Urodeles from the Lower Pleistocene Somssich Hill 2 palaeovertebrate locality (Villány Hills, Hungary)

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*Farkoskétéltű-maradványok a villányi-hegységi Somssich-hegy 2
kora-pleisztocén korú ősgerinces lelőhelyről*

Összefoglalás

A alsó-pleisztocén korú Somssich-hegy 2 ősgerinces lelőhely kétéltűinek vizsgálata a békák tömeges jelenlétét mutatta ki, különösen igaz ez a zöld varangyok (*Bufo viridis*) esetében. A békák mellett főleg postcranialis elemek segítségével sikerült bizonyítani a farkos kétéltűekhez (Caudata) sorolt Salamandridae család jelenlétét. Ezek között kimutatható volt a *Salamandra salamandra, a Triturus cristatus* és a *Lissotriton vulgaris* fajok jelenléte. Habár e nedvesség-kedvelő fajok csontjai ritkák, mégis fontos környezetjelzők. A hasonló környezeti igényű kétéltűek és hüllők csaknem mindenütt megjelennek a szelvényben, ami arra utalhat, hogy valamilyen állandó víztest lehetett a fosszília-felhalmozódási hely közelében.

Tárgyszavak: kora-pleisztocén, Lissamphibia, Caudata, Salamandridae, herpetofauna, paleoökológia

Abstract

A study carried out on the amphibian fauna of the Lower Pleistocene Somssich Hill 2 palaeovertebrate locality revealed a significant presence of frogs, among these especially green toads (*Bufo viridis*). Besides frogs, the presence of the family Salamandridae (Caudata) was detected in the studied material, baseg mainly on postcranial elements. Among these, the following three species were distinuished: *Salamandra salamandra, Triturus cristatus* and *Lissotriton vulgaris*. Although the bones of these moisture-preferring animals are rare, they are important in the reconstruction of the palaeoenvironment. The likewise moisture-preferring lissamphibians and reptiles are present in almost all parts of the succession, therefore taking all these factors into consideration a permanent water surface is indicated near the depositional place of the fossils.

Keywords: Lower Pleistocene, Lissamphibia, Caudata, Salamandridae, herpetofauna, palaeoecology

Introduction

The uppermost Lower Pleistocene Somssich Hill 2 palaeovertebrate locality (Szentesi 2014a, Figure 1) is one of the richest sites among the more than 50 Pleistocene vertebrate localities in the Villány Hills (e.g. Kormos 1937; Kretzoi 1956; Jánossy 1979, 1986; Kordos 1991; Hír 1993, 1998; Pazonyi 2009). Kormos (1937) mentioned these fossiliferous sediments for the first time. Kretzoi (1956) called the locality Villány 11, but the current investigative work started later. Dénes Jánossy and György Topál collected fossils from 50 strata of the site between 1975 and 1984 (the method of this strata separation is unknown), using a screen-washing technique (Jánossy 1999). Samples were collected from top to bottom in small units, called hereafter as layers, although they are not separate beds in a sedimentological sense. In the previous studies several vertebrate taxa had been identified (e.g. Kretzoi 1956; Jánossy 1979, 1983, 1986; Kordos 1991; Hír 1998; Mészáros et al. 2013; Botka & Mészáros 2014, 2015; Szentesi 2014a). This collected fossil material is currently being studied by a research group. The technical advances in methods of geological research have made it possible to revise the older, previously published results. Therefore, new field studies were started in 2014 in order to explain the dimensions and the geology of the fossiliferous sediments at this locality.

On the basis of the vole fauna, the age of this palaeovertebrate assemblage is estimated to be slightly older (approximately 800–900 ka) than the early–middle Pleistocene boundary. It corresponds to the Betfian or Nagyharsányian phase within the Biharian Stage of the local biostratigraphic system (Kordos 1994; Kretzoi 1969; Kretzoi & Pécsi 1982; Pazonyi 2011; Pazonyi et al. 2013a, b). The study on insectivore remains suggests similar results (Botka & Mészáros 2014, 2015a, b).

Up until the present time this exceptionally rich fauna has ony been partially processed (e.g. Jánossy 1983, 1986; Hír 1998; Krolopp 2000; Botka & Mészáros 2014, 2015; Mészáros 2015a, b; Szentesi 2014a, b, 2015). Besides amphibians, this fossil assemblage is known to contain seed (*Celtis* sp.), mollusc, fish, turtle, lizard, snake and bird fossils. It is also rich in small mammal fossils and contains a few, poorly preserved large mammal remains.

