

The Late Miocene Mammal Faunas of the Mytilinii Basin, Samos Island, Greece: New Collection

8. Proboscidea

by

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Abstract

Recent excavations in the Mytilinii basin of Samos Island, Greece, unearthed a rich mammal fossil collection. Among the new Samos material, there are some proboscidean remains which are described in the present article. The Samos proboscidean assemblage is comprised of a few dental remains, nevertheless two species were identified: *Choerolophodon pentelici* and *Zygodolophodon turicensis*. The material is compared with other known Miocene proboscideans from Greece and Eurasia, and the geographic and stratigraphic distribution of these two genera is discussed. The biochronological data offered by the two proboscideans corresponds with the other faunal data from Mytilinii basin and suggests a Middle Turolian age, MN 12 (7.1 - 7.0 Ma) for the studied proboscideans.

Keywords: Late Miocene, Samos, Greece, Mammalia, Proboscidea, Systematics.

Zusammenfassung

Neue Ausgrabungen im Mytilinii Becken der Insel Samos, Griechenland, brachten eine reiche Fossilienansammlung von Säugetieren hervor. In dieser neuen Ansammlung gibt es einige Proboscidier, die im vorliegenden Artikel beschrieben werden. Die Proboscidier-Funde von Samos enthalten wenige dentale Reste, nichtsdestoweniger wurden zwei Arten identifiziert: *Choerolophodon pentelici* und *Zygodolophodon turicensis*. Das Material wird mit anderen Proboscidiern des Miozäns verglichen, welche aus Griechenland und aus Eurasien bekannt sind, und es wird die

geographische und stratigraphische Verteilung dieser zwei Gattungen diskutiert. Die biochronologischen Daten, die anhand der beiden Proboscidier-Arten festgestellt wurden, entsprechen der übrigen Fauna im Mytilinii Becken und deuten das mittlere Turolium als Alter, MN 12 (7.1 - 7.0 Ma) für die studierten Proboscidier an.

Schlüsselworte: Obermiozän, Samos, Griechenland, Mammalia, Proboscidea, Systematik.

1. Introduction

The mammal localities of Samos Island have been well-known since the second half of the 19th century (FORSYTH MAJOR, 1888, 1894). Later on, several palaeontologists or fossil dealers excavated on the island and numerous fossils have been unearthed. The Samos mammalian fossils are housed in several European and American museums and institutions today. More data about the excavations and the mammal collections from Samos is given in KOUFOS (this volume), and for the fossiliferous sites in KOSTOPOULOS et al. (this volume).

Among the collected material from Samos the proboscideans are relatively rare. Two proboscidean taxa are mentioned in the first Samos collection: "*Mastodon*" (= *Choerolophodon pentelici*) and "*Mastodon*" (= *Zygodolophodon turicensis*) (FORSYTH MAJOR, 1894). In the Samos faunal lists given by SOLOUNIAS (1981:tab. IV, V), the species ?*Mammut borsoni* (= *Zygodolophodon turicensis* or *Mastodon tapiroides*), *Stegotetabelodon grandincisivus* (= *Tetralophodon longirostris*), *Choerolophodon pentelici* and *Deinotherium* cf. *giganteum* are mentioned, but the individual locality records include only *Tetralophodon longirostris*, *Choerolophodon pentelici* and *Deinotherium* cf. *giganteum* (SOLOUNIAS, 1981:tab. VII). Some years later, BERNOR et al. (1996) mentioned the taxa *Mammut borsoni*, *Tetralophodon longirostris*, *Choerolophodon pentelici* and *Deinotherium giganteum* from the Main Bone Beds of Mytilinii Formation. In the lists of NOW (2007) *Deinotherium giganteum* is noted from Samos and Samos A1, while *Choerolophodon pentelici* is

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listed from Samos A1. Bearing all the above mentioned facts in mind, there is no certain and clear opinion about the Samos proboscideans. The material has never been studied systematically, except for a more detailed study of *C. pentelici*, housed at the NHMW and at the HNHM (SCHLESINGER, 1917, 1922).

The newly collected material is relatively scanty and includes very few dental remains, which are described in the present article. In this study an isolated tooth (PMMS – 53) from the collection of Prof. J. Melentis (Thessaloniki, Greece) was also included. The material is described and compared with other known remains from Greece and Eurasia. The nomenclature of the bunodont teeth is according to TASSY (1983) and of the zygodont teeth according to TOBIEN (1975). All the studied material is housed at NHMA.

Abbreviations:

HNHM = Hungarian Natural History Museum, Budapest
 NHMA = Natural History Museum of the Aegean, Mytilinii, Samos Island, Greece
 MNHN = Muséum National d'Histoire Naturelle, Paris
 NHMW = Naturhistorisches Museum Wien
 MRG = Maragheh, Iran
 MTLA = Mytilinii – 1A, Samos Island, Greece
 MTLB = Mytilinii – 1B, Samos Island, Greece
 PIK = Pikermi, Greece
 PMMS = Palaeontological Museum of Mytilinii, Samos Island, Greece
 SAM = Samos, old collections
 SLQ = Salonique, Axios Valley, Greece (Arambourg-Collection, housed in MNHN)

2. Systematics

Family Gomphotheriidae HAY, 1922
 Subfamily Choerolophodontinae GAZIRY, 1976

Genus *Choerolophodon* SCHLESINGER, 1917

Choerolophodon pentelici (GAUDRY & LARTET, 1856)
 (Pl. 1, figs. 1, 2)

Locality: Mytilinii-1B (MTLB), Mytilinii Basin, Samos, Greece.

Age: Middle Turolian, MN 12 (Late Miocene); 7.1 - 7.0 Ma.

Material: DP2 sin, MTLB-11; maxilla with M1 - M2 dex and M2 sin, MTLB-126.

Description: The DP2 has a triangular occlusal outline with a distolingual enlargement (Pl. 1, fig. 1). The paracone is slightly larger than the protocone and both are joined, forming a large cusp in the mesial part of the tooth. The metacone is much smaller than the mesial main cusp, whereas the hypocone is very weak. There is a strong mesial-mesiolingual cingulum, as well as a distal cingulum, which is more developed on the lingual side. The tooth bears one mesial and one larger distal

root. Moreover, choerodonty and ptychodonty are well-expressed. The maxillary fragment MTLB-126 preserves the right M1 and both M2 which are just erupted (Pl. 1, fig. 2a). The M1 is broken buccally, lingually and distally. The morphology of the left M2 is not well-preserved, so a description is not possible. The palate is relatively narrow and shallow. The anterior part of the choanae is situated at the distal part of the M2.

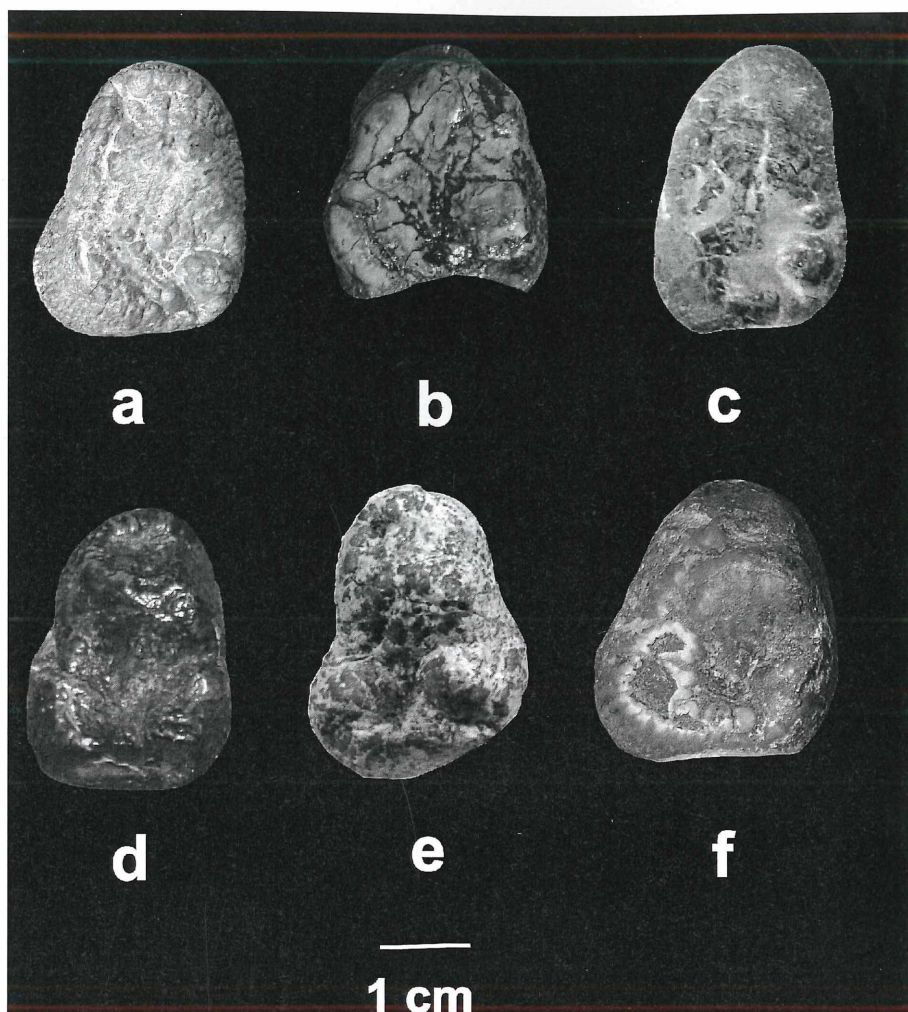
The persistent right M1 (Pl. 1, fig. 2b) has a rectangular shape with three transverse lophes. The protocone and the paracone, as well as the conelets between these two main cusps of the first loph, are not well visible because of wear, which has merged them. In the transverse valley between the first and second loph, there is a rather strong anterior pretrite central conule of the second loph. In the second loph, the two main cusps are partly broken buccally and lingually, respectively. The posttrite halfloph is formed by two conelets, the pretrite by one larger conelet. In the distal wall of the hypocone there is a small and low cusplet, that closes the lingual opening of the transverse valley between the second and the third loph. In the middle of the second transverse valley, there are four central conules (the central is larger), dividing the transverse valley into two parts. The conules are situated in a semicircle and connect the second and third loph. In the third loph, the two main cusps are broken buccally and lingually. In the distal part of the tooth some additional cusplets are developed, forming a cingulum, which is partly broken.

