

Preliminary remarks on the Late Miocene herbivores of Kerassiá (Northern Euboea, Greece)

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Recent systematic excavations are in progress near the village Kerassiá in Northern Euboea. Since 1992, when the first excavations were carried out by the University of Athens (Department of Historical Geology and Palaeontology), a number of fossiliferous sites have been discovered in the area of Kerassiá. In the present report we discuss the available results, mainly concerning the three richest sites until now, Kerassiá 1 (K1), Kerassiá 3 (K3) and Kerassiá 4 (K4). The fauna is characterised by the relative scarcity of the hipparions and especially of bovids. Though the presence of these taxa is significant, there are fewer specimens than usually in the Greek Late Miocene localities. The bovids are represented mainly by dental material making their identification doubtful. Most of the Giraffidae are referred to *Helladotherium*. The rhinocerotid findings include some very rare and impressive specimens (complete skulls and mandibles), but the postcranial material is scanty. A complete skull with articulated mandible from the K4 site is attributable to a new aceratherine species. Another complete, but juvenile, skull from K3 has all the morphological characters of *Ceratotherium neumayri*, while a complete mandible from K4 is referred to '*Dicerorhinus*' cf. *pikermiensis*. The available carnivore material is discussed separately in this volume. The fauna suggests a fairly open environment, as the forest elements (suids, cervids, etc.) are rare or absent. The geological correlation, the sedimentological and taphonomic studies of the Kerassiá sites are still in progress. However, according to the available data the K3 and K4 are plausibly isochronous, as they seem to belong to the same stratigraphic level; the K1 is stratigraphically younger. The locality is of great taphonomic interest, as the material has signs of sorting.

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INTRODUCTION

The continental Neogene of Greece is renowned for its fossil record, mainly because of the rich localities of Pikérmi, Sámos and Axiós Valley. Numerous other large mammal localities of Miocene age are present in the Greek fossil record, comprising the well-known *Hipparion*-fauna. Some of these localities are situated on Euboea Island: Limni, Hagía Anna, Rhoviés, Achládi, Eria, Prokópi,

Halmyropótamos and Palaeóvrissi (Cordella 1878, Woodward 1901, Déprat 1904, Mitzopoulos 1947, Melentis 1970a, 1970b, Jacobi 1982). Most of them are found in the northern part of the island (Fig. 1). The fossil bone beds of Kerassiá were tracked down in 1981 by R.W. Köhler, during geological fieldwork in the area. However, some fossil bone outcrops were already known to local people since 1966, after a road cut north of

the village. The first excavation in the area was carried out in 1982 by Hans de Bruijn, Albert van der Meulen (University of Utrecht) and Constantine Doukas (University of Athens). This was not followed by other fieldwork until 1992, when the University of Athens began new field studies in the locality. Until now, seven fossil mammal sites have been found and have been partly excavated. Three of them are very important, as they are very rich in fossils. Unfortunately, the preservation of the fossils is usually very bad, making their excavation and preparation very difficult and time consuming. The material from Kerassiá, including the 1982 excavation, is temporarily stored in the Museum of Palaeontology and Geology of the National and Kapodistrian University of Athens. In the future it will be exhibited in a new local museum that is planned by the local prefecture.

Fossil findings from Kerassiá are until now known from the unpublished dissertation of Köhler (1983), from a brief description of suids in Van der Made & Moyà-Solà (1989), as well as from three preliminary congress

presentations (Theodorou *et al.* 1995, 1998, 2001). Köhler (1983) reports the presence of *Microstonyx* sp., Bovidae, Giraffidae, two species of *Hipparion*, two species of Proboscidea and a large carnivore. Van der Made & Moyà-Solà (1989) attribute the described material to *Microstonyx major erymanthius* and they also mention the presence of *Deinotherium* and *Dorcatherium* in the locality. They give a middle Turolian age for Kerassiá. Though they do not give any data about the provenance of the material, it is very probable that it comes from the 1982 excavation. In the present paper we report the preliminary results on the faunal composition and the stratigraphy of the locality. The material from the 1982 excavation is not included, as the exact collection site is not known.

