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New findings of Late Pliocene vertebrates from Hajnácka I site (southern Slovakia)

Nuevo hallazgo de vertebrados del Plioceno superior en la localidad de Hajnácka I (Eslovaquia del sur)

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Abstract: The Hajnácka I site is one of the European paleontological localities dated as Lower Villafranchian, MN 16a unit (Late Pliocene). From its discovery in 19th century, many scientists have dealt with the research of this site. After more than 35 years, the new systematic research started in the second half of 90s of the last century. This new research has yielded a quantity of new data and material, especially paleontological. This article provides the first results on a new site of Villafranchian vertebrates discovered in the territory of the Hajnácka I site.
Key words: Villafranchian, Late Pliocene, Vertebrates, Hajnácka, Slovakia.

Resumen: La localidad de Hajnácka I pertenece a localidades paleontológicas de Europa datadas en el Villafranquiense inferior, zona MN 16a (Plioceno superior). Muchos científicos se dedicaron a la investigación de esta localidad deste su descubrimiento en el siglo XIX. Una nueva investigación sistemática de la localidad mencionada empezó después de más de 35 años en la segunda mitad de los noventa en el siglo pasado. Durante esta investigación nueva fue obtenida gran cantidad de datos y materiales nuevos, sobre todo hallazgos paleontológicos. Este articulo refiere los primeros resultados sobre nuevos hallazgos de nuevos vertebrados del Villafranquiense descubiertos en el área de Hajnácka I.
Palabras claves: Villafranquiense, Plioceno superior, vertebrados, Hajnácka, Eslovaquia.

INTRODUCTION

The paleontological locality Hajnácka I in the territory of Slovakia is a type locality of the European Neogene Mammal time scale, dated in the MN 16a zone (Early Villafranchian, Late Pliocene) (FEJFAR & HEINRICH, 1987). This site is worldwide known for its findings of fossil vertebrates, especially mammals, buried in the volcanic ash. Fossil skeletal remains from Hajnácka I site have been known since 1863, when Kubinyi first published evidence (FEJFAR, 1964). In the following years of the research, many scientists have dealt with this locality (e. g. SZABÓ, 1865; PAUL, 1866; KRENNER, 1867; SCHAFARZIK, 1899; KORMOS, 1917; FEJFAR, 1961a,b, 1964; FEJFAR & HEINRICH, 1985; FEJFAR *et al*., 1990; KONECNY *et al.*, 1995; LINDSAY *et al*., 1997; LUPTÁK, 1997; UHER *et al*., 1999; PIPÍK, 2000; VASS *et al*., 2000; etc.).

After more than 35 years (since FEJFAR in 1955-58), new systematic research begun in 1996. The fieldwork part of this research was finished in the summer 2000. This article presents tentative data found during this new research on a new place of vertebrate findings in the territory of this locality.

LOCALITY

The paleontological site of Hajnácka I is situated approximately 1 to 1.5 km SE of Hajnácka village in the Rimavská Sobota district and 500 m N of the trigonometric point 410 m (Matrac hill) (Fig. 1). The locality covers an area from 1,000 to 1,500 m^2 (FEJFAR, 1964). The outcrop consists of deep erosive creeks. The largest of these erosive ravines with E-W orientation is 400 m long and 30 m wide and more than 20 m deep in some places. On the basis of the