Based on the remains of vole faunas, the 50 layers can be separated into six different phases, and together these represent the variable environmental conditions in this section. During the sedimentation the climate changed many times between warm and humid; this is typified by gallery forests and woody environments, and the colder and drier environments, where open steppes dominated (e.g. Pazonyi et al. 2013a, b; Botka & Mészáros 2014; Szentesi 2014a; Mészáros 2015b).

Some previous studies on this fossil assemblage reported a very rich herpetofauna (Szentesi 2013; Szentesi 2014a, b) with a very high number of fossil remains of frogs and about 1 million bones of snakes. *Bufo viridis* (=*Bufotes viridis* or *Pseudepidalea viridis*) is the most abundant (more than 90%) among the more than 183 000 fossils of frogs. Besides the green toad, five other frog species were identified (*Bufo bufo*, *Bombina variegata*, *Pelobates fuscus*, *Hyla arborea* and *Rana temporaria*), but these are infrequent. Based on preliminary studies, the reptile fauna of the locality contains turtles (*Testudo lambrechti* and *Emys orbicularis*), lizards (*Lacerta* cf. *viridis*, *Ophisaurus* sp., *Pseudopus* sp.) and snakes (*Coluber* sp., *Elaphe* sp., *Coronella* cf. *austriaca*, *Natrix natrix*, *N. tesselata* and *Vipera* sp.). The turtle fossils are infrequent isolated bones and shell-fragments. Although the fossils of lizards are present in nearly all layers, they are rare compared with the quantity of snakes (based on cranial elements) (Szentesi 2014b). The prevalence of snake fossils is typical for the Hungarian Lower Pleistocene localities of the Villány Hills (e.g. Kretzoi 1962; Jánossy 1979, 1986).

The salamandrids of Somssich Hill 2 described here are represented with some isolated cranial and postcranial bones, which were previously undetected from this palaeovertebrate site.

Anatomical and taxonomical conventions: The description of the vertebrae follows Ratnikov & Litvinchuk (2007, 2009). Although this work is written on fossil material, it aims to follow the latest taxonomic nomenclature. Many authors have worked on the taxonomy of urodeles (e.g. Titus &

Larsson 1995; García-París et al. 2004; Schmidtler 2004; Carranza & Amat 2005; Litvinchuk et al. 2005; Speybroeck & Crochet 2007; Zhang et al. 2008) but unfortunately, there is no consensus among them. This paper aims to attempt to move towards a consensus and thus it prefers the papers of Frost et al. (2006) and Dubois & Raffaëlli (2009).

Urodele remains of Somssich Hill 2 palaeovertebrate locality

Dénes Jánossy and György Topál collected the sediments containing the bones studied here between 1974 and 1984, while the remains of urodeles were found during the revision of the latter material. The 82 moderately or weakly preserved specimens consist of disarticulated skull and postcranial bones.

Class Amphibia Linnaeus, 1758
Subclass Lissamphibia Haeckel, 1866
Clade Caudata Fischer von Waldheim, 1813
(stem+crown group salamanders)
Order Urodela Dumèril, 1806
(crown-group salamanders)
Family Salamandridae Goldfuss, 1820
Subfamily Salamandrinae Goldfuss, 1820
Tribe Salamandrini Goldfuss, 1820
Genus *Salamandra* Laurenti, 1768
Subgenus *Salamandra* Laurenti, 1768

Salamandra cf. *salamandra* Linnaeus, 1758
(Figure 1, A–E)

1979 *Salamandra salamandra* Linnaeus – Sanchiz & Młynarsky, p. 177, figure 1.
1981 *Salamandra salamandra* Linnaeus – Estes, p. 67, figure 16, F
2007 *Salamandra salamandra* Linnaeus – Ratnikov & Litvinchuk, p. 182, figure6.

Referred material – 2 trunk vertebrae (VER 2015.73.1., 2015.74.1.)