The right M2 (Pl. 1, fig. 2c) has three lophes. The mesial cingulum is almost semi-circular and consists of a series of small cusplets, which decrease toward the buccal side. The cusplet of the mesial cingulum situated most buccally is large, but still smaller than the lingual ones. In the first loph the protocone is larger than the paracone. The posttrite halfloph is formed by the paracone and three conelets, which are all about the same size and fused to each other, as well as with the paracone; the pretrite halfloph consists of a large protocone and a single and more isolated conelet. In the transverse valley between the first and second loph, there is a small posterior pretrite central conule of the first loph. In the second loph the hypocone is larger and situated well behind the metacone. The three posttrite conelets are of the same size and more or less fused to each other, as well as to the metacone. There are two pretrite conelets, the inner being larger than the other. In the second transverse valley there are three central conules of medium size and a larger fourth one. In the third loph, the posttrite main cusp and the two conelets are of the same size and fused to each other, while the pretrite halfloph is formed by a stronger main cusp and two smaller conelets. In the distal cingulum the cusplets are connected to each other and situated almost on a straight line. Their size decreases from the lingual to the buccal side.

Discussion: The oldest choerolophodonts known from the Early - Middle Miocene of Africa are referred to as *Afrochoerodon* (PICKFORD, 2001). This genus includes the following Early - Middle Miocene African and Eurasian choerolophodont species (PICKFORD, 2001; SANDERS, 2003):

Figure 1: Second upper deciduous premolars of *Choerolophodon pentelici* from various localities.

a. DP2 sin, MTLB-11; b. DP2 dex (reverted), MNHN-PIK 3665, Pikermi, Greece; c. DP2 dex (reverted), NHMW-1914 no. 13, Samos, Greece d. DP2 sin, MNHN-SLQ-1124, Axios Valley, Greece; e. DP2 sin, AK2 - 300, Akkaşdağı, Turkey (taken from Tassy, 2005); f. DP2 sin, NHMW-MRG-A 4868, Maragheh, Iran.



• *A. kisumuensis* (McINNES, 1942), Early - Middle Miocene. It is known from the localities of Maboko and Cheparawa in Kenya and from Wadi Moghara in Egypt.

• *A. palaeindicus* (LYDEKKER, 1884), Early Miocene, known from the Bugti beds and possibly from Siwaliks (Pakistan). According to Tassy (1990), it is possible that *A. palaeindicus* and *A. kisumuensis* are conspecific. Recent data from Bugti suggests that the first occurrence of choerolophodons in Eurasia is dated between 17.0 - 16.0 Ma, corresponding to the end of Early Miocene (STEININGER, 1999).

• *A. ngorora* (MAGLIO, 1974), Middle - Late Miocene (13.0 - 9.5 Ma), known from Fort Ternan and Ngorora in Kenya. *A. zaltaniensis* (GAZIRY, 1987) from North Africa could be a synonym of *A. ngorora* (PICKFORD, 2001).

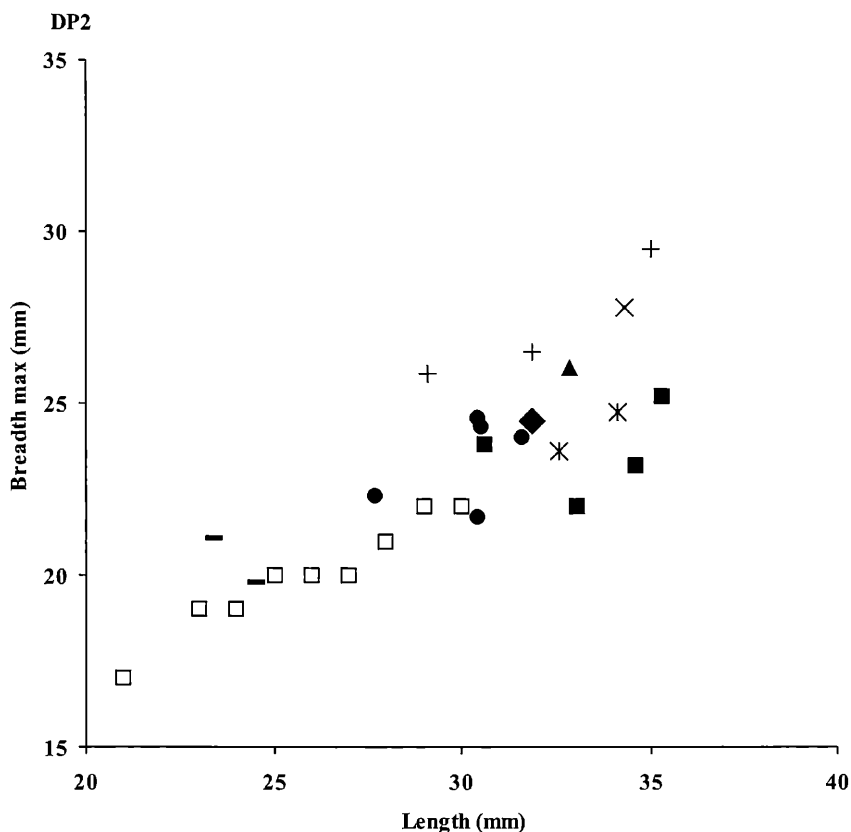
The type species of the genus *Afrochoerodon kisumuensis* and the Late Miocene Eurasian choerolophodons differ in various characters. PICKFORD (2001) mentions that *A. kisumuensis* is characterized by a short and high skull with a steeply inclined facial region, whereas the skull of the Eurasian choerolophodons is elongated and flattened. Moreover, the orbits in *A. kisumuensis* are situated above the M3s and at about $\frac{1}{3}$ of the height of the skull, while in the Eurasian choerolophodons the orbits are behind the rear of the M3s near the top of the skull. The tusks of *A. kisumuensis* emerge downwards and then curve forwards, whereas in the Eurasian choerolophodons the tusks emerge at a sub-horizontal angle and then curve

upwards. Concerning the morphology of the teeth, the permanent cheek teeth of *A. kisumuensis* lack choerodonty and ptychodonty and they are slightly covered with cement in the valleys. In contrast, choerodonty and ptychodonty are well expressed in the permanent cheek teeth of the Eurasian choerolophodons, which are usually heavily covered with cement.

In Europe, the oldest known choerolophodon is *Choerolophodon chioticus* (TOBIEN, 1980) found in the locality Thymiana of Chios Island, Greece (TOBIEN, 1980). The locality is dated to Late Orlanian, MN 5; the palaeomagnetic record suggests an age of ~15.5 Ma for the fossiliferous levels of Thymiana (BONIS et al., 1997a, b, 1998; KOUFOS et al., 1995; KONDOPOULOU et al., 1993). Based on more similarities of *C. chioticus* with *Afrochoerodon* than with the more derived Eurasian choerolophodons, PICKFORD (2001) transferred it to *Afrochoerodon*. The distinction between the Middle and Late Miocene choerolophodons is clear; the first choerolophodons have more primitive characteristics while the later forms are highly specialized. TOBIEN (1980) notes that *A. chioticus* belongs to a more primitive evolutionary stage with regard to *C. pentelici* owing to the narrow temporal region, the elongated skull base and the incipient choerodonty, ptychodonty and cementodonty of the Chios specimen.