GEOLOGICAL SETTING

Euboea is a large island of central Greece (Fig. 1), which is separated from the mainland through a narrow sea channel. The island is covered by extensive Neogene, mainly continental, deposits that overlay

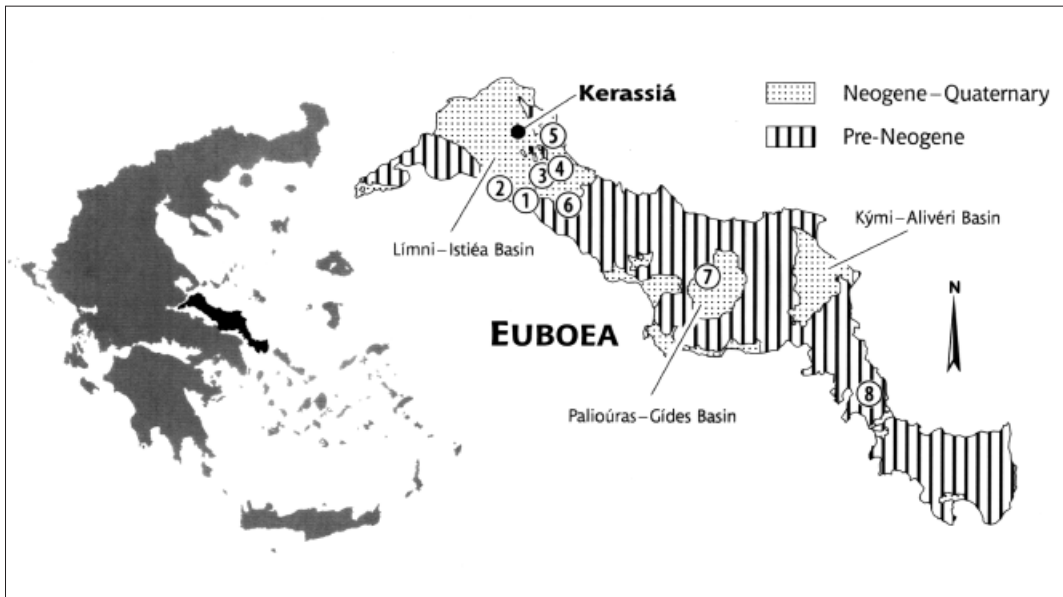


Figure 1. Geographical position of Euboea Island and Kerassiá locality, with a simplified geological map of Euboea showing the position of the three major Neogene sedimentary basins of the island (based on the map of Katsikatsos *et al.* 1981). The other known Neogene mammal localities of Euboea are indicated by numbers: **1**: Límní, **2**: Rhoviés, **3**: Palaеоvrissi, **4**: Hagía Anna, **5**: Achládi, **6**: Prokópi, **7**: Eria, **8**: Halmyropótamos.

Mesozoic sedimentary and igneous rocks of the Pelagonian geotectonic zone. Katsikatsos *et al.* (1981) group the Neogene deposits in three major sedimentary basins (Fig. 1): the Alivéri-Kymi basin, the Palióúras-Gídes basin and the Límní-Istiéa basin. All three are in general very similar lithologically, showing a lower low-energy sequence of fine-grained lacustrine sediments (silts, clays), often with lignite intercalations, and an upper high-energy sequence of generally coarse-grained fluvial sediments (sands, conglomerates, marls, travertines, marlstones).

The Límní-Istiéa basin is the most extensive of the three mentioned above; it occupies the northernmost part of the island. Its geology and stratigraphy have been described by Mettos *et al.* (1991). According to these authors the basin is mostly filled with Late Miocene – Late Pliocene sediments, which have been unconformably deposited on the Early Miocene sediments. The locality Kerassiá is situated in the middle of the basin (Fig. 1). The area is covered by reddish-brown deposits, that are placed in the lower part of upper (fluvial) sequence (Mettos *et al.* 1991, Fig. 2). In this part of the basin the basement consists of Early Cretaceous ophiolites.

STRATIGRAPHY OF THE LOCALITY

The geological prospecting in the area of Kerassiá has proved the presence of numerous fossiliferous sites. Those excavated up to now, K1 to K7 (Fig. 2), are situated north of the village. They belong to the so-called "reddish-brown fluvial deposits" (Mettos *et al.* 1991) in the lower layers of the upper sequence of the Límní-Istiéa Basin. The lower sequence, as well as the ophiolitic basement, are exposed NE of the village Kerassiá. The superposed reddish-brown fluvial deposits include clays, conglomerates, sands, and siltstones in succession. Their total thickness is about 250–300 m. The relative stratigraphic position of these seven sites,

which is crucial for the comparison of their fossil content, is still under investigation. We tried to trace distinctive layers in the sections for this purpose. The sedimentological samples under study (Iliopoulos, in prep.) give additional data to identify the several horizons and make correlation easier.

