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# Reghínio, a new mammal locality from the Plio-Pleistocene of Central Greece

**Athanassios Athanassiou,** Athens

With 4 figures and 2 tables

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**Abstract:** A new fossil mammal locality is described. It was discovered in fluvio-lacustrine sediments in the area of the village of Reghínio in Lokrís, Central Greece. The fossil mammal remains comprise a partially preserved large cervid skull, as well as elephant tusk parts, which are referred to *Eucladoceros* sp. and *Mammuthus* cf. *meridionalis* respectively. Based on the material available to date, the locality can be dated to the late Pliocene – early Pleistocene.

**Keywords:** Central Greece, Plio-Pleistocene, Mammalia, Cervidae, Elephantidae, *Eucladoceros, Mammuthus*.

**Zusammenfassung:** Eine neue Lokalität, die fossile Säugetierreste geliefert hat, wird beschrieben. Die Fossilfunde stammen aus limnisch-fluviatilen Sedimenten in der Nähe des Dorfes Reghínio (Lokris, Mittelgriechenland). Es handelt sich um den unvollständig erhaltenen Schädel eines großen Hirsches und um Elefantenstoßzahnteile, die als *Eucladoceros* sp. bzw. *Mammuthus* cf. *meridionalis* bestimmt wurden. Die bis heute verfügbaren Funde zeigen ein spätpliozänes bis frühpleistozänes Alter an.

**Schlüsselwörter:** Mittelgriechenland, Plio-Pleistozän, Mammalia, Cervidae, Elephantidae, *Eucladoceros, Mammuthus*.

## 1. Introduction

The locality of Reghínio is situated in Lokrís (District of Phthiótis, Central Greece) near the homonymous village (Fig. 1). Its altitude is 280 m. The