During Late Miocene the genus *Choerolophodon* was a common representative of the proboscideans in the faunas

Figure 2: Scatter diagram (length /breadth) comparing the DP2s of *Choerolophodon* from various localities.



- ◆ *C. pentelici*, Samos, MTLB-11
- ▲ *C. pentelici*, Pikermi (MNHN)
- ✱ *C. pentelici*, Axios valley (MNHN)
- + *C. corrugatus*, Siwaliks (TASSY, 1983)
- *C. anatolicus*, Kayadibi (GAZIRY, 1976)
- *C. pentelici*, Samos (NHMW)
- ✕ *C. pentelici*, Akkasdagi (TASSY, 2005)
- *C. pentelici*, Maragheh (MNHN, NHMW)
- *C. anatolicus*, Sinap (SANDERS, 2003)

of the Eastern Mediterranean region, distributed across Eurasia from Southeastern Europe to China, while it is absent in Western and Central Europe and Northern Asia. The type species *C. pentelici* is known from several Greek localities, such as Pikermi (type locality), Axios Valley, Samos, Kerassia, Maramena and Nikiti (KOUFOS, 2006). It is also very common in the Late Miocene faunas of Bulgaria, Turkey, Iran and Afghanistan (NOW, 2007). Contemporaneous with *C. pentelici* is *C. corrugatus* (PILGRIM, 1913), which is present in the Nagri and Dhok Pathan Formations of middle Siwaliks, Pakistan. The choerolophodont material from the Sinap Formation (Turkey) was assigned by OZANSOY (1965) to *C. anatolicus*. SANDERS (2003) proposed that the subspecies "*C. pentelici lydiensis*" also belongs to *C. anatolicus* and thus the material from Esme Akçaköy, Kayadibi, Kemiklitepe-D and Gökdere was included in this species. Furthermore, he suggested that *C. anatolicus* existed during the whole Vallesian and then was replaced by *C. pentelici*.

The distinction between the three Late Miocene species is more complicated. TASSY (1983) notes the difficulty in distinguishing isolated teeth of *C. pentelici* from those of *C. corrugatus*, if there is no indication of the geographic location. The main distinguishing characteristics among the two species are the angulation between ascending and horizontal ramus and the angulation of the symphyseal rostrum on the mandibular corpus, which is strong in *C. corrugatus*. On the other hand, *C. pentelici* is characterized by the absence of the angulation between ascending and horizontal ramus, and the symphysis is situated at the extension of the horizontal ramus.

The distinguishing characteristics between *C. anatolicus* and *C. pentelici* are also related to the morphology of

the mandible. The symphyseal angulation exists in *C. anatolicus*, though in a lesser degree than in *C. corrugatus* (SANDERS, 2003). Moreover, the deciduous premolars of *C. anatolicus* are smaller than those of the other two Late Miocene choerolophodonts. SANDERS (2003) notes that the molars of *C. anatolicus* from Sinap differ from those of *C. pentelici* in having simpler crowns with choerodonty and ptychodonty weaker expressed, therefore being closer to *A. ngorora*, *A. chioticus* and *A. kisumuensis*.

There are no mandibular remains of *Choerolophodon* in the new Samos material which could allow a certain determination of the species. The old material described by SCHLESINGER (1917:Taf. XXV, Abb. 1) as *Mastodon (Choerolophodon) pentelici*, does not show angulation and the mandibles are similar to the type material from Pikermi. Concerning the size of the deciduous premolars, the DP2 from Samos is in fact larger than that of *C. anatolicus* (Fig. 2). This is also supported by the DP2 dimensions in the old collection from Samos. Additionally, choerodonty and ptychodonty are visibly present (Fig. 1).

The DP2 of the holotype from Pikermi (Fig. 1b) is worn and distally compressed, owing to the close contact with the DP3. However, some basic characteristics can be observed: the tooth forms two bunodont lobes; the two mesial cusps are connected; the metacone is well-separated

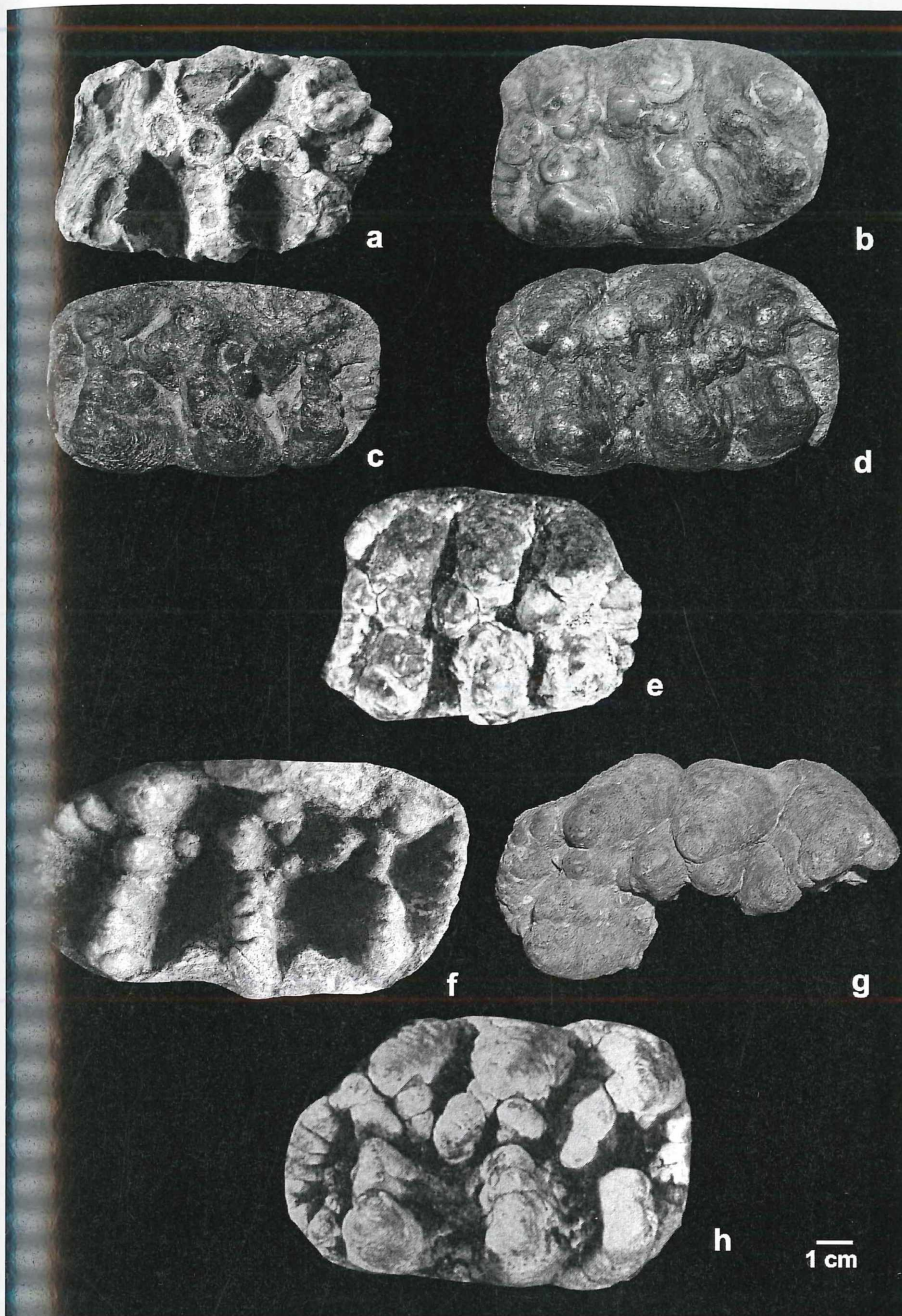


Figure 3: First and second upper molars of *Choerolophodon* from various localities.

a. M1 dex, *C. pentelici*, MTLB-126, Samos, Greece; b. M1 dex, *C. pentelici*, NHMW-1913 no 12, Samos, Greece; c. M1 dex, *C. pentelici*, MNHN-SLQ-1122, Axios Valley, Greece; d. M1 dex, *C. pentelici*, MNHN-MRG-nn, Maragheh, Iran; e. M1 dex, *C. corrugatus*, GSP 15001, Siwaliks, Pakistan (taken from Tassy, 1983); f. M2 dex, *C. pentelici*, MTLB-126, Samos, Greece; g. M2 sin (reverted), *C. pentelici*, NHMW-MRG-nn, Maragheh, Iran; h. M2 dex, *C. corrugatus*, GSP 15001, Siwaliks, Pakistan (taken from Tassy, 1983).

