Gerçek Saraç
MTA, Ankara

Discovery of *Protaceratherium albigense* (Rhinocerotidae, Mammalia) in Oligocene

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Coastal marine deposits at Dolhan (Kirklareli, Thrace, Turkey) yielded some important remains of a land mammal, *Protaceratherium albigense* (Roman, 1912). The material consists of an upper jaw with P2-M3, a humerus, a tarsal (cuboid), two phalanges and one sesamoid bone. The marine origin is indicated by the presence of the large foraminifera *Nummulites intermedius*, *N. fichteli* and *N. vascus* in the same deposits. The fossiliferous horizon is mainly formed of detrital deposits of the Koyunbaba Formation, which covers unconformable the basement (Istranca Massif). The dentition of *P. albigense* from Dolhan is similar in size and morphology to that of the type locality Sauzière-Saint-Jean (Tarn, France). This species is well known in late early to early late Oligocene localities from western Europe and Hungary. The Dolhan discovery particularly enlarges its geographic distribution. Together with this species, the occurrences of several mammalian taxa with European affinities (*Aceratherium* (*Mesaceratherium*) *paulhiacense*, *Anthracotherium magnum*, *Elomeryx woodi* and rodents) in the middle-late Oligocene deposits of Turkish Thrace suggest strong paleogeographic connections with Europe at these times.

Correspondence: G. Saraç, MTA Genel Müdürlügü, Tabiat Tarihi Musesi, 06520 Ankara, Turkey; email: gerceksarac@hotmail.com

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INTRODUCTION

In the northwestern part of Turkish Thrace, the Istranca Massif forms the major relief formed of metamorphic rocks (Paleozoic to Jurassic) and granitic intrusions, which cut the latter in the late Cretaceous. The southwestern slopes of this massif are covered by Tertiary deposits that were intensively studied during the last fifty years because of their importance for occurrences of oil, natural gas and lignite, and industrial materials such as quartz sands, feldspar rich clays and manganese deposits. In geological studies of Tertiary deposits several lithostratigraphic units were defined, but with controversial ages, in particular for the deposits referred to the Eocene and/or Oligocene.

Well-preserved remains of a rhinoceros, associated with some marine animals, have been discovered at Erikdere near Dolhan village, department of Kirklareli (Fig. 1). Beyond its systematic and paleogeographic interest, this record partly contributes to date the related deposits and to enlighten their sedimentary environment. The geographic coordinates of the fossil locality are given below. The rhinoceros remains have been collected during the geological mapping fieldwork in 1981-1983. The specimens are preserved in the collections of the Natural History Museum of the Mineral Research and Exploration General Directorate (MTA) in Ankara.

GEOLOGICAL AND HISTORICAL ANALYSIS

The fossil bearing horizon is included in coastal marine sediments deposited along the southwestern shelf of the Istranca massif in northwestern Turkish Thrace. The coastal detrital facies of the Koyunbaba Formation and the unconformable overlaying recifal limestone (Sogucak Limestones) contain nummulites, and they are mapped as late Middle Eocene. However, in his study area at Kuleli-Babaeski highland, Keskin (1974) attributed these two formations to the Oligocene. In the southern part of the basin (Malkara, Kesan and Uzunköprü areas), the detrital deposits of the Pinarhisar and Danisment formations are attributed to the Oligocene (Lebküchner 1974). They form altogether the Paleogene stratigraphic units of this area.

The Koyunbaba Formation, which overlies with angular unconformity the magmatic-metamorphic rocks of the basement, was defined by Kransert & Malal (1960) and by Kasar (1987). Its type section is in the Magara ravine near Koyunbaba village, some five kilometers SE to the mammal locality. Its thickness may reach 100 m. The recifal Sogucak Limestones transitionally covers the detrital Koyunbaba Formation. In the fossil locality, the Koyunbaba Formation shows a succession of badly lithified pebble conglomerates, sand-siltstones, clays and limestones, and its thickness along the Erikdere valley is about 40 m. The limestone horizons are rich in well-preserved gastropods, pelecypods, echinids, corals (individual and colonies) and foraminifera. All horizons show an intense bioturbation. The horizon that yielded the rhinocerotid remains is also rich in nummulites. Also here, the Sogucak Limestones overlies the Koyunbaba Formaton.

