M_1; L=1.579, W=1.166

Layer 18 (VER 2015.318.)

2.18/1 – Right mandible fragment with A_1, A_2, M_1 and M_2 fragment; M_1: L=1.566, W=1.147

Layer 20 (VER 2015.319.)

2.20/1 – Right maxillary fragment with P^4, M^1 and M^2 fragments

Layer 22 (VER 2015.320.)

2.22/1 – Left maxillary fragment with M^1 and M^2; M^1: LL=1.458, BL=1.647, AW=1.863, PW=2.187; M^2: LL=1.323, BL=1.363, AW=2.106, PW=1.728
2.22/2 – Left mandible fragment with M_3; L=1.058, W=0.648
2.22/11 – Right mandible fragment with M_1 fragment and M_2; M_2: L=1.363, W=0.904
2.22/12 – Left mandible fragment with M_3; L=1.080, W=0.642

Layer 24 (VER 2015.321.)

2.24/1 – Right mandible fragment with M_2 and M_3; M_2: L=1.336, W=0.869; M_3: L=1.093, W=0.637

Layer 25 (VER 2015.322.)

2.25/2 – Left mandible fragment with M_1 and M_2; M_1: L=1.431, W=1.080; M_2: L=1.350, W=0.891
2.25/3 – Left mandible fragment with M_1, M_2 and M_3; M_1: L=1.620, W=1.269; M_2: L=1.512, W=1.080; M_3: L=1.309, W=0.642

Layer 26 (VER 2015.323.)

2.26/1 – Eroded right I^1
2.26/2 – Left mandible fragment with M_1 and M_2; M_1: L=1.539, W=1.188; M_2: L=1.512, W=1.053
2.26/3 – Right M_2; L=1.587, W=1.039

Layer 29 (VER 2015.324.)

2.29/1 – Right mandible fragment with eroded M_2
2.29/2 – Right mandible fragment with M_2; L=1.485, W=0.972
2.29/3 – Left mandible fragment with A_2 and M_1; M_1: L=1.566, W=1.147
2.29/4 – Right mandible fragment

Layer 31 (VER 2015.325.)

2.31/3 – Right mandible fragment with A_1, A_2 and M_1; M_1: L=1.633, W=1.188
2.31/4 – Left mandible fragment with M_1 and M_3; M_1: L=1.593, W=1.107; M_3: L=1.188, W=0.661

Layer 33 (VER 2015.326.)

2.33/2 – Right mandible fragment with M_1, M_2 and M_3; M_1: L=1.431, W=1.058; M_2: L=1.409, W=0.934; M_3: L=1.134, W=0.618
2.33/3 – Right I^1; L=1.782, H=1.498

Layer 36 (VER 2015.327.)