Trunk vertebrae. The centrum length of these opisthocoelous vertebrae is 2–2.5 mm (Figure 1, A–E). The anterior
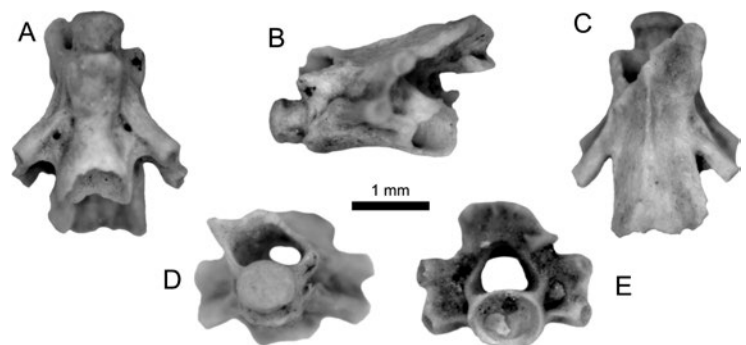
Figure 1. (A-E) S*alamandra* cf. *salamandra* trunk vertebra (VER 2015.74.1.) from the Lower Pleistocene Somssich Hill 2 palaeovertebrate locality. (A) in posteroventral (B) left lateral (C) dorsal (D) anterior and (E) posterior views.

1. ábra (A-E) Salamandra cf. *salamandra thoracalis vertebra (VER 2015.74.1.) a kora-pleisztocén Somssich-hegy 2 ősgerinces lelőhelyről. (A) postero-ventralis (B) bal lateralis (C) dorsalis (D) anterior és (E) posterior nézetben*

surface of the condylus is flat and inclined anteroventrally. The neck of the condylus is well developed. These vertebrae have two small subcentral foramina. The neural arch is low and bears protrusive lamina. The anterior margin of the neural arch is concave at the level of the middle part of the prezygapophyseal articular facets. The posterior margin of the neural arch is in front of the level of the posterior edges of the postzygapophyseal articular facets. The neurapophysis is broken, but it can be observed that it originates behind the level of the anterior margin of the neural arch. The middle part of the neural arch is well developed (it is wide on its base). The zygapophyseal crests are distinctly developed. The ventral crest near the base of the lower rib-bearer is weakly developed.

Remarks – The well-developed neck of the condylus, the small subcentral foramina and the position of the posterior margin of the neural arch suggest that these are *Salamandra* cf. *salamandra* remains (e.g. ESTES 1981, RATNIKOV & LITVINCHUK 2007). The centrum length of the trunk vertebra of *Salamandra salamandra* is between 5.3 and 6.8 mm, as mentioned in previous studies (HODROVA 1984; HALLER-PROBST & SCHLEICH 1994; RATNIKOV & LITVINCHUK 2007). The centrum of these vertebrae are significantly shorter (these possibly belong to a juvenile specimen) and the specimens are not complete so the classification is uncertain.

Subfamily Pleurodelinae TSCHUDI, 1838
Tribe Molgini GRAY, 1950
Subtribe Molgina GRAY, 1950
Infratribe Molgita GRAY, 1950
Genus *Triturus* RAFINESQUE, 1815
Subgenus *Triturus* RAFINESQUE, 1815

Triturus cristatus (LAURENTI, 1768)
(Figure 2, A–S)

1981 *Triturus cristatus* (LAURENTI) – ESTES, p. 80, figure 21, C
1986 *T. cristatus* (LAURENTI) – GONZALEZ & SANCHIZ, p. 483.
1990 *Triturus* cf. *cristatus* (LAURENTI) – VENCZEL, figure1.
2005 *Lophinus* (*T. vulgaris*) (LAURENTI) – LITVINCHUK et al., p. 317.
2007 *Triturus cristatus* (LAURENTI) – RATNIKOV & LITVINCHUK, p. 184, figure 7.
2009 *Triturus cristatus* (LAURENTI) – RATNIKOV & LITVINCHUK, p. 65, figure 9.

Referred material – 2 right dentaries (VER 2015.86.1-2.), 1 left dentary (VER 2015.83.1.) 1 atlas (VER 2015.86.3.), 40 trunk vertebrae (VER 2015.76.1., 2015.86.4-18.), 4 caudal vertebrae (VER 2015.86.21-24.), 3 femurs (VER 2015.8619-20.; V 82.124.1.) and 1 tibia (V 82.124.2.).

Dentary. This 3 mm long bone is only the anterior part of the dentary in the specimen shown (VER 2015.86.1., Figure 2, A–B). The dentary is relatively low; and bears narrow, dense pleurodont teeth with anteriorly tapering lamina horizontalis. The Meckelian canal is open posteriorly 1 mm from the symphysis. The symphysis is wide at the level of the lamina horizontalis and rounded labially. The labial surface of the bone is ornamented with irregular, relatively deep grooves and foramina.

