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

Dániel Botka & Lukács Mészáros
Department of Palaeontology, Eötvös Loránd University,
E-mail: botkadani@gmail.com, lgy.meszaros@gmail.com

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. Thebiostratigraphical 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 & Mézsáros 2014a, 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 & Mézsáros (2014b)
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 (2014a) 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 (2014a) 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, Mt = upper tooth, Ml = 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.  
1984 *Crocidura kornfeldi* Kormos – Reumer, pp. 18–22, tabs 1–2, pl. 1, figs 1–6, pl. 2, figs 1–5.  
1985 *Crocidura* sp. – Gil & Sesé, pp. 495–496, fig. 1.  
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.  
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 M₂ and M₃; M₂: L=1.620, W=1.026; M₃: L=1.269, W=0.675
2.5/54, 55 – 2 right mandible fragments
2.5/71 – Right mandible fragment with M₁ and M₃; M₁: L=1.566, W=1.161; M₃: 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 M₂ and M₃; M₂: L=1.242, W=0.942; M₃: L=1.026, W=0.648

Layer 14 (VER 2015.250.)
2.14/1 – Left mandible fragment with M₂ and M₃; M₂: L=1.485, W=1.031; M₃: L=1.161, W=0.675

Layer 30 (VER 2015.251.)
2.30/2 – Left mandible fragment with A₂, M₁ and M₂; M₁: L=1.544, W=1.296; M₂: L=1.525, W=1.004
2.30/3 – Left mandible fragment with M₁, M₂ and M₃; M₁: L=1.647, W=1.209; M₂: L=1.539, W=1.080; M₃: 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 M₁; L=1.606, W=1.142

Original diagnosis – P₄, M¹ and M² are relatively short and broad, the molars have a short emargination; I₁ is acuspulate; A₁ and A₂ 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”)

<table>
<thead>
<tr>
<th></th>
<th>n (pcs)</th>
<th>min. (mm)</th>
<th>mean (mm)</th>
<th>max. (mm)</th>
<th>SD (mm)</th>
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</thead>
<tbody>
<tr>
<td>M₁</td>
<td>L</td>
<td>1</td>
<td>–</td>
<td>1.61</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>W</td>
<td>1</td>
<td>–</td>
<td>1.14</td>
<td>–</td>
</tr>
<tr>
<td>M₂</td>
<td>L</td>
<td>3</td>
<td>1.24</td>
<td>1.43</td>
<td>1.57</td>
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<tr>
<td></td>
<td>W</td>
<td>3</td>
<td>0.94</td>
<td>1.04</td>
<td>1.16</td>
</tr>
<tr>
<td>M₃</td>
<td>L</td>
<td>5</td>
<td>1.03</td>
<td>1.23</td>
<td>1.40</td>
</tr>
<tr>
<td></td>
<td>W</td>
<td>5</td>
<td>0.65</td>
<td>0.68</td>
<td>0.73</td>
</tr>
</tbody>
</table>
Figs 1–2. Crocidura kornfeldi Kormos, 1934, Somssich Hill 2, scale bar: 1 mm; 1. left mandible fragment with M₁-M₃, layer 30, lingual view; 2. right mandible fragment with M₁-M₂, 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: P4 and M2 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 M1-M2 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.
1971 *Crocidura obtusa* Kretzoi – KÖNIGSWALD, p. 120.

**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 M1; L=1.687, W=1.026
- 2.4/6 – Left mandible fragment with M2; L=1.212, W=1.080
- 2.4/103 – Right mandible fragment

**Layer 5** (VER 2015.256.)
- 2.5/3 – Left mandible fragment with M1 and M2; M1: L=1.728, W=1.296; M2: L=1.512, W=1.120
- 2.5/13 – Left mandible fragment with M3; L=1.269, W=0.756
- 2.5/53 – Left mandible fragment

**Layer 12** (VER 2015.257.)
- 2.12/1 – Left mandible fragment with I1 fragment, A2, M1, M2 and M3; M1: L=1.444, W=1.139; M2: L=1.512, W=0.972; M3: 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 A1, M1 and M2; M1: L=1.363, W=0.985; M2: L=1.220, W=0.904
- 2.25/4 – Left mandible fragment with M2; 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 M2