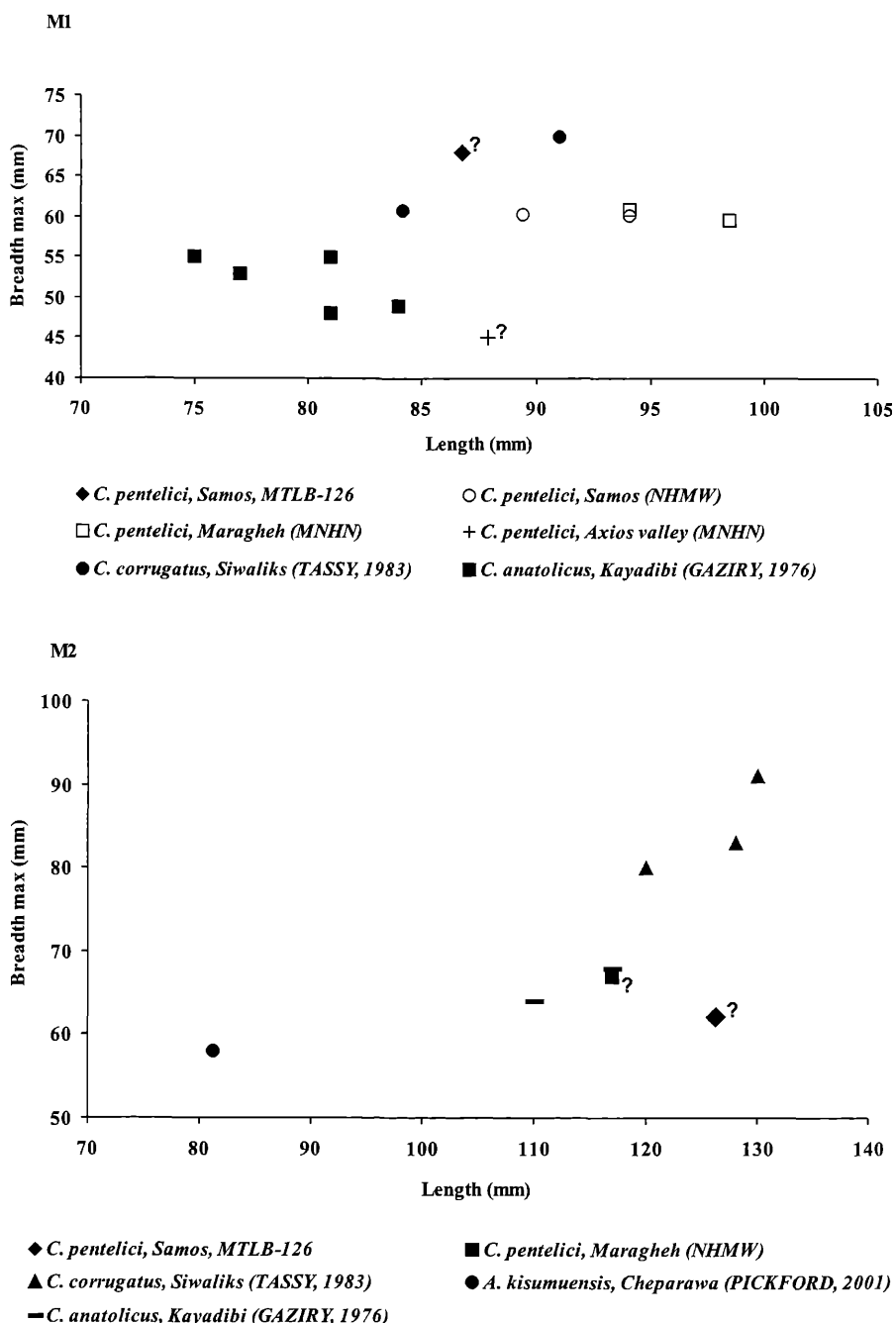
from the hypocone and it is larger-sized; the tooth has a mesial cingulum and a distolingual enlargement. These features are similar to those of Samos DP2, but that of Pikermi is slightly larger in size (Figs. 1, 2).

In the old collection of Samos housed at NHMW, there are two skulls (NHMW-SAM-1914 no. 13 and NHMW-SAM-A 4355) which were originally described by SCHLESINGER (1917), and each of them retains both DP2s. The morphology of these deciduous premolars fits in well with that of MTLB-11 (Figs. 1a, c). The first loph bears the typical massive cusp, while in the second loph the metacone and the hypocone are well separated. In NHMW-SAM-A 4355, these two distal cusps are larger and the sulcus between them is slightly deeper. However, the ratio of the size between the metacone and the hypocone remains the same. The mesial cingulum is well-expressed, while there also is a distal cingulum, which is more de-

veloped on the lingual side of the tooth. The distolingual enlargement is less in NHMW-SAM-1914 no. 13, while in NHMW-SAM-A 4355 it is more expressed.

In Arambourg's collection from Axios Valley (Macedonia, Greece), housed at MNHN, there are two DP2s of *C. pentelici* (Fig. 1d). Their direct comparison to the studied DP2 from Samos suggests similar morphology and size (Figs. 1, 2). However, the distolingual enlargement of the DP2s from Axios Valley is less intense. A DP2 of *C. pentelici* is described by TASSY (2005) from the Turkish locality Akkaşdağı (Fig. 1e). In this tooth, the choerodonty and ptychodonty are less expressed than in the Samos material, probably due to the stage of wear. Concerning the size, the Akkaşdağı DP2 is wider than that of Samos (Fig. 2), nonetheless the distal enlargement of the tooth is of the same degree. Both teeth generally share the same morphology (Figs. 1a, e).

Figure 4: Scatter diagrams (length/breadth) comparing the M1s and M2s of the sub-family Choerolophodontinae from various localities.



Second deciduous premolars of *C. pentelici* are also known from Maragheh (Iran). Some choerolophodont remains of this locality are housed at NHMW and were originally described by SCHLESINGER (1917). The best preserved specimen is a maxilla preserving all the deciduous teeth in both sides (NHMW-MRG-A 4868). The DP2s are in an advanced stage of wear, though the morphological characteristics can be observed. As all DP2s, the teeth bear two lophs, the second one with a distolingual enlargement which is of the same degree as in MTLB-11. All their morphological features fit in well with those of the Samos specimen (Figs. 1a, f). The only difference seems to be the less intense mesial and distal cingulum, but this could be due to attrition. Concerning the size, there is a resemblance between Samos and Maragheh specimens (Fig. 2). The studied maxilla (MTLB-126) obviously belongs to a pro-

boscidean of trilophodont grade. The choerodontology of M1 is similar to that of the Late Miocene forms of *Choerolophodon* from Axios Valley, Maragheh and Siwaliks (Fig. 3). In the old collection of Samos, M1 is known from a skull of *C. pentelici* (NHMW-SAM-1913 no. 12) which bears both DP4-M1 series. The morphology of M1 (Fig. 3b) is similar to that of the studied M1 (Figs. 3a, b). The comparison of the first loph is not possible because it is too worn in the M1 of MTLB-126, nonetheless, they seem to be similar. Both teeth have a strong anterior pretrite central conule of the second loph. Moreover, there is one conelet in the internal part of the hypocone. They differ, however, in the internal part of the metacone, which bears two conelets in MTLB-126 instead of one in the NHMW-SAM-1913 no. 12. In the transverse valley between the second and third loph of the NHMW-SAM-1913 no. 12, there are some

weak conules, which do not block the transverse valley. In both specimens the sulcus of the third loph is wide and deep. The M1 of NHMW-SAM-1913 no. 12 is strongly covered with cement.

The M1 from Axios Valley (MNHN-SLQ-1122) differs from the MTLB-126 in the placement of the conelets between the second and the third loph (Fig. 3c). The conelets of the third loph of MNHN-SLQ-1122 are situated in a straighter line than those of MTLB-126 (Figs. 3a, c). Moreover, there is a posterior pretrite central conule of the second loph of MNHN-SLQ-1122 that is absent in the tooth from Samos. Apart from that, the morphology of the second loph is the same in both samples, showing one strong anterior pretrite central conule of the second loph, two conelets in the inner part of the metacone and one larger in the inner part of the hypocone. The distal cingulum in the two specimens seems to be equally sized.

The studied material from Samos has been directly compared with the sample of *C. pentelici* from Maragheh, housed at MNHN. The M1 from Maragheh (Fig. 3d) shares the same morphological features with the Samos one. They differ in the presence of the small and low cusplets situated on the lingual side of the first and second transverse valley that are entirely missing in the Samos specimen. The Maragheh M1 is larger than MTLB-126 (Fig. 4).