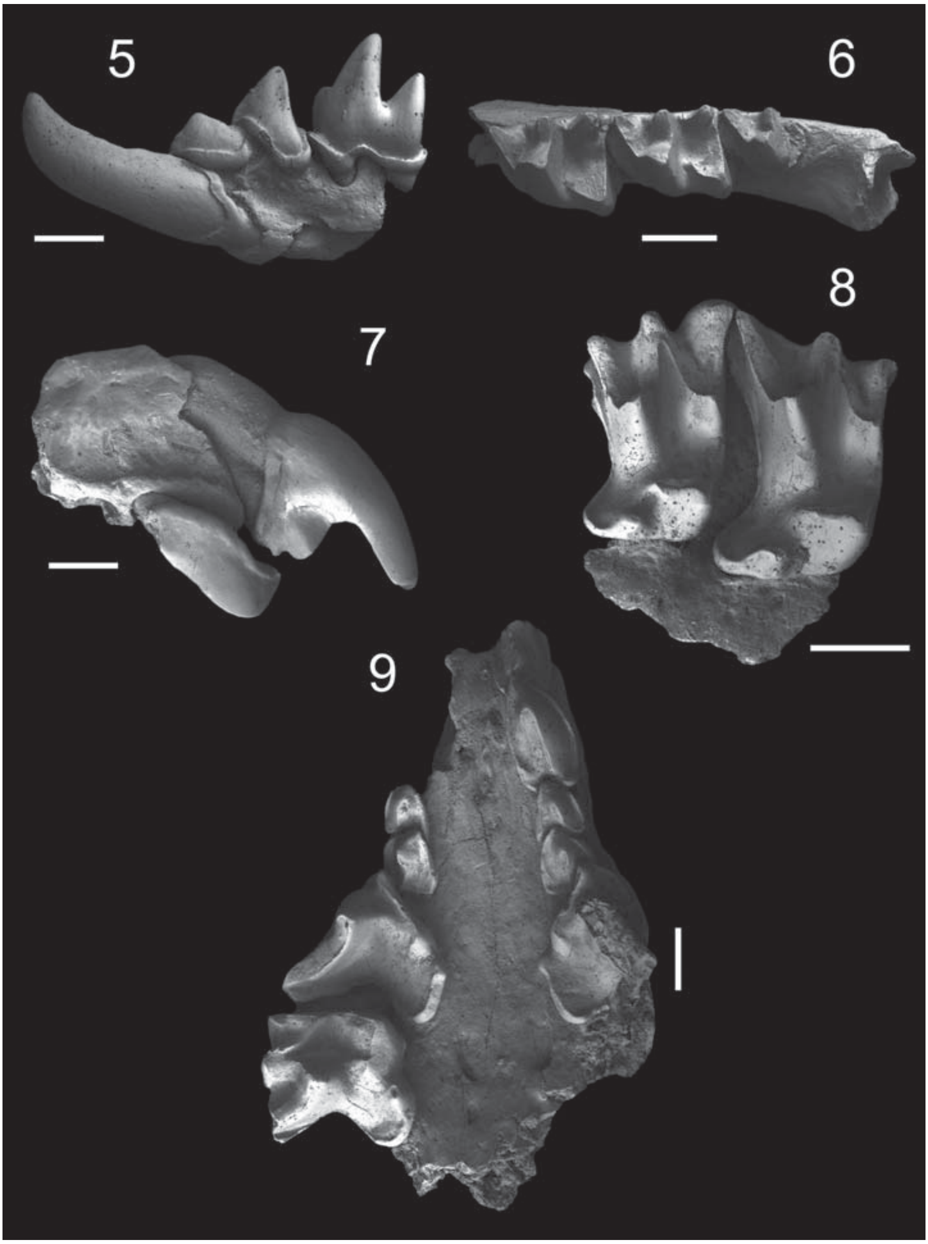
2.36/1 – Left maxillary fragment with P^4; LL=1.242, BL=1.782, W=1.998

Layer 37 (VER 2015.328.)

2.37/2 – Right mandible fragment with M_1 fragment and M_2; M_2: L=1.282, W=0.931
2.37/3 – Left mandible fragment with M_2 and M_3; M_2: L=1.404, W=0.877; M_3: L=1.112, W=0.634
2.37/4 – Left I^1; L=1.755, H=1.228

Layer 38 (VER 2015.329.)

2.38/1 – Left mandible fragment with M_1 and M_2; M_1: L=1.433, W=0.985; M_2: L=1.350, W=0.918
2.38/2 – Left I^1; L=1.876, H=1.296
2.38/3 – Left M_2; L=1.552, W=1.039
2.38/4 – Right I^1; L=1.971, H=1.363
2.38/5 – Left M^1; LL=1.323, BL=1.433, AW=1.795, PW=1.998
2.38/6 – Right M_1; L=1.444, W=1.058



Figs 5–9. *Crocidura* sp. indet. (*kornfeldi* or *obtusa*), Somssich Hill 2, scale bar: 1 mm; **5.** left mandible fragment with I_1-M_1, layer 45, buccal view; **6.** left mandible fragment with M_1-M_3, layer 10, occlusal view; **7.** right maxillary fragment with I^1-A^1, layer 5, buccal view; **8.** right maxillary fragment with M^1-M^2, layer 5, occlusal view; **9.** skull fragment with left I^1-P^4 and right A^2-M^1, layer 12, occlusal view

Layer 41 (VER 2015.330.)

2.41/2 – Left mandible fragment with M_2 and M_3 fragment; M_2: L=1.485, W=0.977

Layer 42 (VER 2015.331.)

2.42/1 – Right mandible fragment with M_2; L=1.350, W=1.001

Layer 43 (VER 2015.332.)

2.43/1 – Left mandible fragment with M_2; L=1.161, W=0.931

Layer 44 (VER 2015.333.)

2.44/1 – Left maxillary fragment with A^1, A^2, A^3 and P^4 fragment

Layer 45 (VER 2015.334.)

2.45/2 – Left mandible fragment with I_1, A_1, A_2 and M_1; I_1: L=3.483, H=0.877; M_1: L=1.593, W=1.147

Layer 46 (VER 2015.335.)