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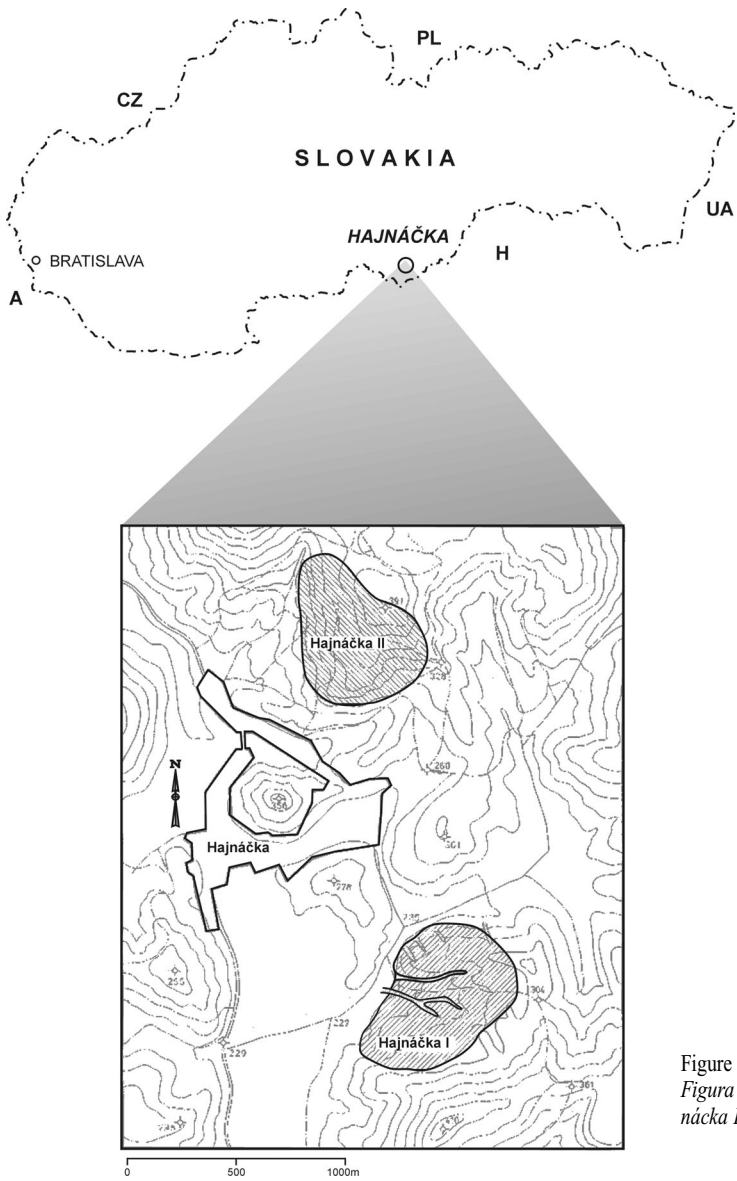

Figure 1.—Location of the Hajnácka I site.
Figura 1.—Localización del yacimiento de Hajnácka I

quantity of skeleton remains found here, this area was named "Kostná dolina" (the Bone Valley or Bone Gorge) (Fig. 2). The volcanic-sedimentary layers appear on the surface of these erosive creek walls. They often contain fossil remains of the Late Pliocene fauna and flora.

The locality belongs to the Cerová Basalt Formation, which is mainly build up by nepheline basanite and volcanic clastics. The radiometric age of the basalt varies from 5.03 to 1.16 Ma (Vass *et al.*, 2000). The fossiliferous layers are situated in a *maar* (pool) depression of elliptical shape (the Bone Valley *maar*) in the northern foothills of Matra Mountains. The *maar* size is approximately 80x50 m (Konecny & Lexa in Bezák *et al*., 1992). The base of the *maar* filling consists of the redeposited Eggenburgian sandstone of the Filakovo Formation (Tachty sand and sandstone) with overlying autochthonous tuff, lapilli tuff, tuffite, fragments of basalt and fine sand. Limonite crusts often envelop the sandy beds. Also, redeposited palagonite tuff and breccias less frequently occur in the *maar* filling. Locally, relicts of