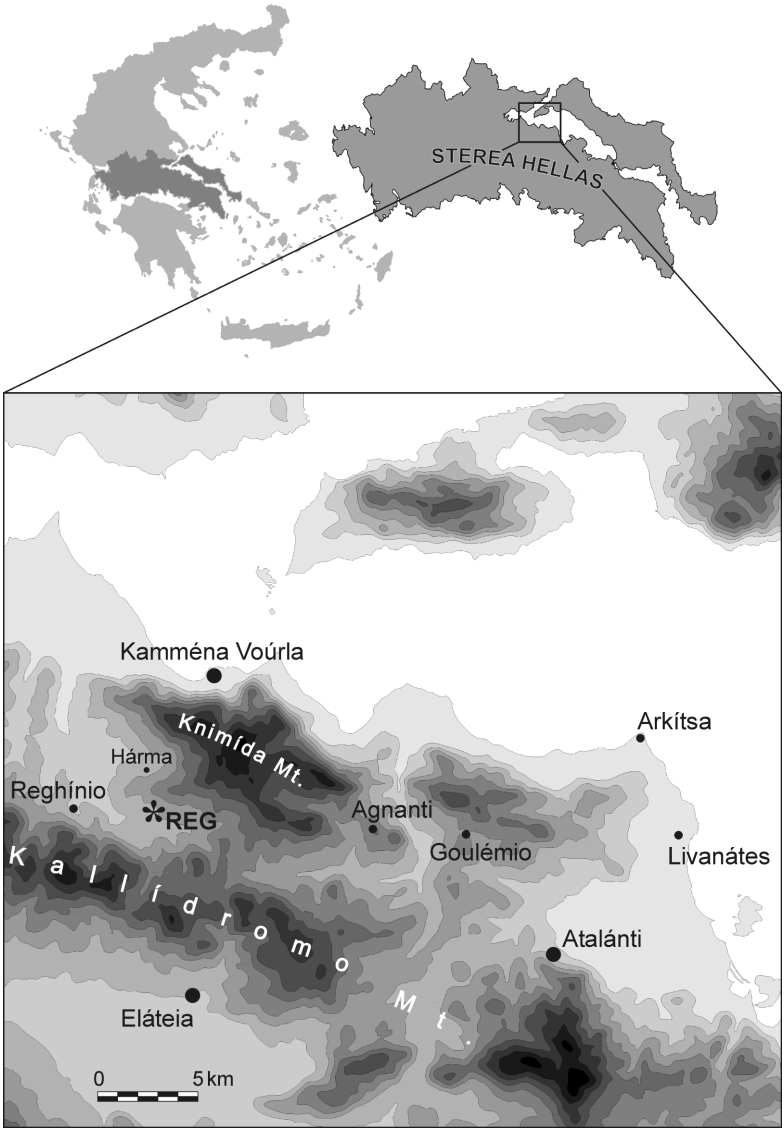


**Fig. 1.** Geographical position (asterisk) of the Reghínio locality (REG). Contour interval: 100 m.

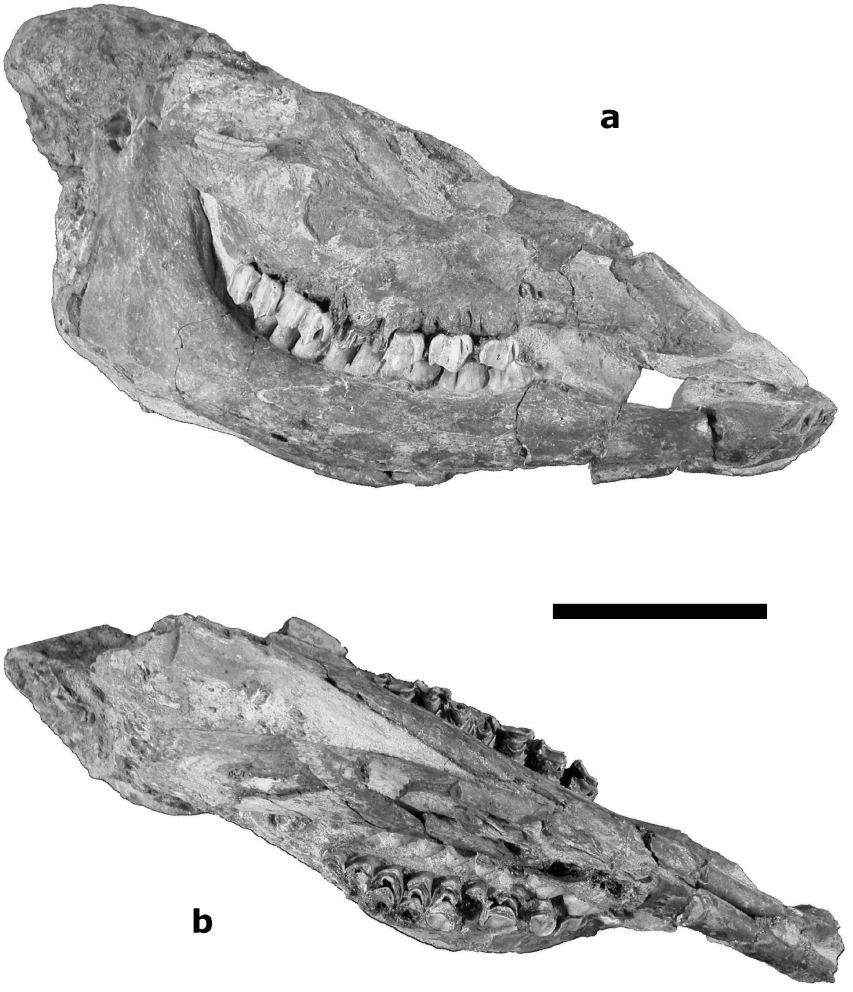


**Fig. 2.** *Eucladoceros* sp. Skull with associated mandible, REG-1: (a) right lateral view, (b) ventral view, scale: 10 cm.

**Table 1.** Measurements of the *Eucladoceros* skull REG-1. L: length, H: height.

| **Cranial measurements** REG-1 | sin | dex |
|---|---|---|
| skull L | >420 | |
| L of the mandible | – | 351.0 |
| L of diastema | – | 106.5 |
| L of symphysis | 40.7 | |
| thickness of mandibular ramus | 20 | 20 |
| min mandibular H | 24.5 | 23.8 |
| mandibular H under $P_2$ | – | 36.4 |
| mandibular H under $P_4$ | – | 36.5 |
| mandibular H under $M_1$ | 41.9 | 41.5 |
| mandibular H under $M_3$ | 42.8 | 43.0 |

site was discovered by local villagers several years ago during agricultural activities, but remained unknown to palaeontologists until quite recently. The findings are scanty, but their good preservation is very promising for the potential fossil content of the site. Though well preserved, the available specimens were unfortunately damaged when local people attempted to collect them, as they were deposited in an extremely hard clayey matrix. Extensive prospecting to find new sites is in progress in the area. The findings are kept in the Archaeological Museum of Lamía.