2.46/2 – Left maxillary fragment with A^2, A^3 and P^4; P^4: LL=1.053, BL=1.903, W=1.890

Anatomical description – The identification of isolated teeth of the genus *Crocidura* is very difficult. The majority of the isolated teeth of the early *Crocidura* species in Europe are referred as *Crocidura* sp.

Dentition – ***I***^{1} – The apex is pointed and the talon also has a little, sharp cone. The cingulum along the posterior buccal margin is narrow but well-pronounced, usually it is undulate.

A^1-***A***^{3} – The first antemolar is the largest, the two posterior ones are considerably smaller. A^2 is significantly smaller than A^3. The talon of A^3 is hidden under the parastyle of the P^4. Cingula are well-developed on both sides of the upper antemolars.

P^4 – The parastyle of P^4 is protruding and separated from the paracone by a deep valley. No parastylar crest is present. The protocone is small and situated buccally to the anterolingual corner, which is therefore rounded. A small hypocone is visible on the cingulum-like ridge running along the lingual margin of the tooth. This hypoconal ridge is separated from the protocone by a valley. The posterior emargination is strong.

M^1-***M***^{2} – Both of the upper molars are relatively broad and short. The protocone is connected to the paracone, but between the protocone and the metacone there is a wide and deep valley. The hypocone is situated posterolingually to the protocone. It is poorly defined and separated from the protocone by a valley. On the M^1, the posterobuccal corner protrudes strongly, the metastyle is straight, while in the anterobuccal corner a little, curved parastyle is present. The M^1 AW is far smaller than the PW. The shape of M^2 is trapezoidal, its anterior part is far wider than the posterior one. The parastyle on M^2 is long and curved, while the metastyle is short and straight.

M^3 – It is not present in the Somssich Hill 2 material.

I_1 – The apex is upturned, the dorsal margin is slightly bicuspulate. The buccal cingulum is narrow but pronounced. I_1 reaches back to the posterior end of A_1, underneath A_2.

A_1 – This element is anteroposteriorly quite elongate, only a small part of it is hidden underneath A_2. The cingula are well-developed on both sides.

A_2 – A_2 is typical for *Crocidura*: a high, pointed, tetrahedron-shaped tooth. The cingula are equally strong on both sides.

M_1-M_2 – The lower molars are also typical for *Crocidura*. The entoconid crest is usually absent. The buccal cingulum is narrow but well-pronounced. It is undulate in all specimens, but it is less undulate on M_2 than on M_1. The lingual cingulum is weak.

M_3 – The talonid of M_3 is reduced to a single cuspid, which is the hypoconid. The development of the cingula is as in M_1 and M_2.

DISCUSSION

There are three *Crocidura* species reported from the Early Pleistocene of the European mainland. *Crocidura zorzii* Pasa, 1942 (Italy, Kotsakis *et al.* 2003) is larger in size than the specimens we found here. The forms reported here can be determined on the basis of morphology and measurements as *C. kornfeldi* or *C. obtusa*.

These two *Crocidura* species can be distinguished morphologically by the characteristics of the mandible. The ramus mandibulae of *C. kornfeldi* is blunter and lower. The tip of the coronoid process of *C. obtusa* leans strongly backwards. The coronoid spicule of *C. obtusa* is distinct, while it is indistinct in *C. kornfeldi*. The condyle is higher and the interarticular area is longer in *C. obtusa* than in *C. kornfeldi*.

On the M_1-M_2, the buccal re-entrant valley opens higher above the cingulum in *C. kornfeldi*, than in *C. obtusa*, but in the case of the isolated teeth it is not useful for the precise identification.

The isolated teeth may be determined by means of morphometrical methods as well. The M_1 L/W rate does not show any segregation within the two species (Fig. 10). Nonetheless, we can see some detachments on the scatter plots of the M_2 and M_3 L/W rate (Figs 11–12).