Atlas. The length of the centrum is 2.5 mm (Figure 2, C–G). The neural canal is nearly rounded. The width of the processus odontoideus is nearly equal to the cotylus, but narrower than the breadth of the neural canal. The dorsal margin of the neural arch is inclined posteriorly in the lateral view. The neurapophysis is low anteriorly and it tapers towards the posterior part. The secondary dorsal crests are low and extend to the posterior edge of the neural arch. Although the left part of the neural arch is broken, it forms a trapezoid in the posterior view. The processus lateralis bears deep grooves. The ventral surface of the centrum and the lateral processes haves many foramina.

Trunk vertebrae. The size of these opisthocoelous vertebrae is variable (the length of the centrum is between 1.5–3 mm). The anterior surface of the condylus is flat (*Figure 2, H–L*). The subcentral foramen is very large, and on some specimens it is supplemented with several more or less smaller foramina. A foramen is present near the base of the rib-bearers. The neural arch is low, and it has a short medial notch on the posterior margin of the neural arch. The anterior margin of the neural arch is concave, and its bottom is situated at the level of the anterior half of the prezygapophyseal articular facets. The neurapophysis is low; it is somewhat higher in the middle part of the neural arch, while it also flattens anteriorly and posteriorly. The anteroventral and zygapophyseal crests are weakly developed. The posterior ventral crests are robust.

Caudal vertebrae. The length of the centrum of these opisthocoelous vertebrae is between 1–2.2 mm. All the bones are broken (Figure 2, M–Q). The anterior surface of the condylus is flat. The neural arch is low, while the haemal arch is deep and wedge-like, tapering ventrally. The anterior margin of the neural arch is moderately concave. The neurapophysis is low and also diminishes anteriorly and laterally.

Femur. The length of these bone-fragments is 6 mm. This bone is slightly sigmoid in shape (Figure 2, R) in both anterolateral and posterolateral views. The epiphysis is cartilaginous and the end of the bone is concave. The trochanter has a spur-like process, which connects to a well developed crista trochanterica. The crista trochanterica passes along the anteroventral margin of the femur to about the middle part of the bone. The distal end of the femur is moderately widened and dorsoventrally flattened.

Tibia. This slightly S-shaped bone is 5 mm long (Figure 2, S). The proximal part is strongly thickened, bends posteriorly and is flattened laterally and medially. The bone bears a lateral crista on the tapering diaphysis posteriorly. The end of the proximal part is slightly convex, while the distal end is broken.