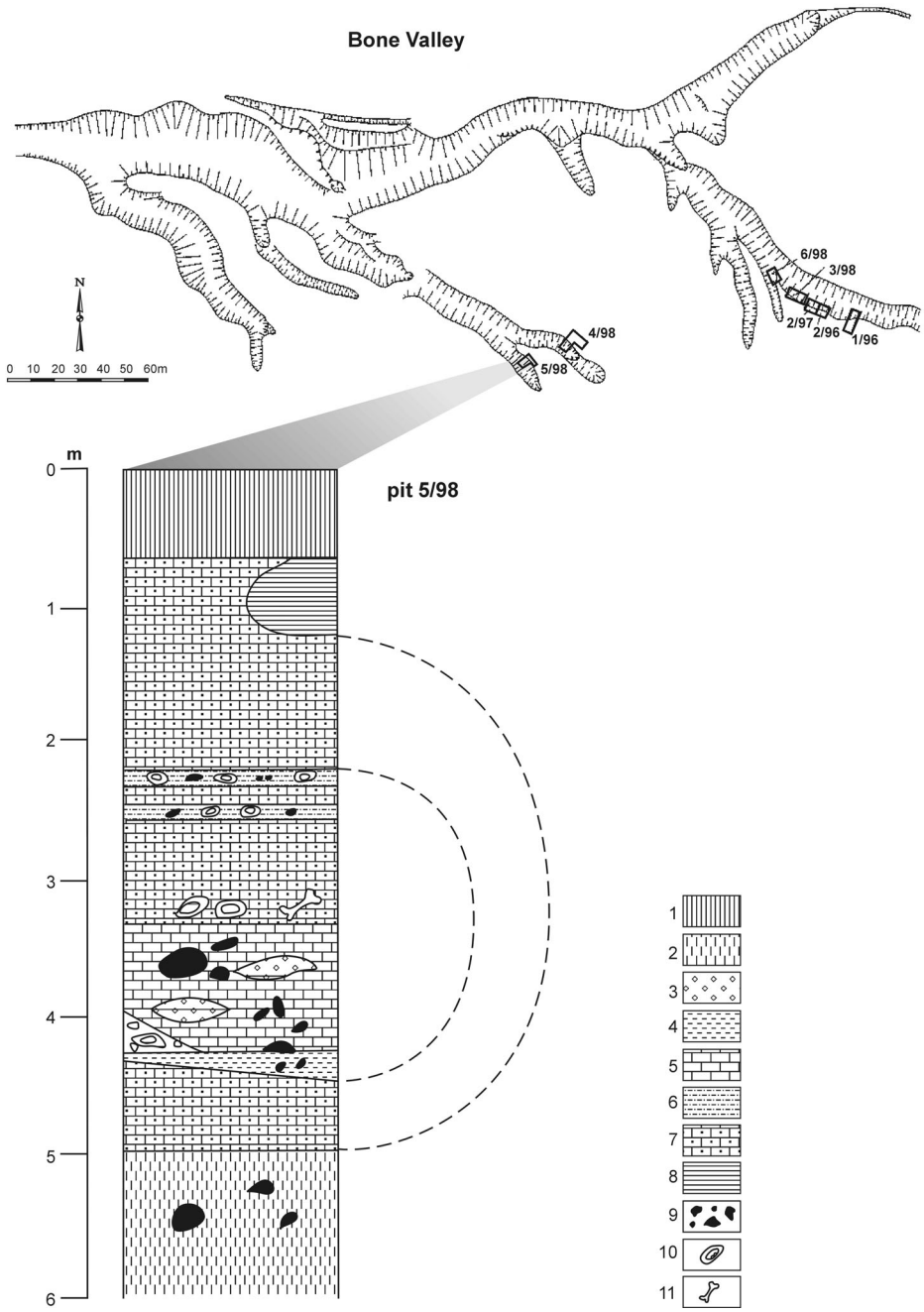

Figure 2.– Location of the pit 5/98 in the Bone Valley and its schematic profile: 1-Holocene dark humous loam; 2-Quaternary light sandy loam; 3-rusty-brown tuffaceous sand often with limonite concretions; 4-dark sandy tuffite; 5-dark tuff, lapilli tuff; 6-light sandy tuffite with intercalation of rusty-brown tuffaceous sand; 7-tuff with intercalation of rusty-brown tuffaceous sand; 8-fragment of primary maar filling; 9-fragments of basaltic rock; 10-baked sandstone; 11-findings of fossil vertebrates.

Figure 2.– Localización del pozo 5/98 en el valle de Kostná dolina, y su perfil esquemático: 1-humus holoceno; 2-suelo cuaternario arenoso claro; 3-arenas tobáceas óxido-marrón, a menudo con concrecciones de limonita; 4-toba arenosa oscura; 5-toba oscura, lapilli; 6-arenas tobáceas claras con intercalaciones de óxido-marrones ; 7-toba con intercalaciones de arenas tobáceas óxido-marrón ; 8-fragmentos del relleno primario del lago; 9-fragmentos de rocas basálticas; 10-arenisca cocida; 11-fósiles de vertebrados.

laminated bituminous beds are situated in the upper part of this filling with the Quaternary loamy and loam-silty deposits covering the marginal parts of the Bone Valley *maar*. The fossil findings have been found in more or less disturbed sediments forming completely preserved stratigraphical unit without *hiatus*. These fossiliferous beds were disturbed especially in the process of land sliding during the Quaternary period.

LITHOLOGICAL AND SEDIMENTOLOGICAL DESCRIPTION OF THE NEW FINDING

During the new research in the locality, six pits have been excavated in the upper parts of two erosive creek areas with a SE orientation (Fig. 2), where the deposits from the Pliocene to the Holocene have been recorded. Five of them (four vertical pits 1/96, 2/96-97, 4/98, 6/98, and one horizontal pit 3/98 situated in the area of 16 square metres approximately) have been dug in the probable sites of the Fejfar´s pits 3/98, 8/56 and 9/56 (SABOL, 2001); pit 5/98 has been dug in a new place with the chancy finding of a larger quantity of vertebrate bones.