The site K1 was excavated in summer 2000 and quite probably represents the site of the first fossil collection in 1982, which is mentioned here as KER. The material of the old excavation is still unpublished, but information by Doukas (pers. comm. 2000), villagers, a map in Köhler (1983), as well as the state of preservation and fossilisation of the old and the new material, support this hypothesis. The other six sites were located and excavated in part during the fieldwork in the area since 1992. K2 is situated in the same section as K1, but in a lower level (about 6.5 m lower), showing that there are at least two fossiliferous horizons in the locality. K2 and K3 are close together and they belong to the same stratigraphic level, as they are found in the same undisturbed section. These two sites can be correlated to K4, as all three share the same sedimentological characters (brown silted mud with few scattered rounded to sub-rounded, polymict grains in a homogeneous matrix), the presence of a red-brown layer above the bone bed, and also the presence of the same trace fossils (roots, insect burrows etc.). K6 is isolated and poor in material, but it possibly correlates with K1, because of the presence of a thin grey-white marly layer above the fossiliferous layer. The sites K5 and K7 (K7 was excavated for the first time in summer 2000 and its study is only in the beginning) cannot be correlated at the moment to either the upper or the lower fossiliferous level.

Summarising, the currently available data permit us to group the sites into two fossiliferous levels, an upper and a lower one. The upper fossiliferous level comprises the sites K1 and K6 and the lower one the sites K2, K3 and K4 (Fig. 3). The relative position of K5 and of the newly discovered K7 is cur-

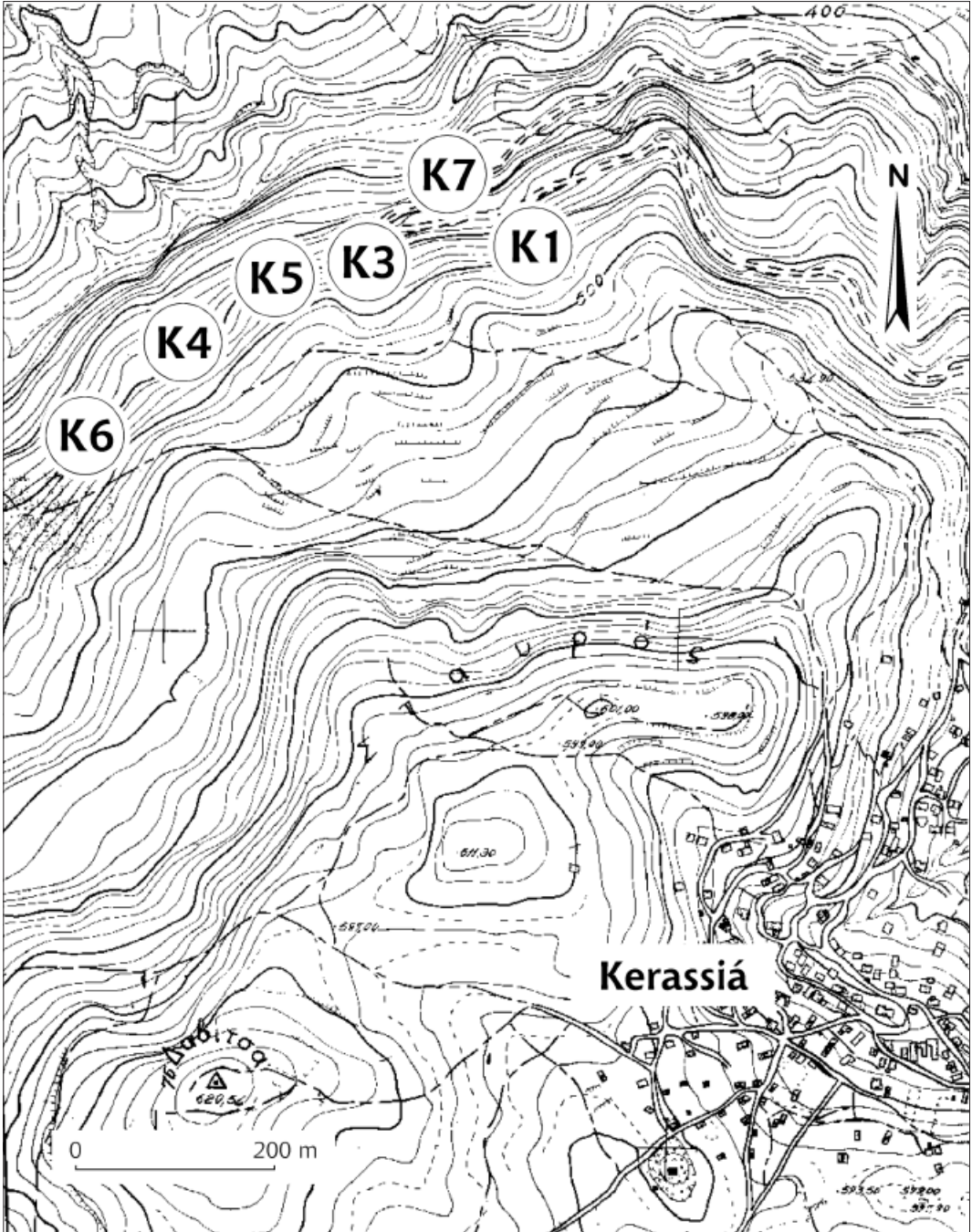


Figure 2 Topographical map of the Kerassiá area, indicating the position of the sites K1–K7. The position of K2 coincides with this of K1.

rently under study.