Remarks – Although the morphology of the trunk vertebrae is similar to *Triturus dobrogicus* (e.g. RATNIKOV & LITVINCHUK 2007, Figure 8.), the posterior height of the neural arch is significantly higher posteriorly; furthermore the distance of the rib-bearer is bigger and the prerib-bearer foramen is lacking in the specimens. shown here. The
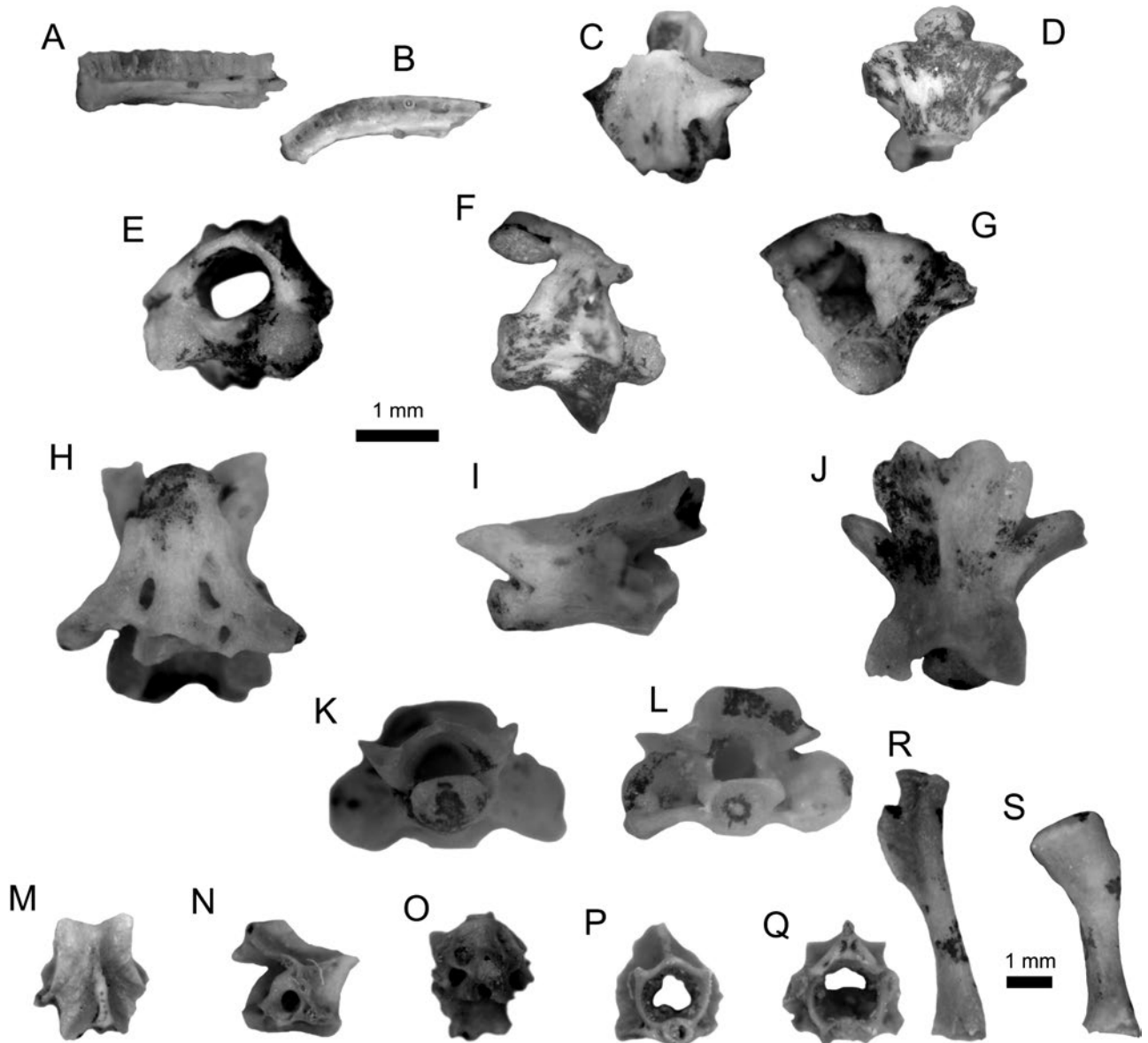
Figure 2. (A–S) *Triturus cristatus* fossils from the Lower Pleistocene Somssich Hill 2 palaeovertebrate locality. (A–B) right dentary (VER 2015.86.1.) (A) in lingual and (B) occlusal views; (C–G) atlas (VER 2015.86.3.) (C) in dorsal (D) ventral (E) anterior (F) left lateral and (G) posterior views; (H-L) trunk vertebra (VER 2015.86.4.) (H) in ventral (I) right lateral (J) dorsal (K) anterior and (L) posterior views; (M–Q) caudal vertebra (VER 2015.86.21.) (M) in dorsal (N) right lateral (O) ventral (P) anterior and (Q) posterior views; (R) femur (V 82.124.1.) and (S) tibia (V 82.124.2.) in ventral view. (The first scale belongs to figured specimens from A to Q, and the second from R to S.)

2. ábra (A-S) Triturus cristatus maradványok a kora-pleisztocén Somssich-hegy 2 ősgerinces lelőhelyről. (A-B) jobb dentale (VER 2015.86.1.) (A) lingualis és (B) occlusalis nézetben; (C-G) atlas (VER 2015.86.3.) (C) dorsalis (D) ventralis (E) anterior (F) bal lateralis és (G) posterior nézetben; (H-L) thoracalis vertebra (VER 2015.86.4.) (H) ventralis (I) jobb lateralis (J) dorsalis (K) anterior és (L) posterior nézetben; (M-Q) caudalis vertebra (VER 2015.86.21.) (M) dorsalis (N) jobb lateralis (O) ventralis (P) anterior és (Q) posterior nézetben; (R) femur (V 82.124.1.) és (S) tibia (V 82.124.2.) ventralis nézetben. (Az első méretarány az A-Q, a második az R-S csontmaradványokra vonatkozik.)

morphology of other figured bones (the relatively low dentary with pleurodont teeth, the slightly sigmoid femur with prominent trochanter and crista trochanterica etc.) (e.g. Estes 1981; Venczel 1990; Ratnikov & Litvinchuk 2007, 2009) suggests that these fossils belong to the species *Triturus cristatus*.