This new finding site (pit 5/98) is situated in a W to SW direction from pit 4/98 (Fig. 2). The pit, approximately 6 metres deep, has been dug in the erosive creek area parallel to the longest SE limb of Bone Valley. The uppermost 65cm of dark-brown loam was deposited during the Holocene period, forming forest soil (brown-earth). The underlying Pliocene sediments consist of thin faintly diagonal bedded grey-brown lens-shaped sandy tuff, with the intercalation of rusty-brown tuffaceous sand. A block of fine laminated grey-brown rock was found in this layer. This block contains thin (0.1 – 0.3 mm) pelitic laminae (tuffaceous silt and clay) rich in palyno-assemblages (VASS *et al.*, 2000), which alternate with more coarse laminae (0.5 mm) of fine to medium-grain sand. The rusty-brown sands also appear below the cemented grey-brown tuff. These sediments approximately reach 3 m, and the intercalation of grey-brown sandy tuffite and rusty-brown tuffaceous sand are situated between 2.15 and 2.55 m in depth. The sandy lenses contain small basalt pebbles (2 to 3 cm in average) and also small baked sandstone pebbles.

In the underlying layer of this volcanic and sedimentary strata, a 20 to 30cm thick layer of grey tuff intercalated with rusty-brown tuffaceous sand contains fossil remains and layers of baked sandstones. The underlying layer consists of a grey-brown tuff with intercalation of rusty-brown tuffaceous sands and basalt fragments, larger than 10cm in diameter. In the left basal part of this layer, grey tuffaceous sands are deposited with scattered baked sandstone pebbles. A layer of grey-brown sandy tuffite with isolated small basalt pebbles, few cm-thick, overlies the almost half m-thick layer which corresponds to the uppermost Pliocene volcano-sedimentary complex. As evidenced in the structure of the creek right wall near the pit, this repetition of layers is probably the result of an ancient landslide. The lowermost layer of the pit consists of brown unconsolidated sandy loam with isolated intercalations of rusty-brown sandy sediments, volcanic rocks (mainly basalt fragments) and calcareous concretions. This layer represents the probable source of the material deposited on the creek bottom. Interesting is the presence of a 5cm thick layer of fossil ash (forest fire?) approximately 40cm under the surface at the right creek wall near the pit.

The occurrence of vertebrate fossil remains is especially connected with the lenses and intercalation of gravel in the rusty-brown tuffaceous sand, often with the presence of limonite concretions and small pyroclastic fragments. This tuffaceous sand consists of redeposited material of the original primary *maar* filling, from the inner slopes of this *maar* ring (VASS *et al.*, 2000). Bones and teeth of tapirs (*Tapirus arvernensis* CROIZET et JOBERT, 1828), rhinos (*Dicerorhinus jeanvireti* GUERIN, 1972), "mastodonts" (especially *Anancus arvernensis* (CROIZET et JOBERT, 1828), and micromammals are the most frequent findings, with larger quantity of fish fossil remains. In the case of small mammals, more than 500 kg of sediment have been sampled.

DISCUSSION

More or less disturbed sediments, often in allochthonous position, have been recorded in the studied pit similar to those found in other pits. These sediments were disturbed not only during their deposition, which probably occurred in a very short time span (FEJFAR *et al*., 1990), but also in the period after the extinction of the Hajnácka biocenosis. In this time, the original layers of *maar* sediments were