Sirel & Gündüz (1976) presented the stratigraphy of these deposits in the area north of Dolhan village and studied nummulites from the Koyunbaba Formation and in particular from the overlaying Sogucak Limestones. In their study, they suggested a Lutetian-Priabonian age for the former deposits, and an early-middle Oligocene age for the latter. They were the first to describe the occurrence of marine Oligocene deposits with nummulites (*N. intermedius*, *N. vascus* and *N. fichteli*) in the area. According to these authors, the limestone horizons, which include the nummulites, conformably overlie the Priabonian aged sandy-micritic limestones.

Umut *et al.* (1984) and Saraç (1987) included these deposits in the Pinarhisar Formation. Siyako & Kasar (1985), Kasar & Aytaç (1986), and Kasar (1987) attributed the marine deposits near Dolhan village to the late Eocene. Dizer (1985) noted that the Islambeyli Formation (= Koyunbaba Formation) and Kirklareli Limestones (= Sogucak Limestones) should be of early Oligocene in age. The record of rhinocerotid remains may contribute to clarify these contradictory age attributions.

SYSTEMATIC PALEONTOLOGY

Order Perissodactyla OWEN, 1848
Family Rhinocerotidae OWEN, 1845
Genus *Protaceratherium* ABEL, 1910
Protaceratherium albigense (ROMAN, 1912)
(Figure 2)

Distribution of the species In Europe during the late early and early late Oligocene (MP 24-28; Antoine *et al.* 2003).

Locality Erikdere, Dolhan village, Kirklareli department, Turkey. 1:25 000 topographic map no E18-a4, Kirklareli sheet. The fossil locality is situated, in the summer dry, Erikdere valley about one kilometer north to the Dolhan village. The bones were unearthed from a horizon about 50 cm above the river bottom. The sediments are marls with sand and intercalations of gravel. The geographic coordinates are N 41° 46' 15" and E 27° 01' 52".

Fossiliferous horizon Pale yellow to beige unconsolidated sandy marls with small gravel, quite rich in gastropods, pelecypods,

Figure 1 Location map of the fossiliferous area (gray square).

echinid fragments and nummulites. The thickness of the fossiliferous horizon is about three meters; it is conformably covered by the Sogucak Limestones.

Material Left maxilla with P2-M3, left humerus, left tarsal IV (cuboid), first phalanx of the second digit, second phalanx of the third digit and sesamoid bone. The material is numbered as U-58-1 to U-58-6, respectively.

DESCRIPTION

The maxilla (Fig. 2) is laterally convex. Along the lateral face, the roots of the cheek teeth form anticlines on the bone. The anterior border of the orbit is located above the anterior margin of M2. Inside the orbit, the fossa sacci lacrimalis is situated in its anterior part. The postpalatine incision reaches the level at the middle of M2. The zygomatic bone is not large indicating that the skull was probably narrow.

Teeth

The available P2-M3, P2 and M1 are much worn, indicating an old individual (no detail of the occlusal surface is retained). The teeth are brachydont, with conical crowns. The premolars and molars are nearly square, wider