Comparing the Somssich Hill 2 *Crocidura* M_1 material with the Sima del Elefante TE8–14 (Rofes & Cuenca-Bescós 2011), Villány 3 and Osztramos 3/2 *C. kornfeldi* remains (Reumer 1984), the length of the teeth does not show significant differences. On the other hand, the talonids of the Somssich Hill M_1 teeth are considerably wider than those of the teeth from the other localities

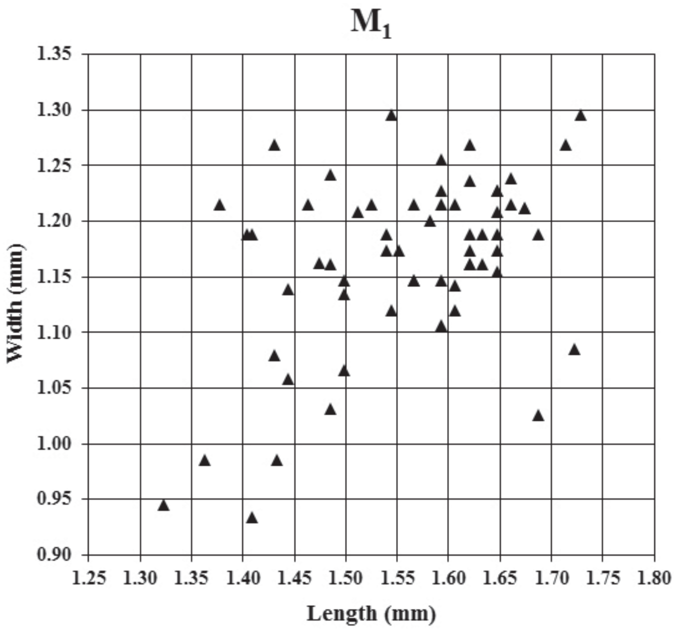


Fig. 10. Scatter plot of the M_1 L/W rate of the *Crocidura* remains from the Somssich Hill 2 locality

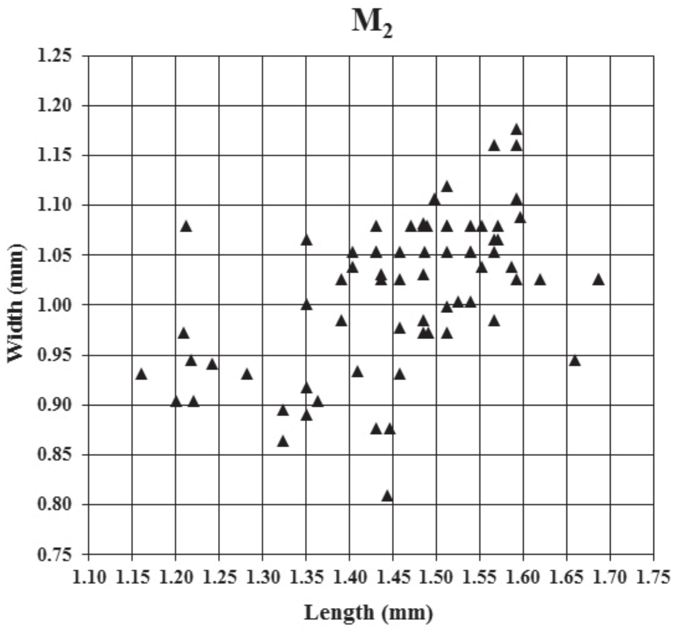


Fig. 11. Scatter plot of the M_2 L/W rate of the *Crocidura* remains from the Somssich Hill 2 locality

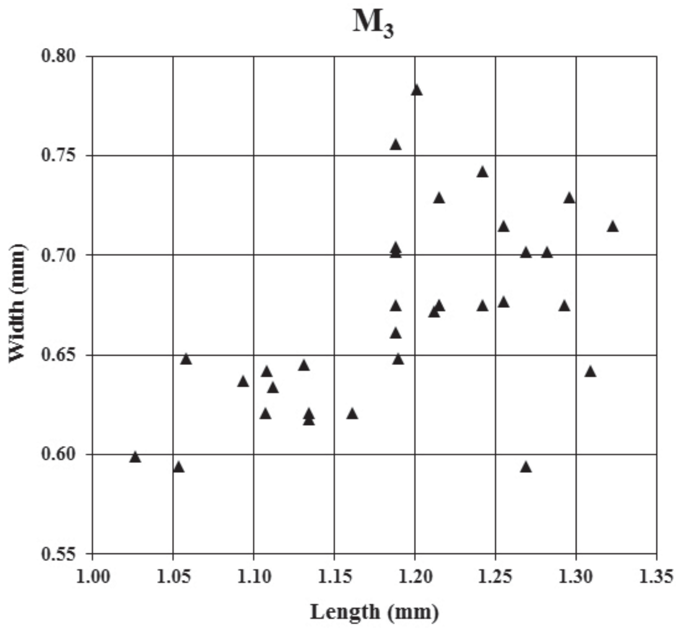


Fig. 12. Scatter plot of the M_3 L/W rate of the *Crocidura* remains from the Somssich Hill 2 locality

mentioned. The *C. kornfeldi* M_1 teeth from Betfia (Rzebik-Kowalska 2000) are in the lower range of our data both in length and in width. The dimensions of *C.* cf. *obtusa* M_1 from Betfia (Rzebik-Kowalska 2000) perfectly fit to the measurements of the studied specimens (Fig. 13).