Lokrís has already yielded fossil mammal remains: Symeonidis (1975) studied remains of *Aceratherium* of late Miocene age, found in the lignitic deposits at Haghii Anárgyri, a locality between the villages Agnanti and Goulémio. In the same area, though in a possibly stratigraphically older conglomerate, the discovery of a late Miocene fossil fauna is mentioned (Lemeille 1977). However, its composition is unknown. Philip (1974) reports the presence of proboscidean, *Equus, Bos* or *Leptobos* and cervid remains in the area of Hárma, which is quite close (about 1500 m) to the new locality, as well as proboscidean remains from an unknown site near Reghínio. Kranis (2003) reports the discovery of a *Hippopotamus* tusk in late Pleistocene deposits at the locality of Toíhos, near the small village of Karavídia.

**Table 2.** Dental measurements of the *Eucladoceros* skull REG-1. LPM: toothrow length, LP: premolar length, LM: molar length, LP/LPM: premolar to toothrow length ratio, LP/LM: premolar to molar length ratio, L: length, l: width.

| **Upper** | | LPM | LP | LM | LP/LPM % | LP/LM % |
|---|---|---|---|---|---|---|
| sin | (max / occlusal) | 127.0 / — | 59.0 / 57.0 | — / — | 46.0 / — | — / — |
| dex | (max / occlusal) | 131.5 / 129.9 | 59.0 / 57.5 | 78.0 / 76.0 | 44.9 / 44.3 | 75.6 / 75.7 |

| **Upper** | $LP^2$ | $lP^2$ | $LP^3$ | $lP^3$ | $LP^4$ | $lP^4$ | $LM^1$ | $lM^1$ | $LM^2$ | $lM^2$ | $LM^3$ | $lM^3$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sin | — | — | — | — | 17.5 | — | 25.7 | — | 27.0 | — | — | — |
| dex | 19.5 | 17.9 | 18.6 | 19.8 | (17.2) | 20.5 | — | — | 26.9 | >23 | 27.0 | — |

| **Lower** | | LPM | LP | LM | LP/LPM % | LP/LM % |
|---|---|---|---|---|---|---|
| sin | (max / occlusal) | 142.5 / 133.7 | 57.5 / 54.0 | 84.4 / 81.5 | 40.4 / 40.4 | 68.1 / 66.3 |
| dex | (max / occlusal) | 142.0 / 135.5 | 58.0 / 54.0 | 87.0 / 84.0 | 40.8 / 39.9 | 66.7 / 64.3 |

| **Lower** | $LP_2$ | $lP_2$ | $LP_3$ | $lP_3$ | $LP_4$ | $lP_4$ | $LM_1$ | $lM_1$ | $LM_2$ | $lM_2$ | $LM_3$ | $lM_3$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sin | 14.4 | — | — | — | 21.5 | — | 23.4 | — | 25.0 | — | 36.1 | — |
| dex | >13.5 | — | 19.9 | — | 21.7 | — | 25.4 | — | 26.0 | — | 35.5 | — |

## 2. Geology

The area of Reghínio is situated in the western part of the Lokrís Basin, which corresponds to a graben and extends between the mountains of Kallí-

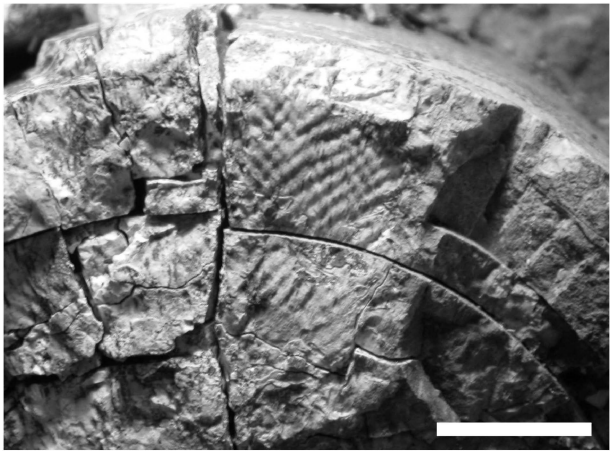

**Fig. 3.** *Mammuthus* cf. *meridionalis*. Section of the tusk REG-2 showing the Schreger pattern; scale: 10 mm.

dromo (to the south) and Knimída (to the north). The basement consists mainly of carbonate rocks (limestones and dolomites) of Middle Triassic-Middle Jurassic age that belong to the so-called 'Sub-Pelagonian Geotectonic Unit'. An ophiolitic series is overthrusted on the carbonates of Kallídromo and Knimída. The basin is filled with a sequence of fluvio-lacustrine deposits (marls, clays, conglomerates, sands, as well as some lignitic layers) of late Miocene-Pleistocene age (KRANIS 2003). They exhibit a generally weak dip to the south (usually about 20-25°) (PHILIP 1974). Their total thickness is several hundred meters, possibly even 1000 m, although more precise estimates are not possible, as the sequence is faulted and most deposits are lenticular, have highly variable thickness, or exhibit lateral transitions.