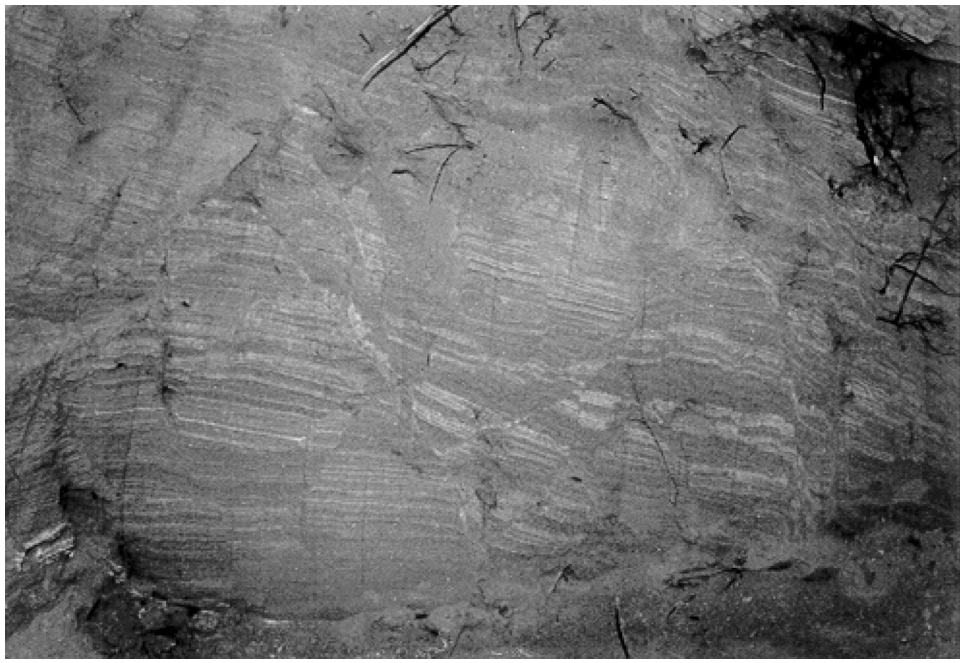

Figure 3.- The fragment of the primary maar filling represented by the fine laminated rock, pit 5/98; photo J. FERLETÁKOVÁ, approximately 1/10 of the natural size.
Figura 3.- Vista detallada al fragmento del relleno original del lago en el pozo 5/98, compuesto por sedimentos finamende laminados; foto de J. FERLETÁKOVÁ, aproximadamente 1/10 de la dimensión natural.

destroyed by the seismic shocks, connected with explosive activity and the rise of the Cerová Highland dome (VASS *et al*., 2000).

Also, these *maar* sediments were disturbed in the Quaternary Period, especially during the Late Pleistocene (erosion, solifluxion and repeated landslides), when they have been redeposited in the bottom of the Hajnácka depression (FEJFAR, 1964). The occurrence of the Late Pleistocene loess sediments (PRISTÁY in BEZÁK *et al*., 1992) together with the Pliocene sediments is evidence of that. Apart from the malacofauna, these Quaternary deposits contained the fossil remains of rodents (*Microtus*, *Clethrionomys*) as well. The mixed occurrence of Pleistocene elements together with the Pliocene fauna has been previously signalled at this locality by SZABÓ (1865) (fossil remains of bison, mammoth and horse) and FEJFAR (1964) (woolly rhinos, rodents) for example. The destroyed stratigraphical data makes difficult to reconstruct the thickness of the Pliocene sedimentary *maar* filling.

The *maar* sediments consist of both, an older primary filling and a younger secondary one. Whereas sediments of the older *maar* filling have been deposited in the conditions of an eutrophic lake during the calm periods between volcanic eruptions (VASS *et al*., 2000), the secondary filling was originated in the environment of a drained lake after removal of the primary one. The remains of the original *maar* deposits are rarely found in the site, as blocks of fine, laminated sediments. One of these largest blocks (more than 1 cubic metre) has been recorded in the profile of the upper parts of the pit 5/98 (Fig. 3).

Besides tuff and tuffite, the repeatedly deposited sandy material from the disintegrated underlying Eggenburgian sandstone of the Filakovo Formation (light marine Tachty sandstone) took part in the forming of the *maar* primary filling. Also they have been redeposited after the removal of the original filling during the post-volcanic erosion (VASS *et al*., 2000) in the time of the *maar* secondary deposition. An evidence of that is the common occurrence of reworked Miocene foraminifers and shark teeth together with the Pliocene vertebrate fossils in the sediments, already referred by KORMOS (1917) and FEJFAR (1964).