CONCLUSIONS

Biostratigraphy

The estimated age of the Somssich Hill 2 locality is approximately 1.0–0.9 Ma (*Mimomys savini-M. pusillus* biozone by Kordos 1994) on the basis of the vole fauna (Pazonyi *et al.* 2013*a*, *b*, Pazonyi & Virág 2013*a*, *b*, Pazonyi 2015) (Fig. 14). The identified shrew and dormouse fauna (*Sorex, Crocidura, Beremendia, Glis, Muscardinus* and *Dryomimus* species) confirmed this hypothesis (Botka & Striczky 2014, Botka & Mészáros 2014*a*, *b*, 2015).

C. kornfeldi is first reported in the European mainland at the boundary of the MN16 and MN17 zones from Tourkobounia 3 and 5 localities (Greece, Reumer & Doukas 1985, Koufos 2001). It disappeared from the continent in the Middle Pleistocene. Its last occurrence is reported in Spain (Cúllar Baza-1, Agustí *et al.* 2010) and in Italy: Rifreddo (Masini *et al.* 2005), Tre Fossi and Visogliano, shelter A (Kotsakis *et al.* 2003). In Hungary, this is the last (the youngest) appearance of the species (Table 4a).

C. obtusa was present in Central Europe (Austria?, Germany, Hungary, Poland, Romania, and Slovakia), mainly in the Carpathian Basin from the Early Pleistocene (1.2 Ma) to the earliest Late Pleistocene (Biśnik Cave VI, ca. 130–115 ka, Stefaniak *et al.* 2009) (Table 4b).

Summarizing, the age of the site mentioned above is supported by all the *Crocidura* occurrences reported here.

Palaeoecology

Crocidurinae prefers milder and more arid climate than the other contemporaneous subfamily (Soricinae) (Rzebik-Kowalska 1995). According to Reumer (1984), *Crocidura* prefers dry terrains, hence these forms are good

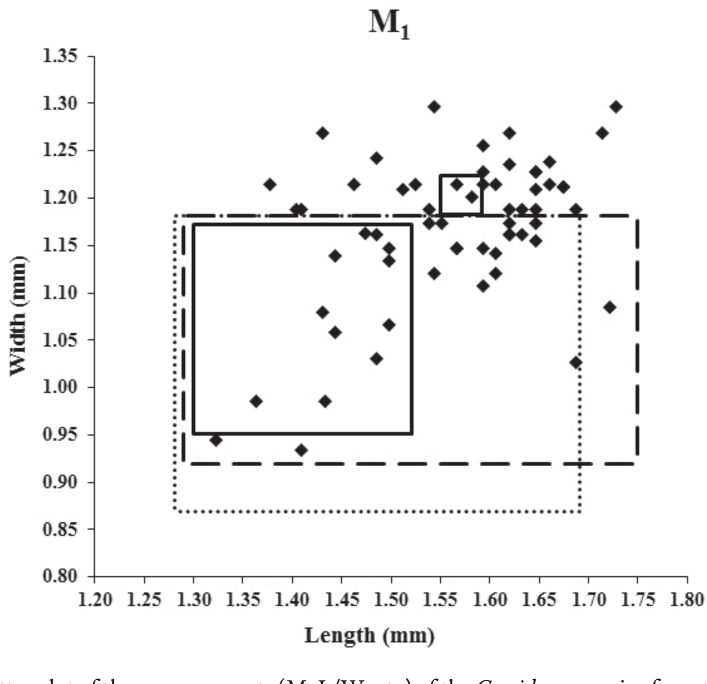


Fig. 13. Scatter plot of the measurements (M_1 L/W rate) of the *Crocidura* remains from the Somssich Hill 2 locality (marked by black dots), compared with remains from other localities. The frames define the minimum and maximum values of the length and width of M_1 teeth (small frame with continuous outline = *C.* cf. *obtusa* from Betfia IX, Rzebik-Kowalska 2000; large frame with continuous outline = *C. kornfeldi* from Betfia V, VII/1, VII/3, IX, X, XI, XII, Rzebik-Kowalska 2000; large frame with dashed outline = *C. kornfeldi* from Osztramos 3/2 and Villány 3, Reumer 1984; large frame with dotted outline = *C. kornfeldi* from Sima del Elefante TE8–14, Rofes & Cuenca-Bescós 2011)