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

<table>
<thead>
<tr>
<th></th>
<th>n (pcs)</th>
<th>min. (mm)</th>
<th>mean (mm)</th>
<th>max. (mm)</th>
<th>SD (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 L</td>
<td>3</td>
<td>1.36</td>
<td>1.51</td>
<td>1.73</td>
<td>0.1947</td>
</tr>
<tr>
<td>W</td>
<td>3</td>
<td>0.99</td>
<td>1.14</td>
<td>1.30</td>
<td>0.1555</td>
</tr>
<tr>
<td>M2 L</td>
<td>6</td>
<td>1.21</td>
<td>1.43</td>
<td>1.69</td>
<td>0.1851</td>
</tr>
<tr>
<td>W</td>
<td>6</td>
<td>0.88</td>
<td>1.00</td>
<td>1.12</td>
<td>0.0965</td>
</tr>
<tr>
<td>M3 L</td>
<td>2</td>
<td>1.13</td>
<td>1.20</td>
<td>1.27</td>
<td>0.0995</td>
</tr>
<tr>
<td>W</td>
<td>2</td>
<td>0.68</td>
<td>0.72</td>
<td>0.76</td>
<td>0.0573</td>
</tr>
</tbody>
</table>
Layer 39 (VER 2015.262.)
2.39/1 – Left mandible fragment

Layer 41 (VER 2015.263.)
2.41/1 – Left mandible fragment with eroded M₂ and M₃

Figs 3–4. Crocidura obtusa Kretzoi, 1938, Somssich Hill 2, scale bar: 1 mm; 3. left mandible with I₁ fragment, A₂ and M₁-M₃, layer 12, buccal view; 4. left mandible fragment with M₁-M₂, layer 5, buccal view
Layer 46 (VER 2015.264.)

2.46/1 – Left mandible fragment

Original diagnosis – KRETOI (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 (KRETOI 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 A1 fragment and M1; M1: L=1.498, W=1.147
2.4/3 – Left mandible fragment with M1; L=1.539, W=1.174
2.4/8 – Left I1; L=3.834, H=1.918
2.4/9, 10 – 2 left I1 fragments
2.4/12 – Left mandible fragment with M1 and M2; M1: L=1.525, W=1.215; M2: L=1.512, W=1.080
2.4/13 – Right mandible fragment with fragmented M1 and M2; M1: L=1.323, W=0.715
2.4/15 – Right M1; L=1.660, W=1.215
2.4/16 – Right mandible fragment with M2; L=1.687, W=1.026
2.4/18, 19 – 2 right I1 fragments
2.4/21 – Right M2 fragment
2.4/22 – Right I1; L=1.701, H=1.323
2.4/23, 25, 32 – 3 right I1 fragments
2.4/24 – Right I¹; L=2.160, H=1.458
2.4/28 – Left I¹ fragment
2.4/30 – Right mandible fragment with M¹; L=1.647, W=1.228
2.4/33 – Left I¹ fragment
2.4/37 – Left mandible fragment
2.4/39 – Left M¹; LL=1.593, BL=1.579, AW=1.755, PW=2.214
2.4/40 – Left mandible fragment with M¹; L=1.485, W=0.985
2.4/41, 42 – Left A¹ and A²
2.4/101 – Left mandible fragment with M¹, M² and M³; M¹: L=1.593, W=1.256; M²: L=1.350, W=1.066; M³: L=1.242, W=0.675
2.4/102 – Left mandible fragment with M¹; L=1.255, W=0.715

Layer 5 (VER 2015.306.)

2.5/1 – Right mandible fragment with eroded M¹, M² and M³
2.5/2 – Right mandible fragment with eroded A¹, M¹ and M²

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

<table>
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<th>Tooth</th>
<th>n (pcs)</th>
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<th>max. (mm)</th>
<th>SD (mm)</th>
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<td>1.97</td>
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<td>P¹</td>
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<td></td>
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<td>1.93</td>
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<tr>
<td>M¹</td>
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<td>0.59</td>
<td>0.67</td>
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Crocidura (Mammalia, Soricidae) remains from the late Early Pleistocene