Genus *Lissotriton* Bell, 1839
Subgenus *Lissotriton* Bell, 1839
Supraspecies *Lissotriton vulgaris* (Linnaeus, 1758)

Lissotriton cf. vulgaris (Linnaeus, 1758)
(Figure 3, A–C)

1981 *Triturus vulgaris* group — Estes, p. 80, figure 21, A.
1986 *T. vulgaris* (Linnaeus) — Gonzalez & Sanchiz, p. 482.
2007 *Lissotriton v*
ulgaris (Linnaeus) — Ratnikov & Litvinchuk, p. 184, figure 13.

Referred material – 17 trunk vertebrae (VER 2015.73., 2015.74., 2015.83.2-4., 2015.86.25-36.).

Trunk vertebrae. These vertebrae are opisthocoelous (Figure 3, A–C), and the length of their centrum varies
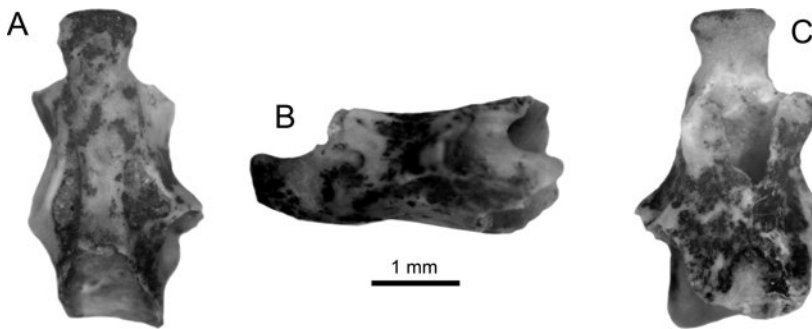
Figure 3. (A–C) *Lissotriton* cf. *vulgaris* trunk vertebra (VER 2015.83.2.) from the Lower Pleistocene Somssich Hill 2 palaeovertebrate locality (A) in ventral (B) left lateral and (C) dorsal views.

3. ábra (A–C) Lissotriton cf. vulgaris thoracalis vertebra (VER 2015.83.2.) a kora-pleisztocén Somssich-hegy 2 ősgerinces lelőhelyről (A) ventralis (B) bal lateralis és (C) dorsalis nézetben.

between 1.6–2 mm. The condylus has a flat anterior surface and a well developed neck. The latter is moderately inclined anteroventrally. Ventrally, the subcentral foramen is very large and almost triangular. The neural arch is high. On the posterior margin of the neural arch is a well developed medial notch. The very high neurapophysis has a horizontal dorsal margin that expands toward the medial notch. The zygapophyseal and the ventral crests are well developed.

Remarks – On these opisthocoelous vertebrae the following can be observed (i) very large subcentral foramina; (ii) a medial notch on the neural arch; (iii) a very high neurapophysis and (iv) well-developed crests (e.g. ESTES 1981; RATNIKOV & LITVINCHUK 2007, 2009). These features suggest that these bones belong to the species *Lissotriton vulgaris*.

Salamandridae indet.

Referred material – 22 trunk (VER 2014.2., 2015.45.1., 2015.76., 2015.77.1-2., 2015.81.1., 2015.82.1., 2015.83.5-9., 2015.86.37-46.) and 4 caudal vertebrae (VER 2015.83.10-13.).

Although these specimens are broken, they bear some characteristic features. These features include: opistho-coelous vertebrae, the presence of the subcentral foramina, the horizontally oval articular surfaces, as well as the well-developed zygapophyseal and ventral crests (see e.g. ESTES 1981; RATNIKOV & LITVINCHUK 2007; VENCZEL 2008) suggest that these vertebrae belong to the family Salamand-ridae.

Discussion

Taphonomical observations

All the examined tailed amphibian bones are isolated. Nevertheless, these bones are relatively well-preserved, except in the respective cases of some specimens. Most tailed amphibian fossils have clear, smooth and hard surfaces. Some bones are covered with manganese oxides on relatively large areas. This coating originated from soluble manganese compounds which transported with the water that infiltrates the sediment. These precipitated alongside an ongoing variation of pH — in this case affecting the surface of the fossilized bones (e.g. LÓPEZ-GONZÁLEZ et al. 2006). Some vertebrae are coated with calcite crust. Traces of predation (for example traces of chewing or digestion) cannot be observed on the respective surfaces of these bones. The amount of the remains of urodeles increases towards the bottom of the section. Most of these occur in the layer 2/46. Unfortunately, the quantity of screen-washed sediment is unknown; as a result, quantitative changes can not be evaluated between these layers.