Although the general morphology of the Samos M1 is similar to that of *C. corrugatus* from Siwaliks, Pakistan (Fig. 3e), there are some distinctive characteristics. In comparison to Samos, the anterior pretrite central conule of the second loph is also strong, but the conelet in the inner part of the hypocone seems to be rather weak. In the transverse valley between the second and the third loph there is one central strong conelet but there are not additional conules connecting the second and third loph as in the Samos specimen. Furthermore, the two transverse valleys are narrower, meaning that the three lophs of the tooth are closer to each other, whereas in the M1 from

Samos the valleys are wider, especially on the buccal side of the tooth. The distal cingulum seems to be the same size, as is the overall tooth size, too (Fig. 4).

Concerning the M2, SCHLESINGER (1917) described a left M2 of *C. pentelici* coming from Maragheh (NHMW MRG-nn). In this tooth (Fig. 3g) the second and third posttrite halflophs, as well as, the distal cingulum are broken. The morphology of the rest of the tooth fits in quite well with the studied M2 (Fig. 3f).

In the M2 of *C. corrugatus* from Siwaliks (Fig. 3h) ptychodonty is more expressed, while in the Samos one it is absent. All three lophs of the M2 from Siwaliks are broader than those of MTLB-126 (Tab. 1 & Fig. 4). There is a variation concerning the length, as the length of *C. corrugatus* varies from 110 mm up to 130 mm (TASSY, 1983). Apart from this, both teeth morphologically resemble each other.

The above mentioned comparison of the teeth indicates that the morphology and size between the various specimens of *C. pentelici* is similar; the small size differences are probably due to sexual dimorphism, variability and wear stage.

Family Mammutidae HAY, 1922

Subfamily Mammutinae HAY, 1922

Genus *Zygodon* VACEK, 1877

Zygodon turicensis (SCHINZ, 1824)

(Pl. 1, fig. 3)

Locality: The studied specimen belongs to the collection of Prof. J. Melentis, housed at NHMA. It was collected from MTLA site in Adrianos ravine (see Koufos, this volume).

Age: Middle Turolian, MN 12 (Late Miocene); 7.1 - 7.0 Ma

Material: dp4 dex, PMMS-53.

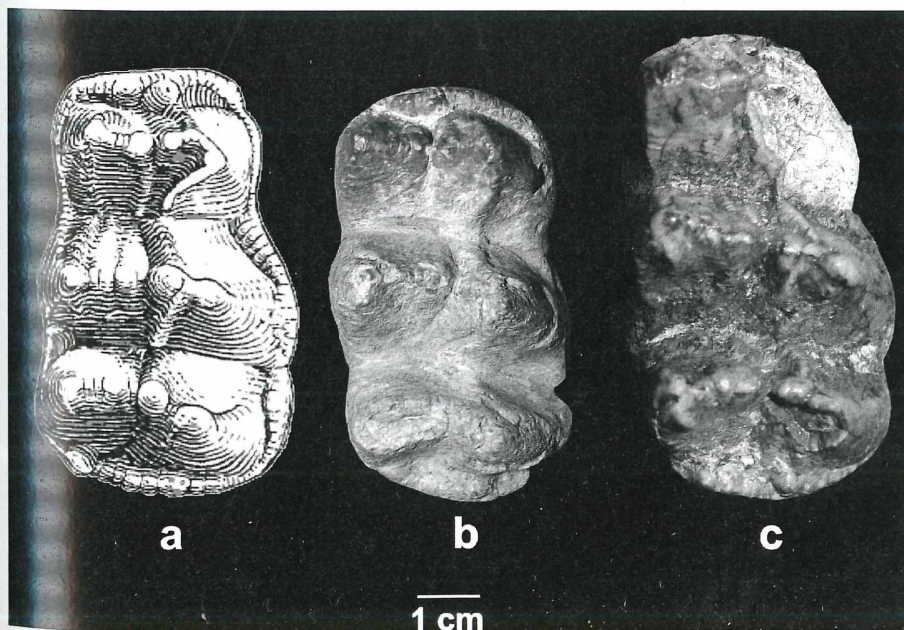


Figure 5: Fourth lower deciduous molars of zygodons from various localities.

a. dp4 sin (reverted), *Zygodon turicensis*, MNHN-Si 11, Simorre, France, (taken from TASSY, 1977); b. dp4 dex, *Zygodon turicensis*, PMMS-53, Samos, Greece; c. dp4 dex, *Mammut cf. borsoni*, MNHN-PIK-3613, Pikermi, Greece.

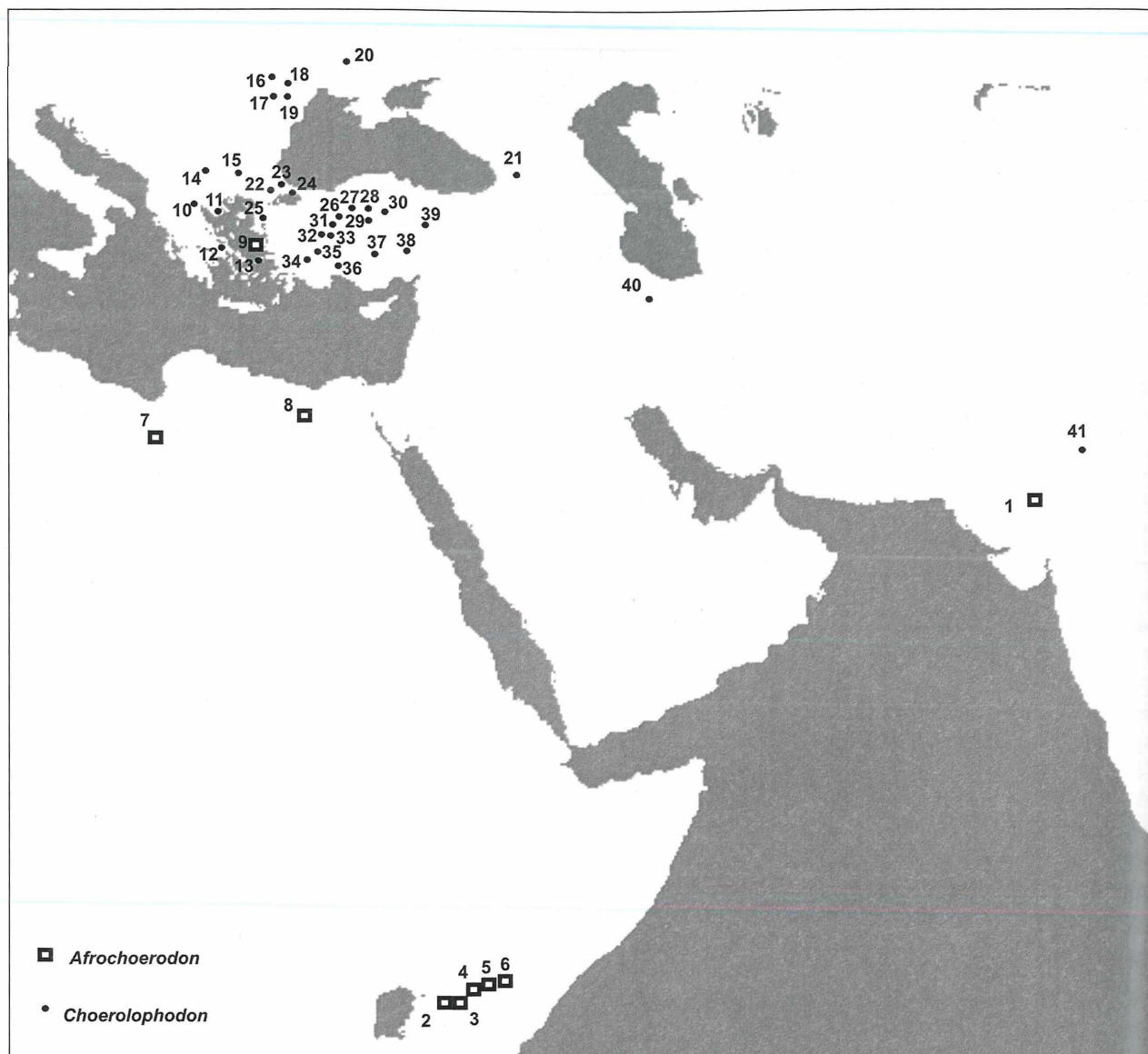


Figure 6: Geographic distribution of the sub-family Choerolophodontinae in Africa, Southwestern Asia and Europe.