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2.5/4 – Left mandible fragment with M1; L=1.566, W=1.215
2.5/5 – Right mandible fragment with M1; L=1.134, W=0.621
2.5/6 – Right mandible fragment with I1 and A1 fragments and M1; M1: L=1.620, W=1.174
2.5/7 – Left mandible fragment with M1 and M2; M1: L=1.593, W=1.107; M2: L=1.215, W=0.675
2.5/8 – Right mandible fragment with M2; L=1.463, W=1.215
2.5/9 – Left mandible fragment with I1, A1, A2, M1 and M2 fragments
2.5/11 – Right M1 fragment
2.5/14 – Right mandible fragment with M1; L=1.188, W=0.702
2.5/15 – Right mandible fragment with M1, M2, and M3; M1: L=1.647, W=1.228; M2: L=1.498, W=1.107; M3: L=1.269, W=0.594
2.5/16 – Left mandible fragment with M1 and M2; M1: L=1.498, W=1.134; M2: L=1.431, W=0.972
2.5/17 – Right mandible fragment with I1 and M1; M1: L=1.620, W=1.161
2.5/18 – Right mandible fragment with M1 and M2; M1: L=1.431, W=0.877; M2: L=1.161, W=0.621
2.5/31 – Left I1; L=2.052, H=1.458
2.5/32 – Right I1; L=2.079, H=1.404
2.5/33 – Right I1; L=2.052, H=1.323
2.5/34 – Left I1 fragment
2.5/35 – Right I1; L=2.106, H=1.404
2.5/36 – Left I1; L=2.079, H=1.431
2.5/37 – Right I1; L=2.160, H=1.431
2.5/38 – Left I1; L=1.944, H=1.323
2.5/39 – Left mandible fragment with M1; L=1.566, W=1.066
2.5/40 – Left mandible fragment with M1; L=1.620, W=1.161
2.5/41 – Left mandible fragment with M2; L=1.120, W=0.783
2.5/42 – Left mandible fragment with M1; L=1.593, W=1.228
2.5/43 – Left maxillary fragment with P1, M1 and M2; P1: LL=0.918, BL=1.971, W=1.998; M1: LL=1.539, BL=1.674, AW=1.890, PW=2.241; M2: LL=1.296, BL=1.350, AW=2.079, PW=1.620
2.5/44 – Right maxillary fragment with P1, M1 and M2; M1: LL=1.593, BL=1.647, AW=1.849, PW=2.268; M2: LL=1.363, BL=1.444, AW=2.065, PW=1.741
2.5/45 – Left maxillary fragment with P1 and M1; P1: LL=1.161, BL=2.133, W=2.133; M1: LL=1.647, BL=1.843, PW=2.295
2.5/46 – Left maxillary fragment with eroded A1 and P4
2.5/47 – Right maxillary fragment with eroded I1 and A1
2.5/48 – Left M2 fragment
2.5/49 – Right M2; LL=1.485, BL=1.485, AW=2.160, PW=1.768
2.5/50 – Left maxillary fragment with P1; LL=0.945, BL=1.890, W=1.863
2.5/51 – Right M2; LL=1.323, BL=1.350, AW=2.025, PW=1.647
2.5/52 – Eroded right M2
2.5/56 – Right mandible fragment with M1 and M2; M1: L=1.404, W=1.188; M2: L=1.431, W=1.053
2.5/61 – Left mandible fragment with M1, M2 and M3; M1: L=1.431, W=1.269; M2: L=1.431, W=1.053; M3: L=1.188, W=0.756
2.5/62 – Right mandible fragment with M1, M2 and M3; M1: L=1.485, W=1.161; M2: L=1.431, W=1.080; M3: L=1.215, W=0.729
2.5/63 – Right mandible fragment with M1 and M2; M1: L=1.404, W=1.053; M2: L=1.134, W=0.729
2.5/64 – Right mandible fragment with M1, M2 and fragment of M3; M1: L=1.620, W=1.188; M2: L=1.539, W=1.053
2.5/65 – Right mandible fragment with M1; L=1.647, W=1.188
2.5/66 – Left mandible fragment with A1 and A2

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2.5/67 – Left mandible fragment with M₁ and M₃; M₁: L=1.458, W=1.026; M₃: L=1.188, W=0.675
2.5/68 – Left mandible fragment with M₁ fragment, M₂ and M₃; M₁: L=1.404, W=1.039; M₂: L=1.282, W=0.702
2.5/69 – Left mandible fragment with M₁ and M₂; M₁: L=1.485, W=1.242; M₂: L=1.390, W=1.026
2.5/72 – Right mandible fragment with M₁ and M₂; M₁: L=1.714, W=1.269; M₂: L=1.593, W=1.161
2.5/73 – Left mandible fragment with M₁, M₂ and M₃; M₁: L=1.633, W=1.161; M₂: L=1.458, W=1.053; M₃: L=1.296, W=0.729
2.5/74 – Left mandible fragment with A₂, M₁ and M₂; M₁: L=1.687, W=1.188; M₂: L=1.566, W=1.053

Layer 6 (VER 2015.307.)