Table 4a. The stratigraphical overview of *Crocidura kornfeldi* and its localities on the basis of the main references. * = The specific identification of these remains is uncertain according to Furió *et al.* (2007)

Countries, Localities	**Pliocene**	**Pleistocene**			**References**
	MN 16	**MN 17**	**Early**	**Middle**	
Austria					Ziegler & Daxner-Höck (2005)
Deutsch-Altenburg 9, 30A		+			Mais & Rabeder (1977, 1984)
Deutsch-Altenburg 2A, 2C, 4B			+		Mais & Rabeder (1977, 1984), Frank & Rabeder (1997)
Croatia					
Podumci 1			+		Paunović & Jambrešić (1997)
Razvode			+		Paunović & Jambrešić (1997)
Tatinja draga			+		Paunović & Jambrešić (1997)
Czech Republic					Fejfar & Sabol (2005)
Ctinêves 1		+			Fejfar & Horáček (1983)
Greece					Doukas (2005)
Tourkobounia 3, 5	+	+			Reumer & Doukas (1985), Koufos (2001)
Marathoussa			+		Koufos *et al.* (2001)
Ravin Voulgarakis			+		Koufos (2001)
Tourkobounia 2			+		Reumer & Doukas (1985), Koufos (2001)
Hungary					
Osztramos 3/2		cf.			Jánossy & Kordos (1977), Reumer (1984), Jánossy (1986), Montuire (1995), Pazonyi (2011)
Villány 3		+			Reumer (1984), Jánossy (1986), Montuire (1995), Pazonyi (2011)
Beremend 16			+		Jánossy (1996)
Nagyharsány-hegy 2			cf.		Kretzoi (1956), Reumer (1984), Jánossy (1986)
Osztramos 2, 8, 14			aff.		Jánossy & Kordos (1977), Reumer (1984), Jánossy (1986), Montuire (1995), Pazonyi (2011)
Somssich Hill 1			+		Reumer (1984), Jánossy (1986)
Somssich Hill 2			+		Jánossy (1986, 1990, 1999), Pazonyi (2011), present article
Újlak Hill			+		Jánossy (1986), Pazonyi (2011)
Villány 5			+		Reumer (1984), Jánossy (1986), Montuire (1995), Pazonyi (2011)

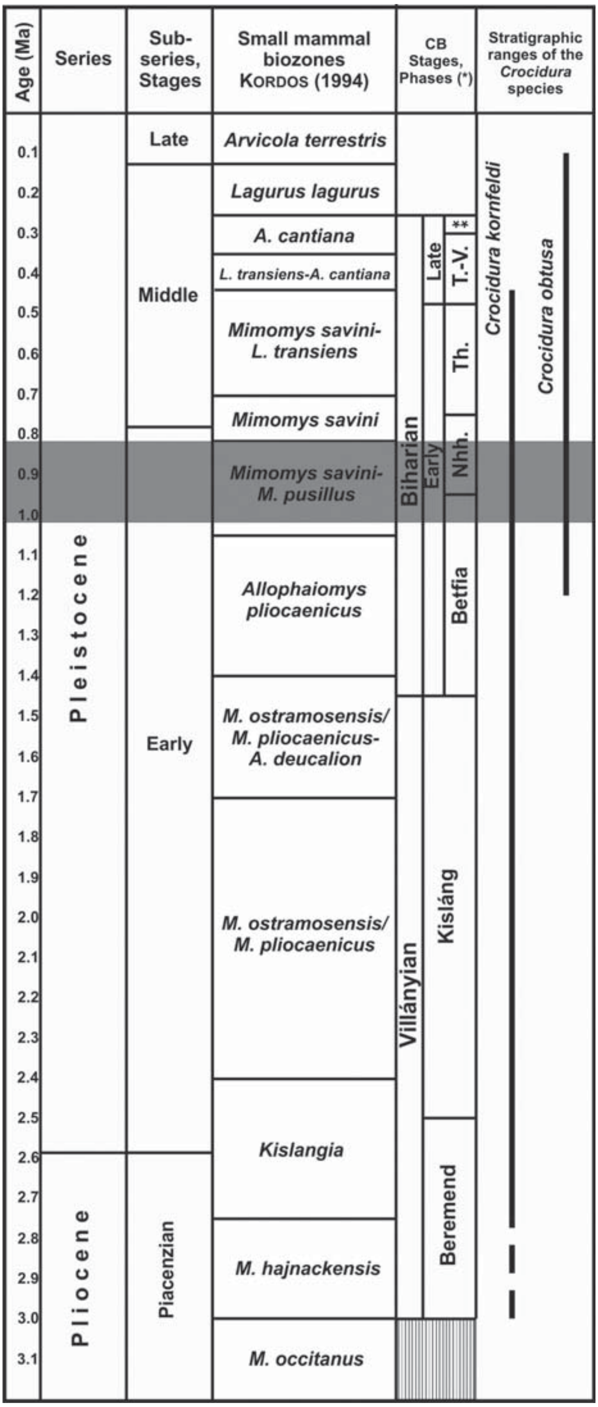
Table 4a (cont.)