The deposits of the western part of the Lokrís Basin are divided in two main formations (KRANIS 2003): a) a lower one of Pliocene age, which comprises unconsolidated polymictic or carbonate conglomerates, sands,

clays and marls; b) an upper one of Plio-Pleistocene age, which consists of polymictic conglomerates, marls, sands and clays with lignitic intercalations. The fossiliferous site of Reghínio is placed in the upper formation. The site area is dominated by clays with some breccia intercalations, in which the fossils were found.

## 3. Systematic Palaeontology

Order Artiodactyla OWEN, 1848
Family Cervidae GRAY, 1821
Genus *Eucladoceros* FALCONER, 1868

*Eucladoceros* sp. Fig. 2

Material: REG-1, skull with associated mandible.

Description: The skull is partially preserved, with strong lateral compression and distortion, mainly at the region of the left orbit. It lacks the occipital, parietal and frontal regions, which have been eroded, revealing a natural cast of the brain. The lack of the frontal region does not allow any inference about the presence of antlers, and, consequently, about the gender of the individual. The lacrymal fossa and the ethmoidal vacuities are well developed. The muzzle is rather elongated. The mandible is preserved in sufficiently good condition. The right hemi-mandible lacks only the articular process, while the left one lacks the ascending ramus, as well as the part below the premolars. There is no indication of pachyostosis. The dimensions of the specimen are given in Table 1.

The dentition is typical for a cervid and is characterised by relatively long premolar rows, moderately wrinkled enamel and non-molarised lower premolars. All teeth are in medium-wear stage. The first two upper premolars ($P^2$ and $P^3$) are bilobed, while the $P^4$ consists of one lobe only. All upper teeth have prominent buccal styles that become broader toward the root. The metastyle is weaker in comparison to the other styles. There is a weak protoconal fold in all the upper molars. A rather weak cingulum is formed at the mesial region, as well as between the lobes of the upper molars. There is no cingulum at the upper premolars. The morphology of the lower teeth is not fully observable, as it is not possible to separate the mandible from the skull. The $P_2$ is simple with weakly developed conids and lacks the paraconid. In the $P_3$ the paraconid is not distinct from the parastylid. The second valley is very wide. The metaconid is moderately developed. The fourth valley is very narrow, as the hypoconid and the entoconid are in contact lingually. The