SYSTEMATICS

The herbivores in the fauna of Kerassiá are mainly Equidae, Rhinocerotidae, Bovidae and Giraffidae. *Hipparion* is the most frequent genus, though it is not abundant as in other Greek Late Miocene faunas. The carnivore material is not considered here, as it is studied by Roussiakis & Theodorou (2003).

Proboscidea ILLIGER, 1811

Proboscidean remains are already mentioned in the locality by Köhler (1983), who reports the presence of two species, and by Van der Made & Moyà-Solà (1989) who mention the presence of *Deinotherium*. The new finds are rather scarce. A mastodont tusk (Fig. 4f) of large size (length following the tooth bend: >189 cm; maximal perimeter: 52 cm) is the only finding at K6. The specimen has circular cross section, moderate bend, and shows no torsion and no trace of enamel band.

Theodorou *et al.* (2001) refer it to *Choerolophodon* sp., as the other genera that lack the enamel band (*Mammut*, *Tetralophodon*) have generally more straight tusks. Another tusk of small dimensions (length following the tooth bend: >132 cm; maximal perimeter: 28 cm) from site K1 is preserved in bad condition. Because of its moderate bend, it could be attributed with reservation to ?*Choerolophodon* sp.

The site K4 has yielded a lower molar (plausibly the d4) and a partly preserved scapula of very large dimensions. The molar is bunodont, with four lophids and a fairly small talonid, thick enamel with smooth surface, without cement in the tooth valleys. The interlophid valleys are blocked by conules that are mainly situated in the median part of the occlusal surface, between each pretrite pair. The maximal tooth dimensions are 87 mm (DAP) and 49 mm (DT). The specimen is referred by Theodorou *et al.* (2001) to *Tetralophodon* cf. *longirostris*, because of the presence of four lophids and the absence of cementodonty, choerodonty (conid multipli-

cation), ptychodonty (furling of the enamel surface) and anancoidy (alternation of the mammillae). The scapula, which is characterised by very robust spine and acromion, shows some resemblance to *Deinotherium*. However, its bad preservation does not allow any certain generic attribution. Some proboscidean findings kept by villagers have not been prepared or studied.

Artiodactyla OWEN, 1848

Suidae GRAY, 1821

Köhler (1983) reports *Microstonyx* sp. Van der Made & Moyà-Solà (1989) describe dental material of a small sized *Microstonyx major erymanthius* that possibly comes from the upper fossiliferous level. No suids have been found yet in the lower level (sites K2, K3, K4). Kostopoulos *et al.* (2001), comparing the suid material from the 1982 excavation, propose that this probably consists a new subspecies. They suggest that it belongs to a small sized form, probably related with the Maragha suid and different from the typical and larger *M. major erymanthius*. Our recent excavations at K1 yielded inadequate dental material.

Giraffidae GRAY, 1821

Findings attributed to the family Giraffidae are common in Kerassiá, in both fossiliferous levels and in most sites. The family is mainly represented by remains of *Helladotherium*, upper and lower tooth rows, as well as postcranial material, but *Palaeotragus* sp. is also found. A third species, probably *Bohlinia* sp., which comes from the old collection, is being studied by Iliopoulos (in prep.). The material of *Helladotherium* comprises cranial and postcranial specimens. They are generally indistinguishable (either morphologically or metrically) from *Helladotherium duvernoyi* (GAUDRY & LARTET, 1856) from Pikérmi. The material consists of an almost complete right hemi-mandible with p2–m3, a part of a left mandibular ramus with m2–m3, a distal tibial part, two complete Mt III–IV (Fig. 4d) and a proximal part of the same bone, an almost