Countries, Localities	Pliocene MN 16	Pleistocene MN 17	Early	Middle	References
Italy					
Montagnola Senese		+			Fanfani (2000), Kotsakis *et al.* (2003)
Pirro Nord			+		Kotsakis *et al.* (2003), Petronio & Marcolini (2013)
Rifreddo				+	Kotsakis *et al.* (2003), Sabato *et al.* (2005), Masini *et al.* (2005)
Tre Fossi				+	Kotsakis *et al.* (2003)
Visogliano, shelter A				+	Kotsakis *et al.* (2003)
Poland					Rzebik-Kowalska (2005)
Żabia Cave A			cf.		Bosák *et al.* (1982), Stefaniak *et al.* (2009), Nadachowski *et al.* (2011)
Romania					
Betfia XIII		+			Rzebik-Kowalska (2000, 2002)
Betfia IX			+		Terzea (1994), Rzebik-Kowalska (2000, 2002)
Betfia V, VII/1, VII/3, X, XI, XII			+		Rzebik-Kowalska (2000, 2002)
Slovakia					Fejfar & Sabol (2005)
Plešivec		+			Fejfar & Horáček (1983)
Včeláre 3		cf.			Fejfar & Horáček (1983), Horáček (1985)
Spain					van den Hoek Ostende & Furió (2005)
Almenara-Casablanca 3			+		Gil & Sesé (1985), Furió *et al.* (2007), Agustí *et al.* (2011)
Barranco León 5/D			+		Agustí *et al.* (2010), Cuenca-Bescós *et al.* (2015)
Cueva Victoria			+		Furió *et al.* (2015)
Orce 3			+*		Martín-Suárez (1988), Rzebik-Kowalska (1995), Furió *et al.* (2007)
Sima del Elefante TE7–14			+		Rofes & Cuenca-Bescós (2011), Cuenca-Bescós *et al.* (2013, 2015), Garcia *et al.* (2014)
Cúllar Baza-1				+	Agustí *et al.* (2010)

Table 4b. The stratigraphical overview of *Crocidura obtusa* and its localities on the basis of the main references

Countries, Localities	Pleistocene				References
	MN 17	Early	Middle	Late	
Germany					
Weißenburg 7		+			Koenigswald (1971)
Hungary					
Beremend 16		+			Jánossy (1996)
Osztramos 8, 14		aff.			Jánossy & Kordos (1977), Jánossy (1986), Montuire (1995), Pazonyi (2011)
Somssich Hill 2		+			Jánossy (1983, 1986, 1990, 1999), Montuire (1995), Pazonyi (2011), present article
Újlak Hill		+			Jánossy (1986), Pazonyi (2011)
Castle Hill (Budapest)			cf.		Jánossy (1986), Montuire (1995), Pazonyi (2011)
Kövesvárad			cf.		Jánossy (1986), Montuire (1995), Pazonyi (2011)
Nagyharsányhegy 4			+		Kretzoi (1956), Jánossy (1986), Montuire (1995), Pazonyi (2011)
Ördöglyuk Cave			+		Pazonyi (2011)
Pongor Cave			+		Pazonyi (2011)
Tarkő 1, 4, 9–14			cf.		Jánossy (1969, 1986), Pazonyi (2011)
Villány 6			+		Jánossy (1986), Pazonyi (2011)
Poland					Rzebik-Kowalska (2005)
Przymiłowice 2B		cf.			Rzebik-Kowalska (2013)
Biśnik Cave VIII, IX			+		Stefaniak *et al.* (2009)
Biśnik Cave VI				+	Stefaniak *et al.* (2009)
Romania					
Betfia IX		cf.			Rzebik-Kowalska (2000, 2002)
Ursilor Cave		cf.			Rzebik-Kowalska (2002)
Slovakia					
Gombasek		+			Kretzoi (1938, 1941), Wagner & Gasparik (2014)