Palaeoecological interpretations

Tailed amphibian remains are represented by 95 bones in five layers in the section of the Somssich Hill 2 (*Table I*). Only a few Caudata fossils were unearthed from the upper region of the section (layer 7) and near the middle of the succession (layer 20). The bones of this group appear in larger quantities in the lower strata from two longer stages (between layers 35 and 39, and near the bottom, between layers 44 and 49). Although the number of tailed amphibian bones is low, these fossils are appropriate for a palaeo-ecological interpretation because these animals are moisture-seeking (e.g. BÖHME et al. 2006).

The distribution of amphibian fossils within the strata concurs with the aforementioned six phases based on vole fossils (SZENTESI 2014a, Figure 7). Fossils of heliophile green toads (e.g. BÖHME et al. 2006) occur in all layers in large numbers (SZENTESI 2014a). The subterranean, arboreal spade-foot toads (*Pelobates fuscus*) (e.g. BÖHME et al. 2006) are also present in almost the full succession but, even so, are fairly rare (SZENTESI 2014a). Lacertid and anguid lizards were also detected, with similar ecological conditions (e.g. BÖHME et al. 2006), in almost all layers (SZENTESI 2014b). The heliophile vipers are rare but they are present in all phases except the fifth (between 17 and 12 layers).

Based on *Mimomys*, *Pliomys* and *Sorex* fossils (PAZONYI et al. 2013a), it appears that the oldest sediments (from layers 50 to 47) were deposited during a more humid climate with forest and gallery forest vegetation. The presence of periaquatic *Bombina variegata* and salamandrid amphi-bians besides *Elaphe longissima* (=*Zamenis longissimus*) and *Natrix tesselata* confirm these data in this part (SZENTESI 2014a, b).

Although the appearance of lemmings (*Lagurus*) indicates a drier, open steppe environment between layers 46 and 35, Urodela and *B. variegata* remains also occur in these layers (SZENTESI 2014a). *Sorex* is more abundant in this region than *Crocidura*. The former shrew was very capable of toleratingthe cold , whilst *Crocidura* is thermophilic, so

Table I. The table shows the distribution of herpetological elements in the succession of Lower Pleistocene Somssich Hill 2 palaeovertebrate locality with the indication of phases

I. táblázat. A herpetofauna rétegenkénti megoszlása a Somssich-hegy 2 ősgerinces lelőhelyen a fázishatárok feltüntetésével

Number of layers/Rétegszám	Salamandra cf. salamandra	Triturus cristatus	Lissotriton cf. vulgaris	Salamandridae indet.	Bombina variegata	Pelobates fuscus	Bufo bufo	Bufo viridis	Hyla arborea	Rana temporaria	Emys orbicularis	Lacertidae	Anguidae	Elaphe longissima	Natrix natrix	Natrix tesselata	Vipera sp.
1					■					■				■	■		
2					■					■		■					
3			■				■									■	
4					■								■				■
5				■	■				■						■		
6																	
7		■			■							■					
8					■												
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10					■												
11					■			■			■						
12						■											
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20			■	■	■					■			■			■	
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48																	
49		■		■				■								■	
50																	

this genus was even rarer at the time of deposition. The dominance of *Sorex* probably indicates a rather cold temperature with a humid climate (MÉSZÁROS 2015a). The almost continuous presence of the opportunist *Beremendia* probably indicates the proximity of a permanent stream or still water (BOTKA & MÉSZÁROS 2015). The sylvan *Elaphe longissima* and the mainly aquatic *Natrix* are frequent in layers 46 to 18 (SZENTESI 2014b).

The ratio of wood mice (*Apodemus*) and dormice (Gliridae) increases with the reduction of the number of *Lagurus* between layers 35 and 25. Voles (*Pitymys*, *Myodes* and *Pliomys*) are more frequent (PAZONYI et al. 2013a, b). *B. variegata* and *Hyla arborea* are more common in this part among the amphibians, while the remains of urodeles appear only in layer 35. The ratio of field and forest shrews shows the *Sorex* genus is significantly more frequent in layer 18, which indicates a closed forest steppe (MÉSZÁROS 2015a).