From the paleontological point of view, the new

Hajnácka I - Late Pliocene taxa		Fejfar *et al.*, 1990	1996 - 2000 5/98
Osteichthyes	*Scardinus* ? *erythrophthalmus* Linné, 1758	+	+
	Tinca furcata Agassiz, 1843	+	+
	Esox sp.	+	
	cf. *Parasilurus* sp.	+	
	Osteichthyes gen. et spec. indet.	+	+
Amphibia	*Pliobatrachus* sp.	+	
	Bufo bufo (Linné, 1758)	+	
	Rana cf. *temporaria* Linné, 1758	+	
	Rana cf. *arvalis Linné, 1758*	+	
	Rana cf. ex gr. *dalmatina-latastei*	+	
	Anura gen. et spec. indet.	+	+
Reptilia	*Chelydra* aff. *decheni* H. von Meyer, 1852	+	
	Emys orbicularis Linné, 1758	+	
	Testudinata gen. et spec. indet.	+	+
Aves	*Mergus* sp.	+	
Mammalia			
Talpidae	*Desmana nehringi* Kormos, 1913	+	+
	Talpa cf. *fossilis* Petényi, 1864		+
Soricidae	*Petenyia hungarica* Kormos, 1934	+	
	Blarinoides mariae Sulimski, 1959	+	
	Beremendia fissidens (Petenyi, 1864)	+	
Cercopithecidae	Colobinae gen. et spec. indet.	+	
Mustelidae	*Lutra* cf. *bravardi* Pomel, 1843	+	+
Procyonidae	*Parailurus hungaricus* Kormos, 1934	+	
Felidae	*Megantereon* (?) sp.	+	
Hyaenidae	*Pliocrocuta perrieri* (Croizet et Jobert, 1828)	+	
Petauristidae	*Pliopetaurista pliocaenica* (Depéret, 1897)	+	
Seleviniidae	Seleviniidae(?) sp.	+	
Anomalomyidae	*Prospalax priscus* (Nehring, 1897)	+	
Muridae	*Apodemus* sp.	+	
Cricetidae	*Baranomys loczyi* Kormos, 1933	+	
	Mimomys (Cseria) stehlini Kormos, 1931	+	
	Mimomys (Mimomys) hassiacus Heller, 1936 (=*Mimomys (M.) hajnackensis* Fejfar, 1961)	+	
	Germanomys sp.	+	
	Cricetidae gen. et spec. indet.		+
Castoridae	*Castor fiber* ssp.	+	
	Trogontherium minus Newton, 1890	+	
Leporidae	*Hypolagus brachygnathus* Kormos, 1934	+	
Mammutidae	*Mammut borsoni* (Hyas, 1834)	+	
Gomphotheriidae	*Anancus arvernensis* (Croizet et Jobert, 1828)	+	+
	Proboscidea gen. et spec. indet.		+
Tapiridae	*Tapirus arvernensis* Croizet et Jobert, 1828	+	+
Rhinocerotidae	*Dicerorhinus jeanvireti* Geurin, 1972	+	+
	Rhinocerotidae gen. et spec. indet.	+	+
Suidae	*Sus minor* (Depéret, 1890)	+	
Cervidae	*Capreolus* sp.	+	
	Cervus perrieri-Arvernoceros ardei	+	
	Cervus pardinensis Croizet et Jobert, 1828	+	
	Croizetoceros ramosus (Croizet et Jobert, 1828)	+	
	Muntjacus sp.	+	
	Cervidae gen. et spec. indet.		+
	Mammalia gen. et spec. indet.		+
	Vertebrata gen. et spec. indet.		+

Table 1.- Preliminary list of the Late Pliocene vertebrate taxa found in the deposits of the pit 5/98 during new research and its comparison with the faunal list of Fejfar *et al.* (1990).

Tabla 1.- Lista preliminar de taxa de vertebrados de Plioceno superior hallados en el pozo 5/98 durante la nueva investigación y su comparación con la lista de la fauna identificada por Fejfar et al. *(1990).*

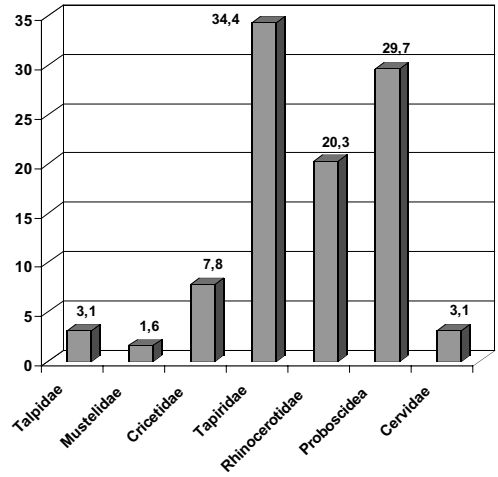

Figure 4.- Relative representation (in percents) of mammalian taxa preliminarily ascertained from sediments of the pit 5/98 in new finding place of the Hajnácka I site.
Figura 4.- Distribución de taxa de mamíferos preliminarmente identificados de los sedimentos del pozo 5/98 en el hallazgo nuevo del yacimiento de Hajnácka I.

finding yielded a large quantity of new vertebrate fossils. Besides large mammal remains, such as tapirs, rhinos and "mastodonts" (Fig. 4), the fossils of small vertebrates, especially fishes and micromammals have been found (Tab. 1). Some taxa have been repeatedly found here (e. g. *Desmana nehringi* KORMOS, 1913; *Lutra* cf. *bravardi* POMEL, 1843 and others), although some taxa already known have not been recorded again (e. g. *Parailurus hungaricus* KORMOS, 1934 and others). On the other hand, fossil remains of new taxa for the Hajnácka biocenosis have been determined (e. g. *Talpa* cf. *fossilis* PETÉNYI, 1864). Approximately 17 vertebrate taxa have been recognised from this new place, whereas FEJFAR et al. (1990) determined 46 vertebrate taxa from Hajnácka I site (Tab. 1).