2.6/1 – Right mandible fragment with A₂, M₁ and M₂; M₁: L=1.647, W=1.155; M₂: L=1.390, W=0.985
2.6/2 – Left mandible fragment with M₁ and M₂; M₁: L=1.571, W=1.066; M₂: L=1.242, W=0.742
2.6/3 – Right mandible fragment with A₂, M₁ and M₂; M₁: L=1.606, W=1.120; M₂: L=1.436, W=1.031
2.6/5 – Left mandible fragment with M₂; L=1.323, W=0.896
2.6/6 – Right mandible fragment with M₁ and M₂; M₁: L=1.47, W=1.053; M₂: L=1.293, W=0.675
2.6/7 – Left I₁; L=3.391, H=0.866
2.6/8 – Left I₁ fragment
2.6/9 – Left maxillary fragment with P⁴ and M⁴; P⁴: LL=1.080, BL=2.052, W=2.049; M⁴: LL=1.647, BL=1.679, AW=1.890, PW=2.362
2.6/10 – Left M₁; LL=1.379, BL=1.409, AW=1.203, PW=1.795
2.6/11 – Left I₁; L=2.052, H=1.428
2.6/12 – Eroded left I₁
2.6/13 – Left I₁; L=2.146, H=1.385

Layer 7 (VER 2015.308.)

2.7/1 – Right mandible fragment with eroded M₂ and M₃
2.7/3 – Right I₁; L=1.922, H=1.339
2.7/4 – Fragmented right M₃

Layer 8 (VER 2015.309.)

2.8/1 – Left mandible fragment with M₁ and M₃; M₁: L=1.606, W=1.215; M₃: L=1.539, W=1.053
2.8/2 – Left mandible fragment with complete dentition; I₁: L=3.685, H=1.026; M₁: L=1.728, W=1.242; M₂: L=1.512, W=0.999; M₃: L=1.296, W=0.680
2.8/5 – Right mandible fragment with A₂, M₁, M₂ and M₃; M₁: L=1.377, W=1.215; M₂: L=1.571, W=1.080; M₃: L=1.255, W=0.677
2.8/6 – Left maxillary fragment with A², A³, P⁴, M¹ and M³; P⁴: LL=0.999, BL=1.922, W=1.957; M¹: LL=1.458, BL=1.471, AW=1.890, PW=2.025; M³: LL=1.474, BL=1.330, AW=2.052, PW=1.728
2.8/11 – Left mandible fragment with M₁, M₂ and M₃ fragment; M₁: L=1.660, W=1.239; M₂: L=1.485, W=1.082
2.8/12 – Right I₁ fragment
2.8/13 – Right M¹; LL=1.525, BL=1.498, AW=1.860, PW=2.268
2.8/14 – Left I₁ fragment
Layer 9 (VER 2015.310.)

2.9/1 – Left mandible fragment with M₁ and M₂; M₁: L=1.517, W=0.945; M₂: L=1.212, W=0.672
2.9/2 – Right mandible fragment with I₁, A₁, A₂, fragment and M₁; M₁: L=1.498, W=1.066
2.9/3 – Left mandible fragment with I₁, A₁, and A₂; I₁: L=3.469, H=0.891
2.9/4 – Left I₁; L=1.660, H=1.147

Layer 10 (VER 2015.311.)

2.10/11 – Left mandible fragment with A₂, M₁, M₂ and M₃; M₁: L=1.474, W=1.163; M₂: L=1.201, W=0.904; M₃: L=1.188, W=0.704
2.10/12 – Left mandible fragment with M₁, M₂ and M₃; M₁: L=1.674, W=1.212; M₂: L=1.597, W=1.088; M₃: L=1.269, W=0.702
2.10/13 – Right mandible fragment with M₁ fragment, M₂ and M₃; M₁: L=1.437, W=1.026; M₂: L=1.026, W=0.599
2.10/14 – Left mandible fragment with M₁ and M₂; M₁: L=1.544, W=1.120; M₂: L=1.296, W=0.972
2.10/15 – Right mandible fragment with M₁ and M₂; M₁: L=1.722, W=1.085; M₂: L=1.190, W=0.648
2.10/16 – Right mandible fragment with I₁, A₁ and A₂; I₁: L=3.577, H=1.053
2.10/17 – Right mandible fragment with M₁ and M₂; M₁: L=1.674, W=1.212; M₂: L=1.490, W=1.080
2.10/18 – Right mandible fragment with M₁ and M₂ fragment; M₁: L=1.593, W=1.177
2.10/19 – Right mandible fragment with M₁ and M₂; M₁: L=1.409, W=1.188; M₂: L=1.471, W=1.080
2.10/20 – Right mandible fragment with M₂; L=1.552, W=1.080
2.10/21 – Left maxillary fragment with P₁ and M₁ fragment and M₂; M₁: LL=1.296, BL=1.444, AW=2.030, PW=1.757
2.10/22 – Left maxillary fragment with P₁ and M₁; P₁: LL=0.837, BL=1.895, W=1.647; M₁: LL=1.458, BL=1.876, AW=1.906, PW=2.173
2.10/23 – Left maxillary fragment with M₁ and M₂; M₁: LL=1.701, BL=1.512, AW=1.944, PW=2.322; M₂: LL=1.377, BL=1.458, AW=2.187, PW=1.757
2.10/24 – Right I₁ fragment