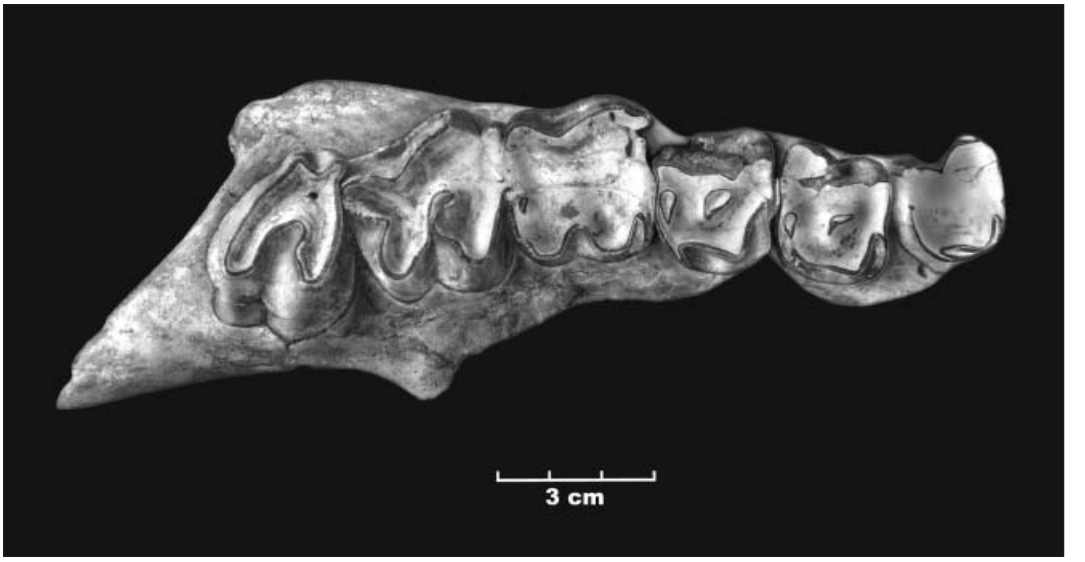

Figure 2 *Protaceratherium albigense*; right maxilla with P2-M3, occlusal view.

than long. There is no cement.

P2-P4 The premolars are semimolariform (protocone and hypocone connected by a lingual bridge; Heissig 1969), further differing from the molars in having strong and complete lingual cingulums. Their ectolophs are broken. The protocone is slightly constricted anteriorly on P3 and P4. There is no crochet at this stage of wear. The wide and drop-like postfossette is as deep as the closed and triangular median valley. There are two distinct labial roots and one large lingual root with two cavities. The size of premolars increases progressively but slightly from P2 to P4 (Table 1).

M1-M3 All the molars have four roots and they display a weak lingual cingulum. The labial cingulum is strong, while the anterior and posterior cingula are weak. The paracone fold is thick on M1-3; the parastyle is sagittally oriented. The protocone is slightly constricted anteriorly, but still stronger than the hypocone is (a shallow groove deforms the antero-lingual side of the hypocone on M2). M2 and M3 have a small antecrochet. The median valley is well open lingually on M2-3. No crochet is preserved on M1-3. The metaloph of M1 is wider than that of M2. The M3 has a straight ectometaloph, resulting from the fusion of the ectoloph and the metaloph. Yet, the talon of M3 is very wide, with a labially displaced posterior cingulum.

Humerus (Fig. 3)

Measurements in mm: Length 257.0; proximal transversal diameter 99.4; proximal antero-posterior diameter 105.2; minimum diameter of diaphysis 36.6; antero-posterior diameter of diaphysis 41.0; distal transversal diameter 75.0; distal antero-posterior diameter 61.3; transversal diameter at *tuberositas deltoidea* 64.0.

The humerus is small and slender. The *tuberculum majus* and minus are broken. The outline of the *caput humeri* forms a regular circle. The *crista humeri*, which starts from the anterior end of the *tuberculum majus cranialis*, comes down to join the *tuberositas deltoidea*, then it turns disto-medially to reach the trochlea humeri. The medial condyle is smaller than the lateral condyle. The *fossa olecrani* is large and laterally elongated. The medial epicondyle forms a small hump above the *fossa olecrani*. The limits of the tuberositas teres on the shaft cannot be observed because of the badly preserved state of this part.

Table 1 Measurements (in mm) of the upper cheek teeth of *Protaceratherium albigense* from Dolhan, Turkey.

	length	width
P2	19.0	23.0
P3	22.0	-
P4	23.0	-
M1	29.0	32.0
M2	33.0	34.5
M3	30.4	34.0

Measurements in mm: Length 39.6; proximal width 22.5; proximal thickness 35.9; width of the proximal articular facet 25.9; height of the same facet 26.5; width of the anterior face 24.2.