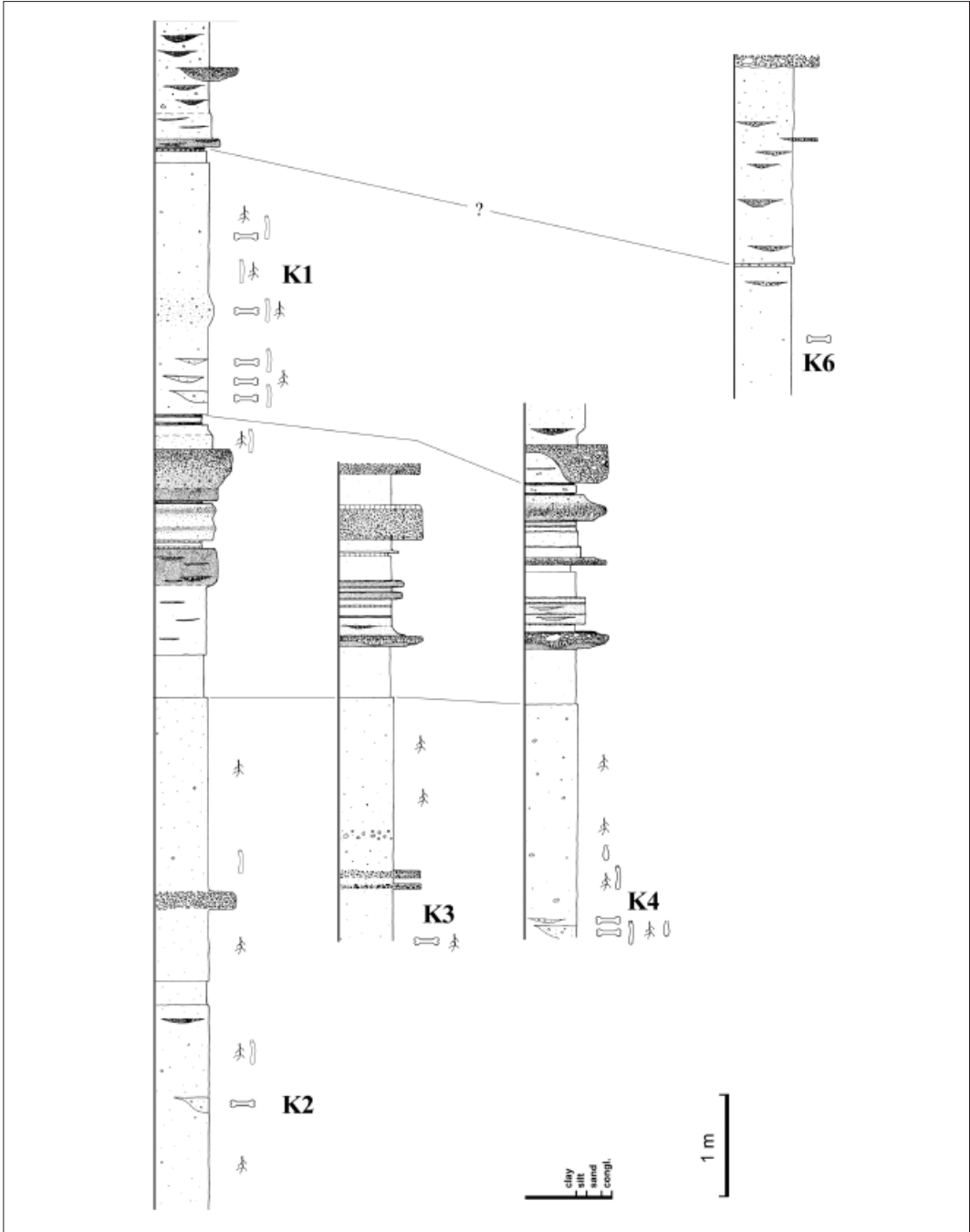


Figure 3 Stratigraphic columns of the sites K1–K2, K3, K4 and K6.

complete left humerus, three complete radii, three proximal and one distal radial parts, one complete and one broken astragalus, two complete Mc III-IV and three distal parts of the same bone.

The two mandibular specimens plausibly belong to the same individual, as they were found next to each other. The p2–m3-length is 245.0 mm, of which 97.4 is the premolar length and 148.4 is the molar length. The premolar length in relation to the molar and the toothrow lengths is 65.6% and 39.8% respectively. The p3 and p4 are molarised. The p2 shows the typical artiodactyl morphology. The molars have generally weak lingual stylids. The third lobe of m3 is round. The postcranial material is represented by significant number of specimens. The limb bones indicate large and very robust animals.

In comparison to other known *Helladotherium* specimens, and especially *H. duvernoyi* from Pikérmi, the studied specimens are very similar. A marked difference is the molarisation of p3, which is not observed in the known specimens of the genus (Pikérmi, Maragha, etc.). The not molarised p3 is considered as a diagnostic character for the genus and of the Sivatheriini in general (Bohlin 1926, Geraads 1986). However, the known *Helladotherium* specimens that retain the p3 are very few, so the variation of the genus regarding the morphology of this premolar is probably not well known.