The next phase (between layers 25 and 18) is separated based on the presence of the remains of voles (PAZONYI et al. 2013a, b). European tree frog fossils appear in nearly all layers in this region, while *B. variegata* emerges on only one occasion. Furthermore only one salamandrid bone was unearthed from layer 20 of this unit (SZENTESI 2014a). An increase in the number of red-backed voles (*Myodes*) indicates the presence of deciduous woods, and this explains the disappearance of *Crocidura* and the reduction in the number of heliophile green toads (PAZONYI et al. 2013a, b; SZENTESI 2014a).

The ratio of lemmings increases again from layer 17 to 12, and this indicates another cooling event (PAZONYI et al. 2013a, b). The number of green toad fossils decreases continuously toward the top of the layers and besides this the urodeles disappear, while *Hyla* and *Bombina* sometimes occur during this phase (SZENTESI 2014a). Among snakes *Natrix tesselata* is present in all layers, while *Elaphe longissima* occurs from layer 15 to 12. The presence of the latter snake suggests that in the proximity of still water or a permanent stream the bushy vegetation remained even in a dry steppe climate (PAZONYI et al. 2013a, b; SZENTESI 2014a, b).

On the top of the succession (from layer 11 to 1) the number of amphibian and reptilian bones is constantly small. Urodeles are represented with a few bones in layers 7 and 3; however, the yellow bellied toad occurs in almost all layers. The disappearance of woody and bushy land pre-ferring *Hyla arborea* is peculiar beside the appearance of the *Apodemus* and dormice (PAZONYI et al. 2013a, b; SZENTESI 2014a). *Elaphe longissima* occurs in these upper layers (except layers 12 and 11) (SZENTESI 2014b). This fact similarly to the presence of small mammals, also proves the return of a warmer and more humid climate and a closed vegetation. The moisture-preferring frogs (*Bombina*) and snakes (*Natrix*) indicate the presence of permanent water near the place of deposition (SZENTESI 2014a, b). The occur-rence of the European pond turtle (*Emys orbicularis*) con-firms this assumption (in layers 11, 7 and from 4 to the top).

In conclusion, the heliophile and subterranean amphi-bians and reptiles are present in periods of deposition , while the periaquatic and sylvan forms occur in those layers where the water and/or forest-preferring small mammals were also present. The quantitative study of the mollusc fauna also suggests a variable climate during the sedimentation of the strata of Somssich Hill 2 in the last phase of the early Pleistocene (KROLOPP 2000). Although forest mammals,

amphibians and reptiles are most abundant at the bottom of the studied section, they are present in varying quantities in all layers (e.g. Szentesi 2014a, b; Mészáros 2015a, b). This fact could indicate that the forest environment existed in all periods of deposition in at least a small area, even when the wider palaeoenvironment was a steppe. Yet this would only have been possible if there was a permanent stream or lake to, allow the formation of dense vegetation, such as scrubland or a gallery forest. The presence of permanent water is demonstrated by fluviatic snails, fish, many amphibians (e.g. salamanders and yellow bellied toads) and reptiles (turtles and *Natrix*) (e.g. Jánossy 1983; Krolopp 2000; Szentesi 2014a, b). This stream or lake ensured the survival of the moisture-seeking and woodland animals during the drier periods.

The amount of fossilized bones of amphibians and reptiles decreases towards the top, although not always uniformly (for example in layer 4). This effect could have been caused by a biological problem (for example it is easier to climb from a shallower hole) or a hitherto unknown taphonomic one.

Conclusions

Based on mainly postcranial bones, the presence of the family Salamandridae (Caudata) was confirmed as a result of the latest revision of the fossilized vertebrate assemblage of Somssich Hill 2. The family is represented by at least three species: *Salamandra salamandra*, *Triturus cristatus* and *Lissotriton vulgaris*.

The Caudata bones are important indicators of the palaeoenvironment. These animals are moisture-preferring, so they indicate a permanent water surface near the site of deposition, which supports the previous results.

The climate changed several times during the sedimentation process — from humid and warm to dry and cold. The palaeoenvironment changed together with the climate between closed forest and open steppe.

The fossils of Urodela and other moisture-seeking vertebrates, suggest a permanent water surface (stream or lake) was near the site of deposition during the periods of sedimentation relevant for all strata.

These amphibians tolerated the temperature changes well (their life cycles were able to adapt to the circumstances); consequently unlike small mammals, they cannot be used as warm or cold climate indicators.

Although the quantity of amphibian and reptilian bones decreases toward the top of the section, these data are unusable because the original amount of screen-washed sediments is unknown.

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