All these fossil remains, together with those of other pits, belong to Pliocene animals which lived in this territory during the formation of the secondary *maar* filling. In this time, shallow swamps were probably situated in some parts of the drained lake coast (FEJFAR, 1964). On the other hand, the lake coast was also surrounded by a bushy, humid primeval forest (but not swampy! - after LINDSAY *et al*. (1997)) with flowing streams and backwater, in which "mastodonts", tapirs, rhinos, cervids (*Muntiacus* sp.) and others forest taxa dominated. The presence of allochthonous elements represented by the genera *Pliocrocuta, Megantereon, Hypolagus* and *Prospalax* (FEJFAR, 1964) or *Baranomys* (FEJFAR *et al.*, 1990) is also evidence of the existence of the steppe or open grassy land in the Hajnácka environment. The whole Hajnácka biocenosis was decimated by the eruption of a nearby volcano (FEJFAR, 1964). However, some animals were killed by gas emanations at the lake bank still before the volcanic eruption and subsequent tephra fall. The animal carrions were washed to the lake later and deposited on its bottom near of the coast. The presence of fish bones, fragments of clam shells (probably *Anodonta* sp., FEJFAR, 1964), and also ostracod shells (PIPÍK, 2000) together with the vertebrate osteological remains in the fossiliferous sediments is evidence of that. A rapid covering of their bodies (or remains) by sediments favoured their fossilisation. However, most vertebrate skeletons disintegrated later on, together with the sediments, during the disturbing geological processes (seismic shocks, landslides, solifluxion and others).

From the biostratigraphical point of view, FEJFAR & HEINRICH (1987) have placed Hajnácka fauna in the Late Pliocene MN 16a unit (2.8 to 3.3 Ma). Thus, it is possible to correlate the Hajnácka fauna with fauna from European sites such as Cornillet, Grenouillet, Commenailles, Seynes, Vialette, Arondelli-Triversa, San Giusto, Carrasco, Valdeganga, Concud, Escorihuela, Moreda, Zujar, Galera 2 and Beremend 1-3, 5 (FEJFAR *et al*., 1990; LINDSAY *et al*., 1997).

CONCLUSION

During new paleontological research in the Villafranchian locality Hajnácka I, a new site of Late Pliocene vertebrate findings has been discovered. The new pit 5/98 dug in this research discovered a large quantity of vertebrate fossil remains has been found.

From the lithological and sedimentological points of view, the sediments of the secondary *maar* filling together with the block of fine laminated sediments of the primary one have been recorded in the profile of this pit. Their sedimentary position is in agreement with the older opinion of FEJFAR (1964) on the "inverted" position and mixed layers caused by the geological processes after the partial destruction of the Hajnácka biocenosis.

From the paleontological point of view, the validity of the most important fossils have been confirmed, although the fossil remains of some taxa (e. g. lesser panda) were not again recorded here. On the other hand, new elements have been found. So far, approximately 17 taxa of vertebrates have been described from the sediments of the studied pit.

Besides of the Pliocene vertebrate fossils, reworked Miocene (foraminifers and shark teeth) and Pleistocene elements (gastropods, rodents) have also been found. This supports the opinions on the repeated redeposition of the underlying Eggenburgian sands and sandstones, and the later mixture of the Pliocene *maar* sediments with the Pleistocene ones after the extinction of the Hajnácka biocenosis.

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REFERENCES

Bezák, V., Bodnár, J., Elecko, M., Konecny, V., Lexa, J., Molák, B., Straka, P., Stankovic, J., Stolár, M., Skvarka, L., Vass, D., Vozár, J. & Vozárová, A. 1992. *Vysvetlivky ku geologickej mape Lucenskej kotliny a Cerovej vrchoviny 1 : 50 000*. 198 pp. GÚDS. Bratislava.

Fejfar, O. 1961a. Die plio-pleistozänen Wirbeltierfaunen von Hajnácka und Ivanovce (Slowakei), CSR. I. Die Fundumstände und Stratigraphie. *Neues Jahrbuch für Geologie und Paläontologie*, **111** (3): 257 – 273.

- 1961b. Die plio-pleistozänen Wirbeltierfaunen von Hajnácka und Ivanovce (Slowakei), CSR. II. Microtidae und Cricetidae inc. sed.. *Neues Jahrbuch für Geologie und Paläontologie*, **112** (1): 48 – 82.