Layer 11 (VER 2015.312.)

2.11/1 – Right mandible fragment with M₁, M₂ and M₃; M₁: L=1.512, W=1.209; M₂: L=1.539, W=1.004; M₃: L=1.131, W=0.645
2.11/2 – Left mandible fragment with A₁, M₁ and M₂ fragment; M₁: L=1.593, W=1.215
2.11/3 – Left mandible fragment with M₁, M₂ and M₃ fragments
2.11/4 – Right mandible fragment with M₁ and M₂; M₁: L=1.620, W=1.236; M₂: L=1.485, W=1.080
2.11/5 – Left mandible fragment with A₁ and M₂ fragments
2.11/6 – Right I₁ fragment

Layer 12 (VER 2015.313.)

2.12/3 – Right mandible fragment with A₁, A₂, M₁ and M₂; M₁: L=1.660, W=1.215; M₂: L=1.660, W=0.945
2.12/4 – Skull fragment with left I₁ fragment, A₁, A₂, A₃, P₁ fragment, right A₁, A₂, P₁ and M₁ fragment; P₁: LL=1.053, BL=2.030, W=1.998
2.12/6 – Right mandible fragment with M₂; L=1.215, W=0.675
2.12/7 – Left mandible fragment with \( M_1 \) and \( M_2 \); \( M_1 \): \( L=1.566, W=0.985; M_2 \): \( L=1.188, W=0.675 \)
2.12/8 – Left mandible fragment with \( M_1 \) and \( M_2 \) 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 \( M_1 \) and \( M_2 \); \( M_1 \):
\( L=1.323, W=0.864; M_2 \):
\( L=1.053, W=0.594 \)
2.13/7 – Right mandible fragment with \( M_1 \) and \( M_2 \); \( M_1 \):
\( L=1.458, W=0.931; M_2 \):
\( L=1.107, W=0.621 \)
2.13/8 – Eroded right \( M_1 \)
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 \( M_1 \) and \( M_2 \) fragment; \( M_1 \):
\( L=1.593, W=1.026 \)
2.14/4 – Right mandible fragment with \( A_1 \) 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 \( M_1 \); \( L=1.058, W=0.648 \)
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 \( M_1 \); \( L=1.080, W=0.642 \)
Layer 24 (VER 2015.321.)
2.24/1 – Right mandible fragment with M₂ and M₃; M₂: L=1.336, W=0.869; M₃: L=1.093, W=0.637

Layer 25 (VER 2015.322.)
2.25/2 – Left mandible fragment with M₁ and M₂; M₁: L=1.431, W=1.080; M₂: L=1.350, W=0.891
2.25/3 – Left mandible fragment with M₁, M₂ and M₃; M₁: L=1.620, W=1.269; M₂: L=1.512, W=1.080; M₃: L=1.309, W=0.642

Layer 26 (VER 2015.323.)
2.26/1 – Eroded right I₁
2.26/2 – Left mandible fragment with M₁ and M₂; M₁: L=1.539, W=1.188; M₂: L=1.512, W=1.053
2.26/3 – Right M₃; L=1.587, W=1.039

Layer 29 (VER 2015.324.)
2.29/1 – Right mandible fragment with eroded M₂
2.29/2 – Right mandible fragment with M₂; L=1.485, W=0.972
2.29/3 – Left mandible fragment with A₂ and M₁; M₁: L=1.566, W=1.147
2.29/4 – Right mandible fragment