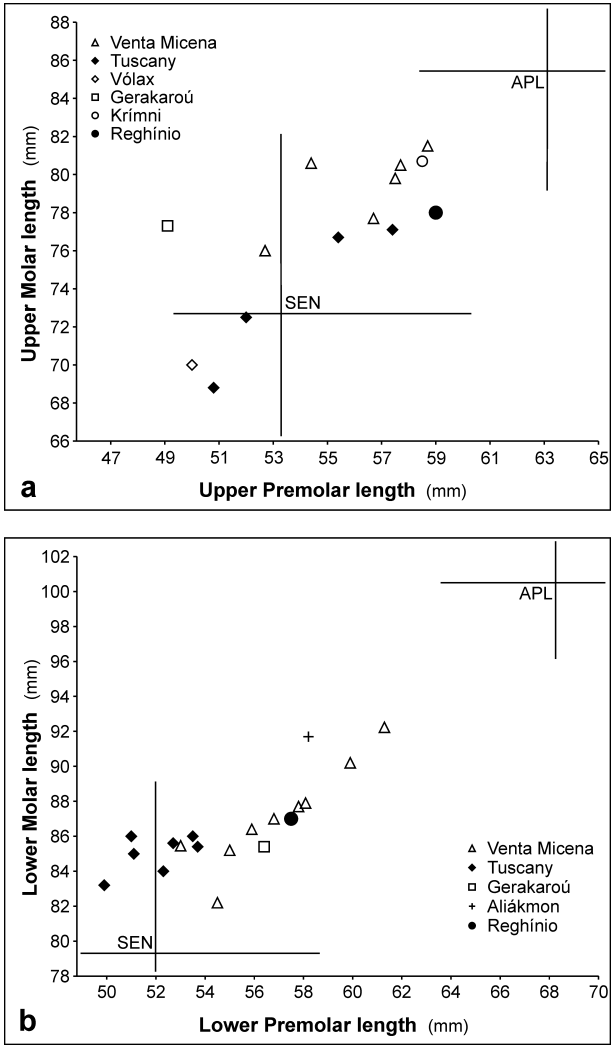


**Fig. 4.** Scatter diagrams comparing the molar with the premolar row of *Eucladoceros* and *Megaloceros* from various European localities: (a) upper dentition, (b) lower dentition. SEN and APL represent the ranges of Senèze and Apollonía samples respectively. Data from HEINTZ (1970), CALOI & PALOMBO (1980), MENÉNDEZ (1987), AZZAROLI & MAZZA (1992a), KOSTOPOULOS (1996, 1997a, 1997b).

morphology of the $P_4$ is quite similar. However, the paraconid is more developed but still not distinct from the parastylid, leaving only a trace of the first valley. The metaconid is very well developed and bifurcated, but it does not fuse with the adjacent conids. The lower molars have an ectostylid, which weakens from $M_1$ to $M_3$, as well as a cingulum at their proximal region and between the lobes. The dental dimensions of REG-1 are given in Table 2.

Order Proboscidea ILLIGER, 1811
Family Elephantidae GRAY, 1821
Genus *Mammuthus* BURNETT, 1830

*Mammuthus* cf. *meridionalis* (NESTI, 1825)

Material: REG-2, REG-3, partial tusks ($I^2$).

Description: The REG-2 is a 40 cm long partial tusk, corresponding to the proximal region of the tusk. The cross section is subcircular, with minimum and maximum diameters of 20 and 22 cm. The REG-3 is about 50 cm long and its minimum and maximum diameters are 19 and 21 cm. Both specimens exhibit moderate bend and torsion. The Schreger pattern (PALOMBO & VILLA 2001, TRAPANI & FISHER 2003) is clearly visible on the section surface of both specimens, mainly near the periphery (Fig. 3). The Schreger outer angles range from 80° to 92°, while near the tooth axis the angles are considerably more acute.

## 4. Discussion

The size of the cervid skull suggests a large deer. With the exception of the morphologically aberrant *Alces*-like cervids, two large-sized deer genera are known from the Plio-Pleistocene: *Eucladoceros* FALCONER, 1868 of Pliocene-early Pleistocene age and *Megaloceros* BROOKES, 1828, of primarily middle-late Pleistocene age, the latter comprising two groups, the "*M. giganteus*" and the "*M. verticornis*" group. The distinction between the two genera, as well as their species-level taxonomy, are mainly based on antler morphology. *Megaloceros* is also generally larger in size, having more robust limb bones and exhibiting pachyostosis of the mandibular ramus. However, these characters are not always well pronounced, especially in the early representatives of the genus. The dental morphology does not offer any diagnostic character either. The lack of antlers associated with the studied skull does not allow a direct attribution to any of these large-sized genera. Never-

theless, some of its morphological characters can provide clues about its taxonomic affinities: The skull from Reghínio has a slender mandible, much thinner than any *Megaloceros* mandible (CALOI & PALOMBO 1980, KAHLKE 1997). Moreover, its dentition is generally smaller and has a high premolar/molar ratio in comparison to *Megaloceros* (AZZAROLI 1948, CALOI & PALOMBO 1980), except for some material from England (*Megaloceros dawkinsi*) (AZZAROLI 1953) and Italy (Muratella di Mezzo) (CALOI & PALOMBO 1980); even the relatively small *Megaloceros boldrinii* has a longer dentition (AZZAROLI & MAZZA 1992b). The big cervid from Venta Micena, described by MENÉNDEZ (1987) as *Praemegaceros solilhacus*, has a size comparable to that of the studied skull (Fig. 4), but its taxonomy was later revised to *Eucladoceros giulii* (KAHLKE 1997). *Megaloceros* dentitions are already known in Greece from Megalópolis (SICKENBERG 1976), Petrálona (TSOUKALA 1989) and Apollonía (KOSTOPOULOS 1997a, CROITER & KOSTOPOULOS 2004). The former two samples consist of fragmentary single specimens. All three samples are larger in dimensions than the studied material, especially in the molar section (Fig. 4). The taxonomy of the large-sized deer from Apollonía has been disputed (VAN DER MADE 1999), while CROITOR & KOSTOPOULOS (2004), in a revision of this material, refer a part of it to *Arvernoceros* sp., a rare, late Pliocene genus that is supposed to have survived into the Pleistocene in Eastern Europe. However, for the purposes of this paper the Apollonía sample will be considered as *Megaloceros* sp.