Legend: 1. Bugti, India; 2. Maboko, Kenya; 3. Fort Ternan, Kenya; 4. Cheparawa, Kenya; 5. Ngorora, Kenya; 6. Nakali, Kenya; 7. Gebel Zelten, Libya; 8. Wadi Moghara, Egypt; 9. Thymiana, Greece; 10. Axios valley (Pentalophos, Xirochori, Ravin de la Pluie, Ravin des Zouaves, Vathylakkos, Prochoma, Dytiko), Greece; 11. Nikiti, Greece; 12. Pikermi, Greece; 13. Samos, Greece; 14. Titov Veles, FYR of Macedonia; 15. Various sites in Bulgaria; 16. Varnitsa, Moldova; 17. Kalfa, Moldova; 18. Tiraspol, Moldova; 19. Chobruchi, Moldova; 20. Novaja Emetovka, Ukraine; 21. Eldari I, Georgia; 22. Yulafli, Turkey; 23. Batalcesme, Turkey; 24. Küçükcesmece, Turkey; 25. Gülpınar, Turkey; 26. Gökdere, Turkey; 27. Eminova, Turkey; 28. Inonu 2, Turkey; 29. Sinap, Turkey; 30. Corakyerler, Turkey; 31. Sofca, Turkey; 32. Akin, Turkey; 33. Garkin, Turkey; 34. Kemiklitepe, Turkey; 35. Esmek Akçaköy, Turkey; 36. Kayadibi, Turkey; 37. Akkaşdağı, Turkey; 38. Dadasun, Turkey; 39. Duzyala, Turkey; 40. Maragheh, Iran; 41. Siwaliks, Pakistan. The data was taken from NOW (2007).

Description: The right dp4 is trilophodont, rootless and has a rectangular shape (Fig. 5). The halflophids of the first lophid are situated opposite each other, whereas the halflophids of the second and third lophid are slightly oblique to the longitudinal axis of the tooth, panted mesiolingually - distolabially. The number of conelets is higher in the posttrites, so that the median sulcus is shifted labially. The lophids are separated by transverse valleys which are open lingually and buccally. The buccal wall of the buccal halflophids is inclined, while the lingual wall

of the lingual halflophids is vertical. In the first lophid there is an anterior and a weaker posterior crescentoid of the first pretrite. The metaconid bears at least three conelets and the protoconid two conelets. These conelets are laterally merged and situated in a straight line. There is a weak zygodont crest in the posttrite halflophid. The second lophid is worn, and as a result the conelets cannot be clearly distinguished. The anterior crescentoid of the second pretrite is weak due to wear. In the third lophid, the tip of the posttrite main cusp and the conelets are

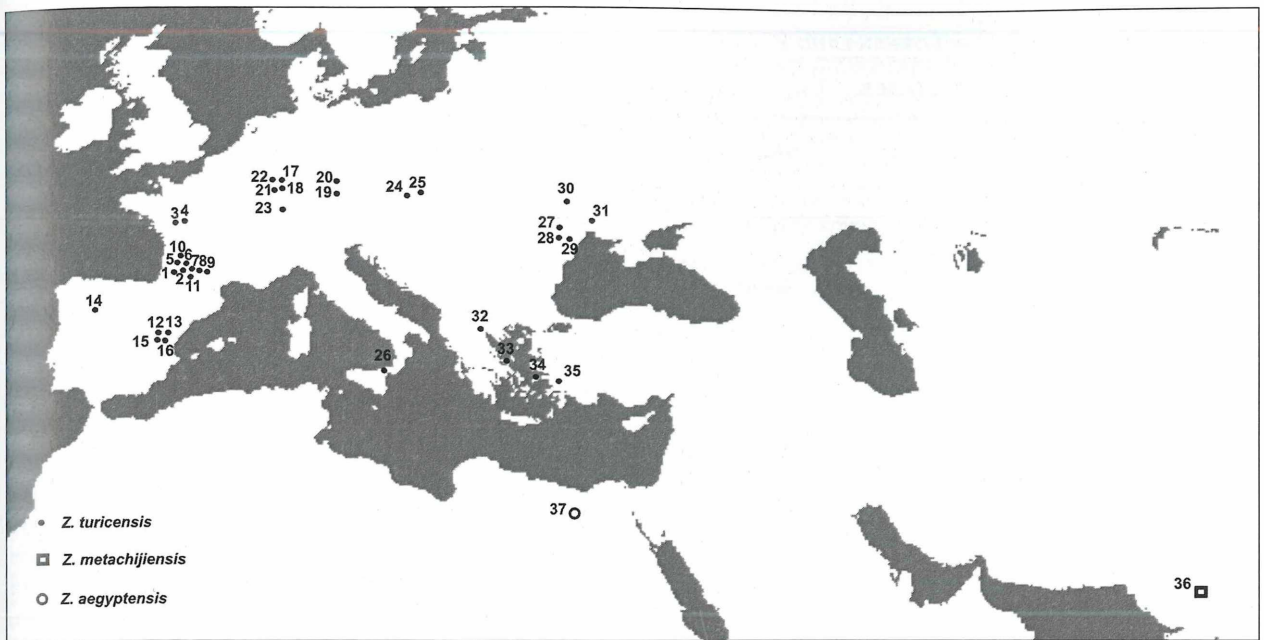


Figure 7: Geographic distribution of *Zygodont* species in Africa, Southwestern Asia and Europe.

Legend: 1. Sansan, France; 2. La Romieu, France; 3. Evres-Marine Faluns; 4. Pontlevoy, France; 5. Simorre, France; 6. Poudenas, France; 7. Malartic, France; 8. Bourg-Saint-Bernard, France; 9. Montbrun-Bocage, France; 10. Castelnau, France; 11. Saint-Gaudens, France; 12. El Arquillo 1, Spain; 13. Concud, Spain; 14. Benavente, Spain; 15. Las Casiones, Spain; 16. Cerro de la Garita, Spain; 17. Gau-Weinheim, Germany; 18. Esselborn, Germany; 19. Wartenberg, Germany; 20. Breitenbrunn, Germany; 21. Dinotheriensande, Germany; 22. Bermersheim, Germany; 23. Elgg, Switzerland; 24. Devínska Nová Ves, Slovakia; 25. Novalky, Slovakia; 26. Gravitelli, Italy; 27. Lapushna, Moldova; 28. Chimishlija, Moldova; 29. Taraklia, Moldova; 30. Borshchi, Ukraine; 31. Novo-Elizavetovka, Ukraine; 32. Axios valley, Greece; 33. Halmyropotamos, Greece; 34. Samos, Greece; 35. Akçahisar 1, Turkey; 36. Dera Bugti 6, Pakistan; 37. Wadi Moghara, Egypt. The data was taken from NOW (2007).

broken. There is a mesial and a stronger distal cingulum. The mesial cingulum continues to the buccal side of the first lophid. The distal cingulum is badly preserved and it is difficult to trace its morphology.

Discussion: The family Mammutidae is characterized by the zygodont pattern (yoke-like transverse crests) of the intermediate molars and M3. The first representative of the family is the primitive genus *Eozygodon*, which is the smallest zygodon, known from the Early Miocene of Kenya (TASSY & PICKFORD, 1983). In Eurasia the family is represented by two genera only, *Zygodont* and its descendant *Mammut*. The “*Zygodont turicensis* group” includes four Eurasian species: the type species *Z. turicensis* (SCHINZ, 1824) from Europe, *Z. atavus* from Kazakhstan, *Z. metachijiensis* from India and *Z. gobiensis* from Mongolia and China (TASSY, 1996). Recently, *Zygodont* has been discovered in Wadi Moghara, Egypt, with the new species *Z. aegyptensis*, dated to Early Miocene (SANDERS & MILLER, 2002). The zygodons generally seem to be a conservative group with limited evolutionary changes, especially in comparison to the bunodonts, who appear more diversified.

In Greece, *Zygodont turicensis* is less common than *Choerolophodon pentelici*. The species is known by a skull with DP2 - DP4 dex and sin from Ravin des Zouaves 5 (Axios Valley, MN 11) and a maxilla with DP2 - DP4 dex and sin from Halmyropotamos (MN 12) (MELEN-

TRIS, 1967; KOUFOS, 1980). The mammutid material from Pikermi (MN 12) housed at MNHN includes a maxilla with DP2 - DP4 dex and sin, associated with the mandible with dp3 sin and both dp4, and is referred to as *Mammut* cf. *borsoni* (GAUDRY, 1862-67; TASSY, 1985). TASSY (1977) described a left dp4 of *Zygodont turicensis* from the Middle Miocene of France (Simorre). Morphologically, the dp4 PMMS-53 from Samos and those from Simorre and Pikermi present the same zygodont characteristics (Fig. 5). The dp4 of *Z. turicensis* from Samos differs from that of Simorre in having a semicircular mesial cingulum whereas in the Simorre specimen, the cusplets of the mesial cingulum are arranged in a straight line. Moreover, the cingulum appears all around the tooth from Simorre, being particularly strong on the buccal side. A lingual cingulum is not observed in the teeth from Samos. The distal cingulum of the dp4 from Samos seems to be slightly stronger. The dp4 from the three mentioned localities are different in size. The teeth from Pikermi show larger dimensions, while the teeth from Samos and Simorre have similar dimensions (Tab. 2).