Layer 31 (VER 2015.325.)
2.31/3 – Right mandible fragment with A₁, A₂ and M₁; M₁: L=1.633, W=1.188
2.31/4 – Left mandible fragment with M₁ and M₂; M₁: L=1.593, W=1.107; M₂: L=1.188, W=0.661

Layer 33 (VER 2015.326.)
2.33/2 – Right mandible fragment with M₁, M₂ and M₃; M₁: L=1.431, W=1.058; M₂: L=1.409, W=0.934; M₃: L=1.134, W=0.618
2.33/3 – Right I₁; L=1.782, H=1.498

Layer 36 (VER 2015.327.)
2.36/1 – Left maxillary fragment with P₄; LL=1.242, BL=1.782, W=1.998

Layer 37 (VER 2015.328.)
2.37/2 – Right mandible fragment with M₁ fragment and M₂; M₁: L=1.282, W=0.931
2.37/3 – Left mandible fragment with M₁ and M₂; M₁: L=1.404, W=0.877; M₂: L=1.112, W=0.634
2.37/4 – Left I₁; L=1.755, H=1.228

Layer 38 (VER 2015.329.)
2.38/1 – Left mandible fragment with M₁ and M₂; M₁: L=1.433, W=0.985; M₂: L=1.350, W=0.918
2.38/2 – Left I₁; L=1.876, H=1.296
2.38/3 – Left M₂; L=1.552, W=1.039
2.38/4 – Right I₁; L=1.971, H=1.363
2.38/5 – Left M₁; LL=1.323, BL=1.433, AW=1.795, PW=1.998
2.38/6 – Right M₁; 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 I₁-M₁, layer 45, buccal view; 6. left mandible fragment with M₁-M₃, layer 10, occlusal view; 7. right maxillary fragment with I¹-A¹, layer 5, buccal view; 8. right maxillary fragment with M¹-M³, layer 5, occlusal view; 9. skull fragment with left I¹-P⁴ and right A²-M¹, layer 12, occlusal view.
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** – 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 cusp, 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
mentioned. The *C. kornfeldi* M₁ 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* M₁ 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. 2013a, b, Pazonyi & Virág 2013a, 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 2014a, 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 (Bišnik 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
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)

<table>
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<td>Paunović &amp; Jambrešić (1997)</td>
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<td>Fejfar &amp; Sabol (2005)</td>
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<td></td>
<td>Fejfar &amp; Sabol (2005)</td>
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<td>van den Hoek Ostende &amp; Furió (2005)</td>
</tr>
<tr>
<td>Barranco León 5/D</td>
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<td>Orce 3</td>
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*Fragmenta Palaeontologica Hungarica 32, 2015*
### Table 4b. The stratigraphical overview of *Crocidura obtusa* and its localities on the basis of the main references

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<td>Jánossy (1986), Pazonyi (2011)</td>
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<td>Pazonyi (2011)</td>
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<td>Pongor Cave</td>
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<td>Villány 6</td>
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<td>Jánossy (1986), Pazonyi (2011)</td>
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</tr>
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<td>Kretzoi (1938, 1941), Wagner &amp; Gasparik (2014)</td>
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<td>Gombasek</td>
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**Crocidura (Mammalia, Soricidae) remains from the late Early Pleistocene**

<table>
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<th>Age (Ma)</th>
<th>Series</th>
<th>Sub-series, Stages</th>
<th>Small mammal biozones</th>
<th>CB Stages, Phases ((^\text{(*)}))</th>
<th>Stratigraphic ranges of the Crocidura species</th>
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<td>A. cantiana</td>
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<td>L. transiens-A. cantiana</td>
<td>Th.</td>
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<td></td>
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<tr>
<td>0.6</td>
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<td></td>
<td>Mimomys savini</td>
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**Pleistocene**

<table>
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**Pliocene**

<table>
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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 mor-
phological 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)

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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).

*Acknowledgements* – The work was supported by the Hungarian Scientific Research Fund (OTKA K104506 project). The authors are indebted to the members of the OTKA Research Team, mainly to Piroska Pazonyi (project leader), Zoltán Szentesi, Mihály Gasparik and Attila Virág for their useful help and valuable suggestions. Special thanks to Károly Bóka for his kind help in making the SEM photos and to Piroska Pazonyi for her useful reviewer comments.

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http://dx.doi.org/10.17111/FragmPalHung.2014.31.51


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http://dx.doi.org/10.17111/FragmPalHung.2014.31.125