The genus *Palaeotragus* GAUDRY, 1861 is very common in Eurasian and Greek faunas of Late Miocene age. In Kerassiá it is present in all three major sites (K1, K3, K4). The available material consists of six mandibular parts, a distal humerus part, a proximal Mt III-IV part, one complete Mc III-IV (Fig. 4c) and four proximal parts of the same bone, one complete and four partly preserved astragali and one scaphocuboideum. The total lower tooth row length is 158.8 mm, of which 66.5 mm is the premolar and 92.4 mm the molar length. The indices $Lp2-p4 / Lm1-m3$ and $Lp2-p4 / Lp2-m3$ are 72% and 42% respectively. The p4 is molarised, while the

p3 shows only a feeble molarisation. The molars have triangular labial cuspids, especially the hypoconid. The third lobe of m3 is rounded. The long bones are slender. The robustness index of the complete metacarpal is 8.4.

Bovidae GRAY, 1821

The bovid material curiously comprises mainly dental remains; postcranials are relatively rare, while the horn cores are practically absent. An almost complete skull that comes from the excavations of 1982 is referred to *Gazella* sp. (Iliopoulos in prep.). Other specimens attributable to the same species are several tooththrows and some cranial fragments, while the horn core and postcranial material is relatively scarce. In general the bovid material can be divided to four size groups, based on the dental samples. A partial skull from K1, with both horn cores but without teeth, is referred to *Tragoportax* cf. *amalthea* (Fig. 4b). It possesses slightly twisted and laterally compressed horn cores with an anterior keel, almost flat lateral surface and convex medial one. All these characters can be found in *Tragoportax amalthea* (ROTH & WAGNER, 1854) and *T. rugosifrons* (SCHLOSSER, 1904). The presence of postcoronular fossae, however, makes the present skull more similar to *T. amalthea*, since *T. rugosifrons* lacks them (Bouvrain 1994).

Apart from the mentioned artiodactyls, Van der Made & Moyà-Solà (1989) also mention the presence of *Dorcatherium* in the locality.

Perissodactyla OWEN, 1848

Equidae GRAY, 1821

The family is represented by *Hipparion* (Fig. 4e), which is the most common genus in Kerassiá. The findings include dental and postcranial material, which have not been studied yet. The metapodial sample seems to represent two groups, a slender and a relatively robust one. However, this observation has to be statistically proved. The study of *hipparions* is very critical for the biostratigraphic correlations and biochronology of the