The facets for the astragalus and calcaneum form a quite flat saddle. The limit between the facets is marked by a weak sagittal groove. The dorsal central facet has a common border with that of the astragalus. On the medial side, the plantar central facet has also a common border with the posterior facet for Tarsale III. The anterior facet for Tarsale III is elongated antero-posteriorly and it is longer than high. The plantar tuber is large, resembling in that to *Aceratherium simorrense*.

Phalanx I (second digit of posterior limb) (Fig. 5a)

Measurements in mm: Maximum length 25.0; anterior length 18.5; minimum width 20.8; proximal maximum width 23.2; proximal maximum depth 19.3; distal articular maximum width 17.4. The proximal articular facet has a circular outline and it is concave. The distal articular facet is slightly convex. The transverse medial prominence is larger than that of the lateral side. The eminence for collateral ligament is strong.

Phalanx II (third digit of posterior limb) (Fig. 5b)

Measurements in mm: Maximum length 23.1; anterior length 18.0; minimum width 29.9; proximal maximum width 26.0; proximal maximum antero-posterior diameter 17.0; distal articular width 23.6.

The proximal articular facet has an ellipsoid outline. The proximal posterior prominence forms a sharp process. The eminence for the collateral ligament is weak. There is a shallow groove in the medial part of the distal articular surface. This phalanx is wider than longer.

Sesamoid bone (Fig. 5c)

Measurements in mm: Length 18.3; width 12.8. This bone is trapezoidal in its general outline; it has two unequal articular facets.

Figure 3 *Protaceratherium albigense*; left humerus in posterior view.

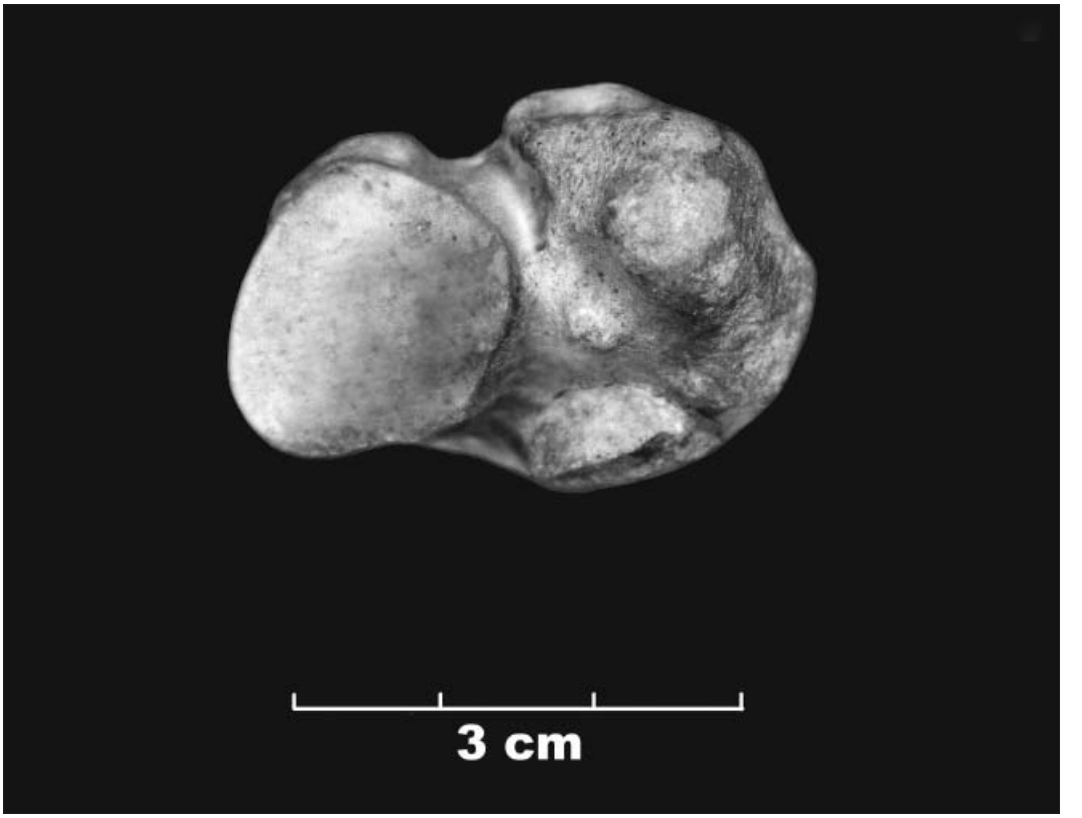

Figure 4 *Protaceratherium albigense*; tarsale IV (cuboid), ventral view.