Fig. 14. Stratigraphical position of the Somssich Hill 2 locality (after Kordos 1994, Kretzoi 1969, Kretzoi & Pécsi 1982, Pazonyi *et al.* 2013a), and the stratigraphical range of the studied species (CB = Carpathian Basin, * = after Kretzoi 1969, Kretzoi & Pécsi 1982, Nhh. = Nagyharsányhegy Phase, Th. = Templomhegy Phase, T.-V. = Tarkő-Vértesszőlős Phase and ** = Uppony Phase)


Age (Ma)
Series
Sub-series, Stages
Small mammal biozones KORDOS (1994)
CB Stages, Phases (*)
Stratigraphic ranges of the Crocidura species
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3.0
3.1
Pleistocene
Pliocene
Late
Middle
Early
Piacenzian
Arvicola terrestris
Lagurus lagurus
A. cantiana
L. transiens-A. cantiana
Mimomys savini-L. transiens
Mimomys savini
Mimomys savini-M. pusillus
Allophaiomys pliocaenicus
M. ostramosensis/ M. pliocaenicus-A. deucalion
M. ostramosensis/ M. pliocaenicus
Kislangia
M. hajnackensis
M. occitanus
Biharian
Villányian
Late
Early
**
T.-V.
Th.
Nhh.
Betfia
Kisláng
Beremend
Crocidura kornfeldi
Crocidura obtusa

indicators of more or less open grasslands in the warmer phases of the Plio-Pleistocene (Rzebik-Kowalska 1995).

The separation of the two *Crocidura* species is difficult because of the morphological similarities in the succession of the Somssich Hill 2 locality. However, the occurrence of the genus is very useful as a palaeoecological indicator. Its abundance can be evaluated only in comparison with the *Sorex* remains. The

Table 5. The occurrence of the genus *Crocidura* in the layers of the Somssich Hill 2 locality, with the number of specimens, the number of teeth, and the minimum number of individuals (MNI)

Layer	Number of specimens	Number of teeth	MNI	Layer	Number of specimens	Number of teeth	MNI
1	–	–	–	26	3	4	1
2	–	–	–	27	–	–	–
3	–	–	–	28	–	–	–
4	30	33	5	29	4	4	3
5	56	97	11	30	3	6	3
6	12	19	3	31	4	6	2
7	3	4	2	32	–	–	–
8	9	24	3	33	2	4	1
9	4	10	1	34	–	–	–
10	14	32	4	35	–	–	–
11	6	15	3	36	1	1	1
12	9	29	3	37	3	5	1
13	8	13	3	38	6	7	2
14	5	12	3	39	1	–	1
15	1	2	1	40	–	–	–
16	3	6	2	41	2	4	2
17	–	–	–	42	1	1	1
18	1	4	1	43	1	1	1
19	–	–	–	44	1	4	1
20	1	3	1	45	2	4	1
21	–	–	–	46	3	4	2
22	4	6	2	47	–	–	–
23	–	–	–	48	–	–	–
24	1	2	1	49	–	–	–
25	4	9	4	50	–	–	–
				∑	208	375	76

study of *Sorex* species is currently in progress, the results will be published in the next volume of this journal. However, some conclusions are deduced merely on the basis of the *Crocidura* species.

The crocidurines are completely absent in the lowermost layers of the succession (layers 50–47). This fact suggests the presence of a forested environment. After this period open grasslands were also present beside the closed vegetation in most part of the time interval represented by the layers 46–4. The occurrence of the genus was the most frequent in the layers 16–4. They are absent in the uppermost layers (layers 3–1) as well as in the lowermost part of the sequence. The absence of *Crocidura* species in the uppermost layers is not an evidence for the disappearance of the open grassy vegetation, because the small number of specimens makes the evaluations uncertain (Table 5).

*

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