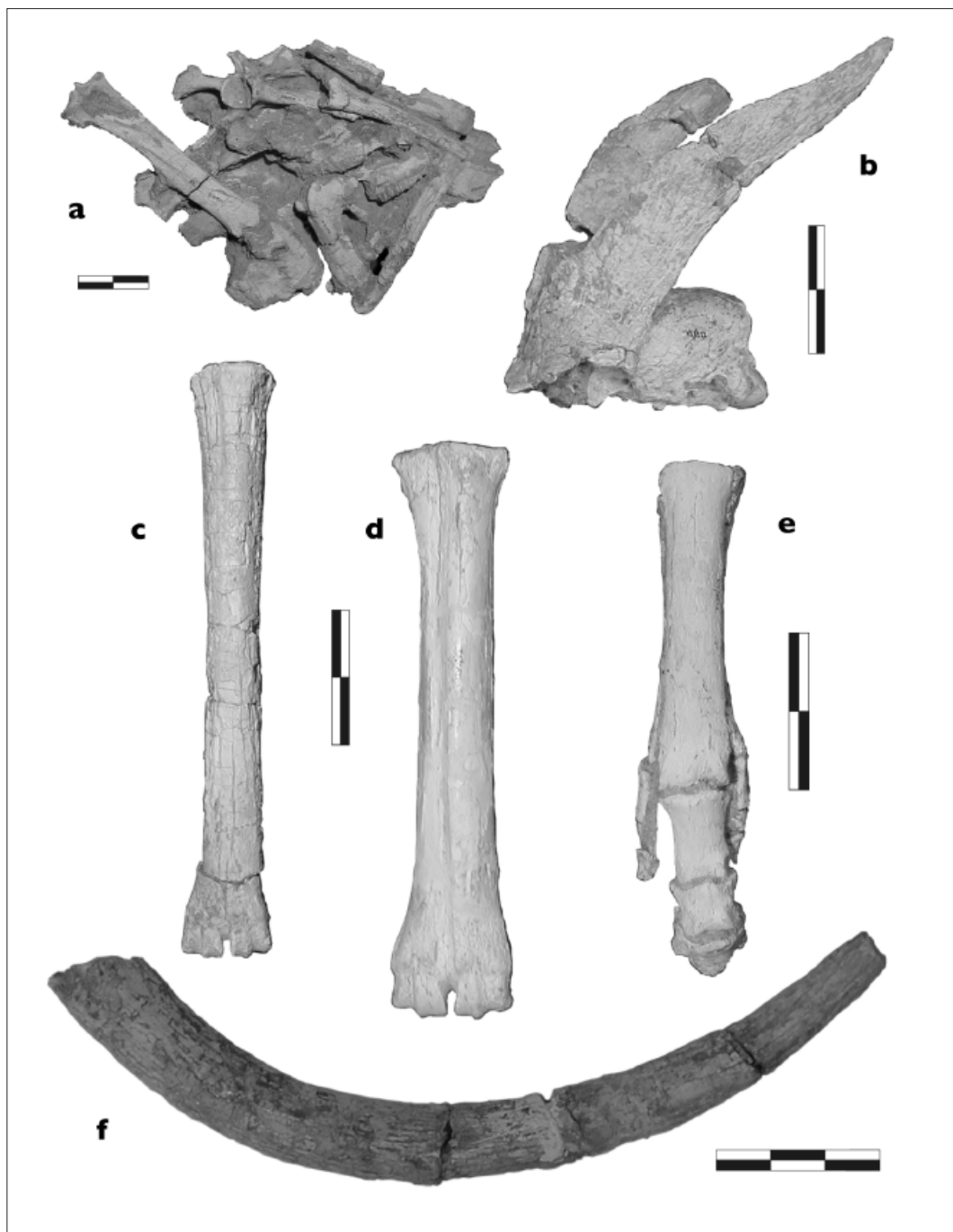


Figure 4 **a**- partly prepared bone-bearing block, showing the distribution of bones in the sediment; **b**- *Tragoportax* cf. *amalthea*, cranium part with both horn cores, K1/12, lateral view; **c**- *Palaeotragus* sp., right metacarpal III-IV, K4/331.5; **d**- *Helladotherium* cf. *duvernoyi*, right metatarsal III-IV, K1/83; **e**- *Hipparion* sp., right metacarpals II-IV and phalanges, K4/67.1; **f**- *Choerolophodon* sp., tusk, K6/1. Tusk scale: 30 cm, all other scales: 10 cm.

Late Miocene localities. Kerassiá postcranial *Hipparion* material is still insufficient for biometrical purposes.

Rhinocerotidae OWEN, 1845

Some of the most impressive findings at Kerassiá belong to this family. Two complete skulls and two complete mandibles have been found, as well as some postcranial bones. The first skull comes from K3 and it belongs to a juvenile individual. It has both toothrows with D1–D4 and the erupting M1. The skull is characterised by the low position of the orbit, the absence of any contact between the lachrymal and the nasal bone and the position of the post-tympanic processes, which do not project laterally more than the post-glenoids ones. The occipital is not yet fused to the other cranial bones (it was found separately) and it has a rectangular aspect in posterior view. The deciduous teeth are characterised by the presence of crista and crochet and the absence of antecrochet. The metaloph is generally not parallel to the protocone. Both M1 are completely unworn; they have a crochet but no crista. The specimen has many common characters with *Ceratotherium neumayri* (OSBORN, 1900) and it is attributed to this species.

The second skull belongs to an adult aceratheriine. It was found in K4. The skull is low and elongated. It is characterised by very thin nasals, high position of the orbit and deep jugular. The mandible is slender, with very short diastema and symphysis, and it is associated to the skull. The specimen has complete tooth rows. The tooth morphology is, however, not well observable, as the mandible is in life position. The lower incisors are relatively large in size, though much smaller than in other hornless rhinoceroses, like *Chilotherium*. The general aspect of the skull, which does not show sufficient similarities with the other known hornless rhinoceroses, suggest that it very possibly represents a new species.

Two mandibles, coming from K4 and K5, retain both rami and most of the teeth. The

specimens are fairly strong and characterised by long symphysis and straight lower border. Both belong to aged individuals and their teeth are very worn and not well preserved. Their morphology is similar to that of '*Dicerorhinus*' *pikermiensis*.

Chalicotheriidae GILL, 1872

A distally broken third metacarpal from K1 and a complete second metatarsal from K4 can be referred to *Ancylotherium* sp. The metacarpal is broken at the level of the distal condyles, but its total length can be estimated to 140–150 mm, smaller than the length of the corresponding bone of *Ancylotherium pentelicum* (GAUDRY & LARTET, 1856) from Pikémi or Sámos. On the contrary, the second metatarsal from K4 is slightly large (about 150 mm) compared to *A. pentelicum*. However, the size range of the second metatarsal of this species is known from very few specimens (Roussiakis & Theodorou 2001). Both specimens are proximally not very well preserved, and their morphological characters cannot be clearly observed.

Tubulidentata HUXLEY, 1872

Orycteropodidae BONAPARTE, 1852

A nearly complete mandibular ramus with broken teeth, which comes from K1, is referred to *Orycteropus* sp.