The genus *Eucladoceros* is considered by DE VOS et al. (1995) to comprise three species in Europe: *E. tetraceros, E. dicranios,* and *E. ctenoides*, characterised by antler morphology. KAHLKE (1997) added another species, *E. giulii*, based mainly on the limb bone morphology. A detailed metrical comparison of the studied skull with similar, already published, *Eucladoceros* specimens is not possible, due to the considerable distortion and incomplete preservation of REG-1. A comparison of the dental dimensions of the studied skull with the large sample of *Eucladoceros ctenoides* from Senèze (HEINTZ 1970) reveals the former to be close to the maximum values of the Senèze size range (Fig. 4). This is also the case for the *Eucladoceros* samples from Saint-Vallier and La Puebla de Valverde (HEINTZ 1970). [Note that HEINTZ (1970) measured the dental rows on the occlusal surface]. The samples from Tuscany described by AZZAROLI & MAZZA (1992a) differ mainly in being slightly smaller and having a somewhat shorter premolar section. Dental remains of *Eucladoceros* are already known from the Greek localities of Aliákmon Q-Profil, Dafneró, Gerakaroú, Krímni and Vólax (STEENSMA 1988, KOSTOPOULOS 1996, KOSTOPOULOS 1997b, KOSTOPOULOS & ATHANASSIOU 2005). A collection of isolated teeth from Libákos (STEENSMA 1988) may also belong to *Eucladoceros.* The dentition of REG-1 is metrically close to these samples. The upper dentitions from Gerakaroú

and Vólax have, however, a proportionally shorter premolar row and smaller dimensions (Fig. 4).

The preserved proboscidean tusk parts are rather small, which makes their identification difficult. Their moderate bend and torsion points towards the genus *Elephas,* as well as to the early forms of *Mammuthus* (particularly *M. meridionalis*), as the late Pleistocene *M. primigenius* possesses strongly bent tusks. Thus, more data are necessary for a generic attribution: The study of the ivory internal structure has been enhanced recently, providing good criteria for the identification of the proboscidean tusks, based on the Schreger pattern (PALOMBO & VILLA 2001, TRAPANI & FISHER 2003). The Schreger pattern is a characteristic feature of proboscidean dentin, usually visible in tusk cross sections as intersecting spiral lines. The morphology of these lines differs among proboscidean taxa, offering a useful discriminating character. The angles formed by the intersecting lines near the periphery of the cross section are most often used for this purpose. The acute-to-right angles formed by the Schreger lines near the dentine/cement junction in the studied tusk fragments suggest an attribution to *Mammuthus*. In *Elephas* these angles are well obtuse; in *Anancus* they are acute, but do not change significantly from the pulp cavity to the dentine/cement junction as they do in the studied specimens; in *Mammut* they reach their maximum values of more than 100° about halfway between the pulp cavity and the dentine/cement junction (PALOMBO & VILLA 2001, TRAPANI & FISHER 2003). Considering the above morphological data, the proboscidean tusks from Reghínio certainly represent an early *Mammuthus*. Although their association with *Eucladoceros* points to a probable attribution to *M. meridionalis*, the material is inadequate for a positive specific determination. *M. meridionalis* is a quite common proboscidean species of late Pliocene – early Pleistocene age.

## 5. Conclusions

The new locality of Reghínio yielded mammal remains, which are referred to *Eucladoceros* sp. and *Mammuthus* cf. *meridionalis*. The currently available material is still insufficient for a detailed biochronological and palaeoecological study. Nevertheless, the locality can be dated to the late Pliocene-early Pleistocene. Palaeoecologically, the presence of deer usually points towards a forested environment, while *Mammuthus* is a woodland form. This probably indicates a mixed or woodland environment for the Reghínio area during the Plio-Pleistocene.

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## Address of the author:

ATHANASSIOS ATHANASSIOU, Hellenic Ministry of Culture, Department of Palaeo-anthropology-Speleology, Arditou 34 B, GR-11636 Athens, Greece;
E-mail address: aathan@cc.uoa.gr