Summarizing the above mentioned data and since the transition from *Zygodont* to *Mammut* is not clear (especially in the milk teeth features), the studied dp4 is assigned to *Z. turicensis*. The discovery of new material with permanent dentition will allow more detailed comparisons and will probably lead to more certain taxonomic conclusions.

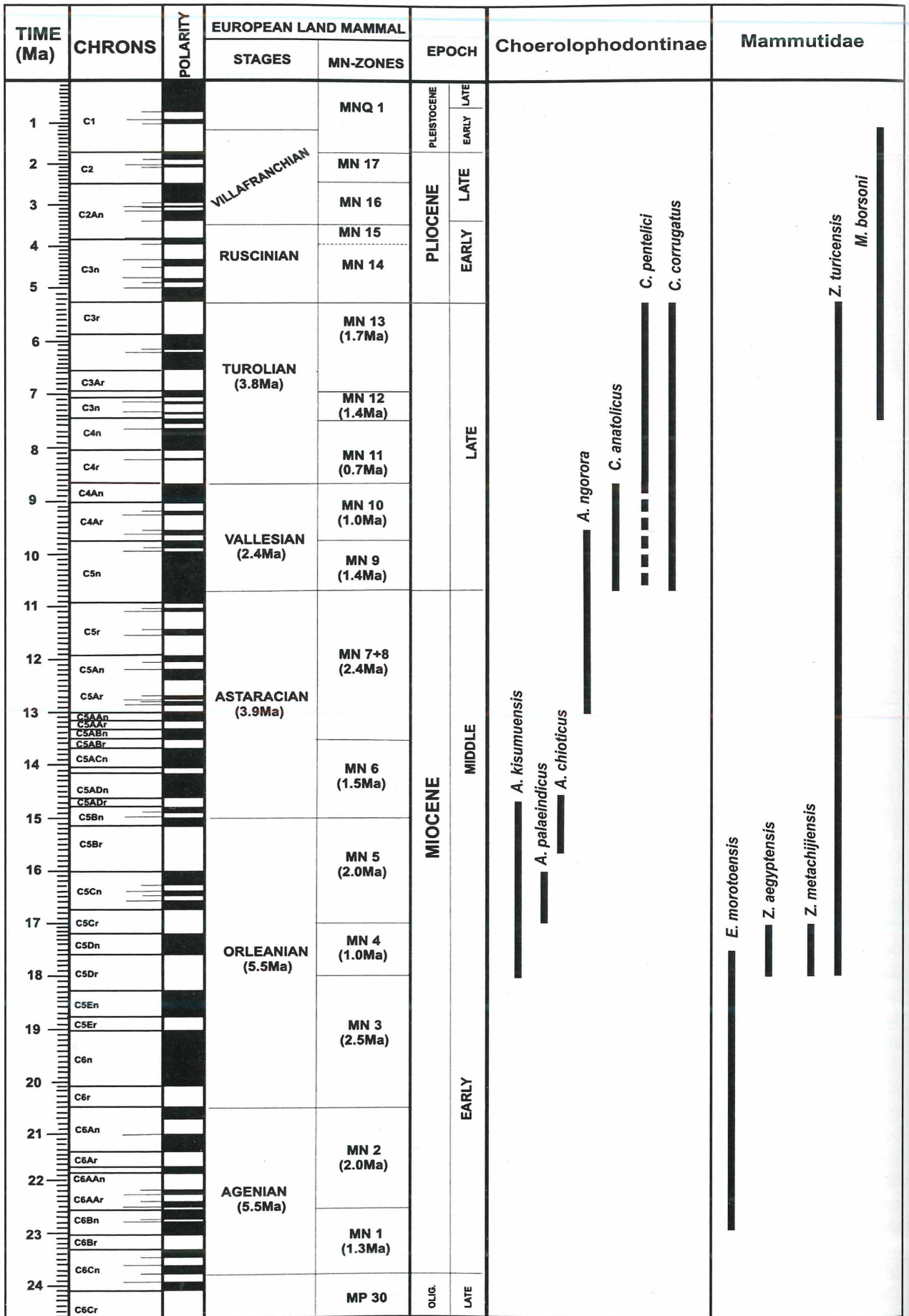


Figure 8: Chronology and biostratigraphy of the sub-family Choerolophodontinae and the family Mammutidae. The data was taken from NOW (2007), SANDERS (2003), SANDERS et al. (2002), PICKFORD (2001).

3. Geographic and Stratigraphic Distribution

The oldest known Eurasian choerolophodons were found in Bugti (Pakistan) and they are assigned to *Choerolophodon palaeindicus*, a species that has been recently transferred to *Afrochoerodon* (TASSY, 1990; PICKFORD, 2001). The Bugti Beds are dated to Early Miocene (~20.0 Ma) by TASSY (1990). Earlier BARRY et al. (1985) considered the Bugti fauna as belonging to the end of MN 3 (~18.3 Ma). Recent data from Bugti date the presence of choerolophodons to the late Early Miocene at about 17.0 - 16.0 Ma (WELCOMME et al., 2001). On the other hand, the oldest known choerolophodon of Africa is *A. kisumuensis* dated to 18.0 - 17.0 Ma (SANDERS & MILLER, 2002). Thus, the original hypothesis of TASSY (1983) for a south Asian origin of choerolophodons changed and an African origin was proposed for them. It is suggested that they arrived in Eurasia across the "Gomphotherium-Landbridge" at ~18 Ma together with the gomphotheres and deinotheres (TASSY, 1990; RÖGL, 1999). The first arrival of proboscideans in Europe is known as "Proboscidean-datum" and it is well-traced in Lesbos Island (Greece), where *Prodeinotherium* was recognized in levels older than 18.5 Ma (KOUFOS et al., 2003). After their arrival the choerolophodons dispersed in Europe and Asia (Fig. 6). In the Eastern Mediterranean region the oldest choerolophodon is *A. chioticus* known from the locality of Thymiana (Chios Island, Greece), dated to MN 5 (~15.5 Ma). The genus *Afrochoerodon* covers a long time span, as it is known from the Early Miocene (MN 4) to the Vallesian (MN 10) of Africa (Fig. 8). The genus *Choerolophodon* appeared in Vallesian and persisted during the whole Late Miocene. At the end of the Miocene the choerolophodons disappeared, having their last occurrence in the locality of Maramena (Greece), dated to the end of the Turolian, MN 13/14 (SCHMIDT-KITTLER et al., 1995) (Fig. 8). In spite of their great geographic expansion, the choerolophodons stopped in the Balkans and Eastern Europe and did not enter Central and Western Europe, probably because of the different palaeoecological conditions (KOUFOS, 2003).

During the "Proboscidean-datum", the first zygodons arrived in Eurasia. Their ancestors were found in Kenya and are referred to as *Eozygodon* (TASSY & PICKFORD, 1983). The sole known European representative of *Zygodon* is *Z. turicensis*, with numerous occurrences (Fig. 7) and a great stratigraphic expansion, covering the Middle and the Late Miocene of Europe (Fig. 8). The first occurrences of this species are traced in the locality La Romieu, France, and in the locality Akçahisar, Turkey, both dated to MN4 (NOW, 2007). Its last appearances are known from the localities El Arquillo 1, Spain, and Gravitelli, Italy, both dated to MN 13 (NOW, 2007). Its descendant, *Mammuth borsoni*, is represented in the Pliocene faunas of Europe and existed until Early Pleistocene. In the Late Miocene of Europe it is rare and is known from Moldova, Ukraine, Hungary, Bulgaria and Pikermi, Greece (NOW, 2007). In spite of the rarity of the proboscideans in the new collection of Samos, they offer some biochronological data. According to SANDERS (2003), the Late Miocene

choerolophodons are divided into three different species. *C. anatolicus* is typical for Vallesian, while *C. pentelici* is its descendant and occurs in Turolian. The genus *Choerolophodon* disappeared at the end of Miocene. Based on the similarities of the MTLB *Choerolophodon* with *C. pentelici* from Pikermi, Axios Valley and other localities, a Turolian age can be proposed for the MTLB fauna. *Z. turicensis* has a great stratigraphic range (Fig. 8) and cannot be significant for biochronology. However, the other faunal data from MTLA and MTLB suggests a Middle Turolian age, and the palaeomagnetic record indicates an age of 7.1 - 7.0 Ma (KOUFOS et al., this volume).