BIOCHRONOLOGY - PALEO-ECOLOGY

The currently available data on the fauna of Kerassiá (Table 1) can give some clues about the age of the locality. Van der Made & Moyà-Solà (1989) already gave a possible dating of late MN12 for the first findings of the locality, considering the relatively small size of the studied *Microstonyx* specimens, together with the presence of *Deinotherium* and *Dorcatherium*. Kostopoulos *et al.* (2001), comparing the *Microstonyx* material coming from the excavation of 1982, also date Kerassiá to MN12. However, the generally bad conservation of fossils that makes their specific determinations very doubtful, does

Table 1 Faunal content of the excavated sites at Kerassiá. KER represents the old collection of 1982 and K1 to K6 the sites excavated from 1992 onwards. K1 and K6 belong to the upper fossiliferous level; K2, K3 and K4 belong to the lower fossiliferous level. The stratigraphic position of K5 is yet unknown.

	KER	K1	K2	K3	K4	K5	K6
Carnivora							
<i>Machairodus giganteus</i>					+		
<i>Metailurus cf. parvulus</i>		+					
<i>Adcrocuta eximia</i>		?			+		
<i>cf. Ictitherium pannonicum</i>				+			
<i>Plioviverrops sp.</i>				+			
Proboscidea							
<i>Deinotherium sp.</i>	+						
<i>Tetralophodon cf. longirostris</i>					+		
<i>Choerolophodon sp.</i>		?					+
Artiodactyla							
<i>Microstonyx major erymanthius</i>	+	+					
<i>Palaeotragus sp.</i>		+		+	+		
<i>Helladotherium cf. duvernoyi</i>		+			+		
<i>Bohlinia sp.</i>	+						
<i>Samotherium sp.</i>		+					
<i>Tragoportax cf. amalthea</i>		+					
<i>Gazella sp.</i>	+	+			+		
<i>Dorcatherium sp.</i>	+						
Perissodactyla							
<i>Hipparion sp.</i>		+	+	+	+	+	
<i>Ceratotherium neumayri</i>				+			
" <i>Dicerorhinus</i> " <i>cf. pikermiensis</i>					+	+	
Rhinocerotidae sp. nov.					+		
<i>Ancylotherium sp.</i>		+			+		
Tubulidentata							
<i>Orycteropus sp.</i>		+					
Aves							
Genus and sp. indet.					+		

not allow any precise age estimate. The carnivores show a Turolian age (Roussiakis & Theodorou 2003). The proboscidean remains are rather scanty to give any precise biochronological data. *Tetralophodon longirostris* is considered of MN8–MN11 age (Göhlich 1999), though Mein (1990) accepts the species presence in MN12 too. *Choerolophodon* has a wide biochronological range that covers

the entire Miocene (Shoshani & Tassy 1996: 338). The artiodactyls are also not very useful, as they mainly consist of dental remains, which cannot be specifically determined. The very large *Helladotherium* mandible, which is very similar but not morphologically identical to *H. duvernoyi*, indicates an MN11–MN13 age (Gentry & Heizmann 1996). Similar is the stratigraphical range for *Palaeotragus*

(MN9–MN12) and *Bohlinia* (MN10–MN13) (Gentry & Heizmann 1996). However, *Tragoportax amalthea* gives a more precise dating of MN11–MN12 (Gentry *et al.* 1999). The rhinocerotids found in Kerassiá have a range throughout the Turolian; '*Dicerorhinus*' *pikermiensis* is present in MN12 and MN13, but it possibly invaded the Eastern Mediterranean area in MN11; *Ceratotherium neumayri* has a wider range of MN9–MN13 (Heissig 1999). Combining the above given data, an MN12 age is plausible for the fauna of Kerassiá, although MN11 cannot be rejected. A biochronological distinction of the two fossiliferous levels found in Kerassiá is not possible for the moment. Some faunal differences do exist between the two levels, as *Microstonyx*, *Orycteropus* and *Bohlinia* are until now absent from the lower level. However, *Bohlinia* and, especially, *Orycteropus* are rare elements in the Late Miocene faunas. The forthcoming study of hipparions will probably solve the problems concerning the biostratigraphy of the locality and the relationships among the several sites.

The numerical dominance of bovids and hipparions in the fauna of Kerassiá indicates an open and rather dry environment. Forest elements as cervids and suids are rare or absent. The giraffids, as well as *Tragoportax*, may have lived in open woodland environments (Gentry *et al.* 1999). A paleoecological shift between the lower and the upper fossiliferous level is possible due to the small differences in the faunal content, but such an assumption requires more material from both levels.

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