- 1964. *The Lower Villafranchian Vertebrates from Hajnácka near Filákovo in Southern Slovakia*. 116 pp. Ústrední Ústav Geologick . Praha.

- Heinrich, W. D. 1985. Zur Bedeutung der Wirbeltierfundstätten von Ivanovce und Hajnácka für die Säugetierpaläontologie im Pliozän und frühen Pleistozän in Europa: Kenntnisstand und Probleme. *Vestník Ústredního ústavu geologického*, **60** (4): 213 – 224.

- Heinrich, W. D. 1987. Zur biostratigraphischen Gliederung des jungeren Känozoikums in Europa an Hand von Muriden und Cricetiden (Rodentia, Mammalia). *Casopis pro mineralogii a geologii*, **32** (1): 1 – 16.

- Heinrich, W. D. & Heintz, É. 1990. Neues aus dem Villafranchium von Hajnácka bei Filakovo (Slowakei, CSSR). *Quatärpaläontologie*, **8**: 47 – 70.

Konecny, V. & Lexa, J. 1992. Pliocén – pleistocén. Cerová bazaltová formácia. In: *Vysvetlivky ku geologickej mape Lucenskej kotliny a Cerovej vrchoviny 1 : 50 000*. V. Bezák, J. Bodnár, M. Elecko, V. Konecny, J. Lexa, B. Molák, P. Straka, J. Stankovic, M. Stolár, L. kvarka, D. Vass, J. Vozár & A. Vozárová. pp. 99 - 105. GÚDS. Bratislava.

- Lexa, J., Balogh, K. & Konecny, P. 1995. Alkali basalt volcanism in Southern Slovakia: volcanic forms and time evolution. *Acta Vulcanologica*, **7** (2): 167 – 171.

Kormos, T. 1917. Die pliozänen Schichten von Ajnacskö und ihre Fauna. *Jber. ung. geol. R.-Anst.*, (1915): 564 – 582.

Krenner, J. S. 1867. Ajnacskö ösemlösei. *Magyar Földtani*, **3**: 113 – 132.

Lindsay, E. H., Opdyke, N. D. & Fejfar, O. 1997. Correlation of selected late Cenozoic European mammal faunas with the magnetic polarity time scale. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **133**: 205 – 226.

Lupták, P. 1997. Upper Jaw Fragment of the *Anancus arvernensis* (Croizet & Jobert, 1828) (Mastodontidae, Proboscidea, Mammalia) from the Villafranchian of Hajnácka, Slovakia. *Geologica Carpathica*, **48** (5): 341 – 343.

Paul, C. M. 1866. Das Tertiärgebiet nördlich von Mátra in Nord-Ungarn. *Jahrbuch geol. R.-Anst.*, **16** (4): 515 – 525.

Pipík, R. 2000. Neogene habitats and freshwater Ostracoda on the territory of Slovakia. *Slovak Geological Magazine*, **6** (2-3): 116 – 119.

Pristás, J. 1992. Kvartér. In: *Vysvetlivky ku geologickej mape Lucenskej kotliny a Cerovej vrchoviny 1 : 50 000*. V. Bezák, J. Bodnár, M. Elecko, V. Konecny, J. Lexa, B. Molák, P. Straka, J. Stankovic, M. Stolár, L. Skvarka, D. Vass, J. Vozár & A. Vozárová. pp. 105 - 115. GÚDS. Bratislava.

Sabol, M. 2001. Villafranchian Locality Hajnácka I: Comparison of Older Data with New Ones. *Slovak Geological Magazine*, **7** (3): 275 – 287.

Schafarzik, F. 1899. Adatok az ajnácsköi csontos ártok geológiai ismer eténez. *Földtani Közlöny*, **29**: 363 – 366.

Szabó, J. 1865. Pogányvár hegy Gömörben mint bazaltkráter. *Math. Term. Közlöny*, **3**: 334 – 335.

Uher, P., Sabol, M., Konecny, P., Gregánová, M., Táborsky, Z. & Puskelová, L. 1999. Sapphire from Hajnácka (Cerová Highlands, southern Slovakia). *Slovak Geological Magazine*, **5** (4): 273 – 280.

Vass, D., Konecny, V., Túnyi, I., Dolinsky, P., Balogh, K., Hudácková, N., Kovácová-Slamková, M. & Belácek, B. 2000. Origin of the Pliocene Vertebrate Bone Accumulation at Hajnácka, Southern Slovakia. *Geologica Carpathica*, **51** (2): 69 – 82.