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| <i>Choerolophodon pentelici</i> | | | | | | | | | | | | | | | | | | | | | |
|---------------------------------|------|-------------|----------|-----------------|-------------|-----------------|--------------|-------------|--------------|--------------|---------------|---------------|---------|----------------------|-------|----------------------|-----------|-----------------------|--------|-----------------|------|
| Mytilinii - 1B | | Pikermi | | Samos | | | | Maragheh | | Axios Valley | | Akkasdagı | | <i>C. corrugatus</i> | | <i>C. anatolicus</i> | | <i>A. kisumuensis</i> | | | |
| | | MTLB-11 | MTLB-126 | NHMW-1914 no 13 | NHMW-A-4355 | NHMW-1913 no 12 | NHMW -A-4868 | MNHN- nn | NHMW -A-4868 | NHMW -nn | MNHN-SLQ-1124 | MNHN-SLQ-1122 | AK2-300 | Siwaliks | Sinap | Kayadibi | Cheparawa | BAR | 219'99 | | |
| | | orig. meas. | | orig. meas. | | orig. meas. | | orig. meas. | | orig. meas. | | TASSY (2005) | | TASSY (1983) | | SANDERS (2003) | | GZIRY (1976) | | PICKFORD (2001) | |
| | | dex | sin | dex | sin | dex | sin | dex | sin | dex | sin | dex | sin | average | sin | average | sin | average | dex | sin | dex |
| DP2 | | | | | | | | | | | | | | | | | | | | | |
| L | 31.9 | — | 34.6 | 33.0 | 35.3 | 30.6 | — | — | — | — | 30.5 | — | 32.6 | — | 34.3 | 32.0 | 24.5 | 25.9 | — | — | — |
| B 1 st loph | 20.7 | — | 19.5 | 19.7 | 19.6 | 20.6 | — | — | — | 21.1 | — | 19.7 | — | — | — | — | — | — | — | — | — |
| B 2 nd loph | 24.5 | — | 23.2 | 22.0 | 25.2 | 23.8 | — | — | — | 24.3 | — | 23.6 | — | 27.8 | 27.3 | 19.8 | 20.0 | — | — | — | — |
| M1 | | | | | | | | | | | | | | | | | | | | | |
| L | — | [86.8] | — | — | — | — | 94.1 | 89.4 | — | — | — | — | — | — | — | 87.6 | — | 79.6 | — | — | — |
| B 1 st loph | — | [60.5] | — | — | — | — | 54.3 | 55.0 | — | — | — | — | — | — | — | 63.8 | — | — | — | — | — |
| B 2 nd loph | — | [68] | — | — | — | — | 60.1 | 60.4 | — | — | — | — | — | — | — | 65.5 | — | — | — | — | — |
| B 3 rd loph | — | — | — | — | — | — | 59.1 | 59.5 | — | — | — | — | — | — | — | 63.7 | — | — | — | — | — |
| M2 | | | | | | | | | | | | | | | | | | | | | |
| L | — | 126.3 | — | — | — | — | — | — | — | — | — | — | — | — | — | 125.8 | — | 113.5 | — | — | 81.2 |
| B 1 st loph | — | 62.2 | — | — | — | — | — | — | — | — | — | — | — | — | — | 81.0 | — | 64.5 | — | — | 52.8 |
| B 2 nd loph | — | [58] | — | — | — | — | — | — | — | — | — | — | — | — | — | 83.1 | — | 65.0 | — | — | 58.0 |
| B 3 rd loph | — | [56] | — | — | — | — | — | — | — | — | — | — | — | — | — | 83.9 | — | 53.0 | — | — | 52.8 |

Table 1: Dental measurements of the sub-family Choerolophodontinae from various localities.

| dp4 | <i>Zygodontodon turicensis</i> | | <i>Mammot cf. borsoni</i> | |
|--------------------------|--------------------------------|---------------------------|---------------------------|--------|
| | Mytilinii-1 (? MTLA) | Simorre | Pikermi | |
| | PMMS-53 | MNHN-Si 11 | MNHN-PIK-3613 | |
| | | GOEHLICH (pers. comm.) | original measurements | |
| | dex | sin | dex | sin |
| L | 67.9 | 70 | 75.6 | [68.1] |
| B 1 st lophid | 36.9 | 35 | 42.7 | 42.5 |
| B 2 nd lophid | 38.8 | 41 | 51.6 | 48.7 |
| B 3 rd lophid | 37.9 | 41 | 47.5 | — |

Table 2: Measurements of the dp4 of *Zygodontodon turicensis* from Samos and Simorre and *Mammot cf. borsoni* from Pikermi. The measurements of the Simorre specimen were given to us by Dr. U. Göhlich.

PLATE 1

Choerolophodon pentelici, Mytilinii – 1B (MTLB), Samos, Greece, Middle Turolian (MN 12)

Fig. 1. DP2 sin, MTLB – 11; a. occlusal, b. buccal, and c. lingual view.

Fig. 2. a. Maxilla with M1 - M2 dex and M2 sin, MTLB – 126; occlusal view

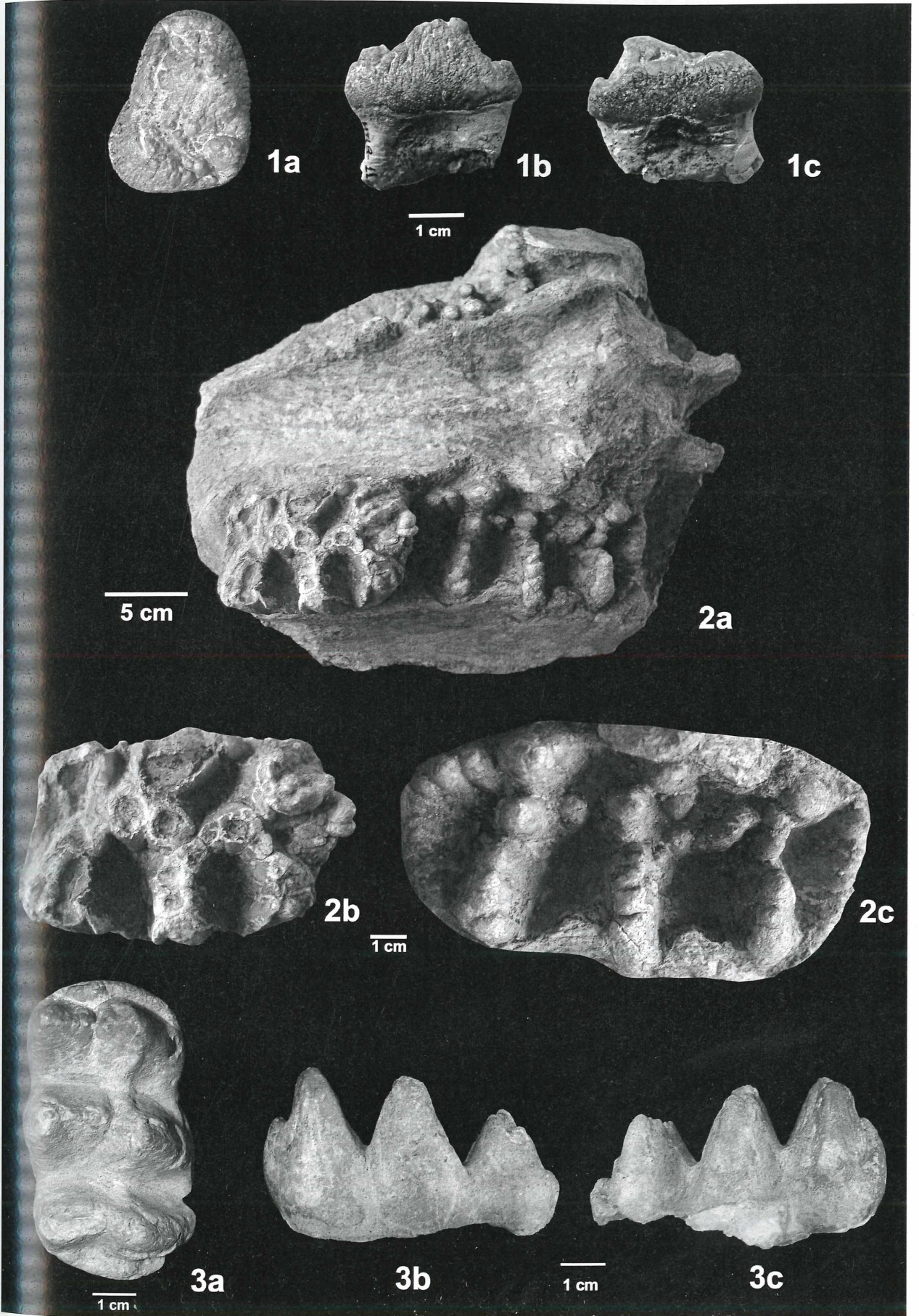
b. M1 dex of the maxilla MTLB – 126; occlusal view

c. M2 dex of the maxilla MTLB – 126; occlusal view.

Zygalophodon turicensis, possibly Mytilinii – 1 (? MTLA), Samos, Greece, Middle Turolian (MN 12)

Fig. 3. dp4 dex, PMMS – 53; a. occlusal, b. lingual, and c. buccal view.

PLATE 1



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