DISCUSSION

Several dental and postcranial features – such as the combination of an antecrochet and an ectometaloph on M3, the general shape of the humerus and the high posterior tuberosity on the cuboid – point out a rhinocerotid condition. The rhinocerotid from Dolhan is more advanced than *Epiaceratherium* from the early Oligocene of Europe and South Asia (Dal Piaz 1930, Uhlig 1999, Antoine *et al.* 2003), especially on the premolars (lingual cusps, metaloph) and the cuboid, and clearly smaller than other Paleogene rhinocerotids (Antoine *et al.* 2003). On the other hand, the dental features of P2-M3 are similar to those of *Protaceratherium albigense* (ROMAN, 1912) from southern France (Sauzière-Saint-Jean and Marseilles; Roman 1912): general proportions, development of the lingual cingula, shape of the ectoloph, postfossette. Even though 10 mm shorter than the type series (University of Lyon-Villeurbanne, cast FSL 9809), the P2-M3 series from Dolhan falls into the size range of other upper cheek teeth series referred to the same species (Roman 1912, Antoine pers. comm. 2002). Besides, the size of P2-M3 from Dolhan is close to that of *Protaceratherium albigense* from the "middle" Oligocene fissure filling of Csakbery in Hungary (Kretzoi 1940). Yet, the premolar series described by Hugueney & Guérin (1981) from the late Stampian (late Oligocene) of Saint-Menoux (Allier, France) is longer, and thus more advanced, than that of the Dolhan maxilla.

Up to now, the postcranial bones of *P. albigense* had never been described. The small and slender bones at Dolhan locality are recorded together with the cranial fragment, and they show features and dimensions very

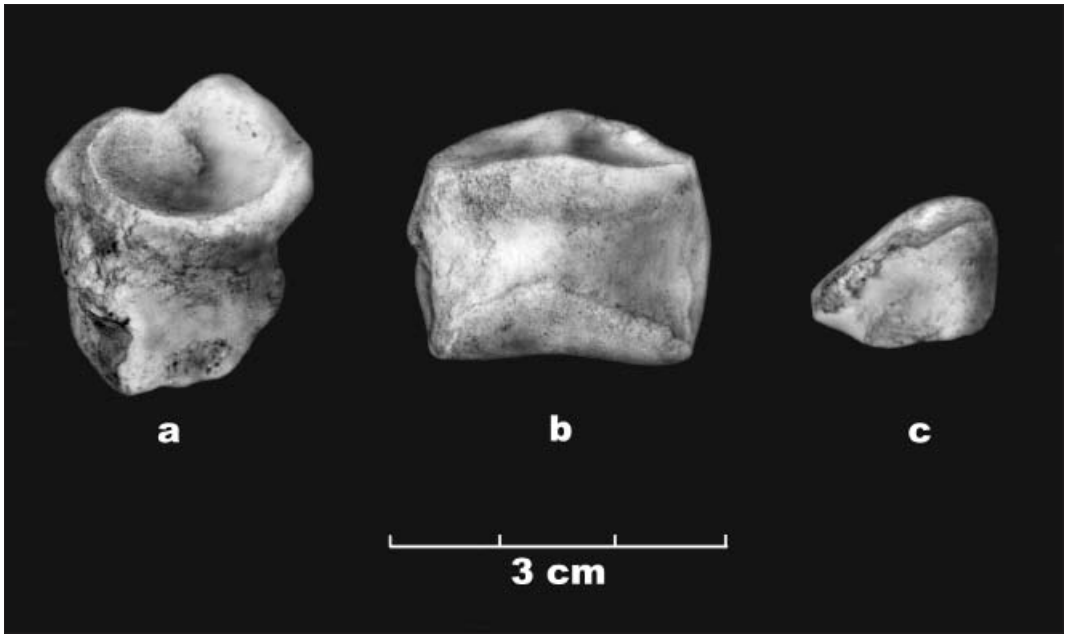

Figure 5 *Protaceratherium albigense*; **a**: phalanx II1, proximal-anterior view; **b**: phalanx III2, anterior view; **c**: sesamoid in articular view.

similar to those of undescribed specimens from the early late Oligocene of Marseilles, stored in the University of Lyon-Villeurbanne (Antoine pers. comm. 2002).

PALEOGEOGRAPHIC AND STRATIGRAPHIC DISTRIBUTION

Beside the type locality, *Protaceratherium albigense* has been recorded at Antoingt and Etampes (France, MP24), Saint-Henri, Saint-André and Les Miles (France, MP27), Coderet (France, MP30) and Itzac (France, late Oligocene), and more doubtfully at Montalbán (Spain, MP23) (Repelin 1916, Thenius 1959, Ginsburg 1969, Brunet 1979, Russell *et al.* 1982). In Belgium, this species was mentioned from the Oligocene deposits at Argile de Boom (Russell *et al.* 1982) and in Hungary in the karstic deposits at Csakbery (Kretzoi 1940). The record at Dolhan is the easternmost occurrence of this species.

CONCLUSIONS

In Turkish Thrace, the fossiliferous Koyunbaba Formation (bottom flow or Islambeyli Formation in Keskin 1974) is formed of coastal detrital sediments, and it unconformably covers the Istrance Massif along its southern slopes. In turn, it is conformably overlain by the Sogucak Limestones (= Kirklareli Limestones). Both formations are rich in nummulites. They were referred in some previous studies to the middle-late Eocene and/or Oligocene. Some other authors (Sirel & Gündüz 1976, Dizer 1985) revealed that these deposits to demonstrate the presence of marine Oligocene in the area.

At the Dolhan locality, the remains of *Protaceratherium albigense* are found in coastal marine deposits, which also include in situ nummulites. This rhinocerotid indicates a late Early to early Late Oligocene age for these deposits (MP24-28; Antoine *et al.* 2003). Several drillings in the area for the purpose of petroleum and natural gas research did not allow the distinction of the Eocene and Oligocene layers based on their nummulite content. The Priabonian age attributed to detrital and recifal deposits

(Koyunbaba formation) of Thrace by some authors is no more trusted than others because of the uncertain boundaries of this stage even in its stratotype (Martini *et al.* 1986).

The oil extracted from the Thracian oil pits is rich in paraffin, and thus suggests an origin of terrestrial plants (Keskin 1974). In the area, sedimentary deposits did not yield yet any Eocene plant fossils. In the southern part of the basin (Malkara, Kesan and Uzunköprü areas), detrital deposits with a dozen interbedded lignite seams cover large areas, and they are known as the Danisment Formation (Lebküchner 1974). They yielded rich mammalian faunas dated to the "middle" Oligocene (Ünay 1989) and also plant remains. The dense vegetation, which favoured the formation of lignite seams, may also be in the origin of paraffin rich oilfields.

The coastal deposits along the southern slopes of the Istranca Massif indicate the presence of shallow marine depositional environments in the area. The quartz sand rich detrital deposits should correspond to depositional environments in bays, while the oolitic limestones are probably deposited in flat shelves with tides. The occurrence of *Congeria* rich limestones suggests also lagunal depositional environments. The lignite formation usually occurs in swamp areas, and in the present context, in marshy basins behind the coastline.

The record of *Protaceratherium albigense* associated with *Nummulites* sp. in the upper horizon of the Dolhan Formation, the discovery of *Mesaceratherium paulhiacense* in the quartz sands of the same formation (Saraç 1987), and the occurrence of *Anthracotherium magnum*, *Elomeryx woodi* and many rodent faunas in the lignite deposits of the southern area (Lebküchner 1974, Saraç 1987, Ünay 1989) show that during the "middle" Oligocene part of the region had terrestrial depositional environments. All these taxa have strong European affinities, and thus indicate that Thrace had strong paleogeographic relationships with Europe during the Oligocene.

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