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THE LATE MIOCENE PERISSODACTYLA IN SAZAK (KALE-DENİZLİ)

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ABSTRACT.- A new mammalian fauna is recognized in the southwest of Sazak (Kale-Denizli). *Hipparion matthewi Abel* and *Ceratotherium neumayri* (Osborn) are described and compared with similar forms from Turkey and Eurasia. The Perissodactyla is indicative of a late Late Miocene (Middle Turolian) age The paleoecologic characteristics suggest a steppe environment with patches of bushes.

INTRODUCTION

The objective of this paper is to describe the Perissodactyla of a new fauna in Sazak, and to discuss their biochronological and the paleoecological aspects.

There is no published data which is directly concerned with the geology of the Sazak area (Kale-Denizli). Regional studies have dealt with some units, which in part may be correlatives of the Neogene continental deposits in the Sazak area (e.g. Nebert, 1956; Yalçınlar, 1951; Taner, 1975). Becker-Platen et al. (1975) recorded *Hipparion* sp., *Diceros neumayri* (Osborn) and *Chilotherium schlosseri* (Weber) in Mahmutgazi (Çal-Denizli), with reference to the Kınık and Garkın fauna groups. Staesche and Sondaar (1979) recognized *Hipparion matthewi* Abel in Mahmutgazi, and suggested a Middle Turolian age. Gökçen (1982) recorded a lower shallow marine and an upper continental Neogene sequence in the surroundings of Muğla-Denizli, and established 10 lithologic subdivisions ranging in age from Early Aquitanian to Pontian, on the basis of ostracods. The Sarayköy lignites are late Middle Miocene and early Late Miocene in age (E. Akyol, 1992, oral communication).

The fossils presented in this paper have been recovered from the continental strata exposed at the Kapuşçabaşı Mevkii, between Kurt Tepe and Yayla Tepe, 1 km. southwest of Sazak (Kale) (Fig. 1).

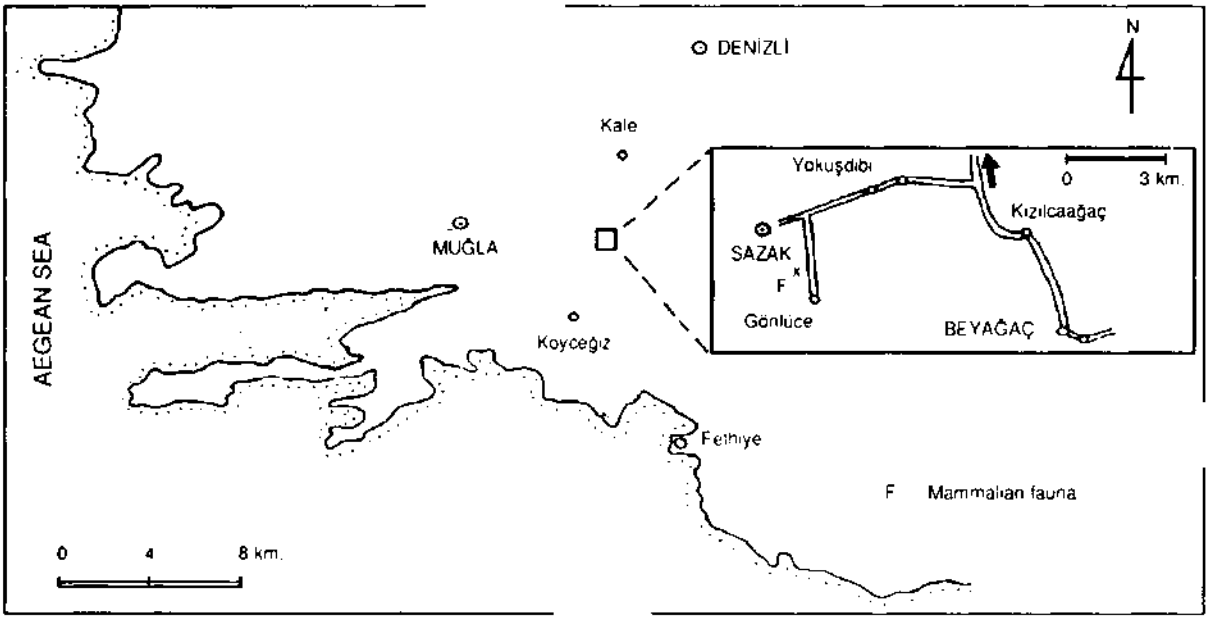

Fig. 1- Location map.

The osteological and odontological terms and systematics used for Hipparion and Ceratotherium follow those of Forsten (1968), Gromova (1952) Prothero and Schoch (1989) and Heissig (1972, 1989), and Klaits (1973). The geological scale is according to Steininger et al. (1989). Mammalian zones are according to Mein (1975). Measurements are given in mm. The material is stored in the Natural History Museum (İzmir).

Abbreviations used in this work are: breadth (br); diameter (dia); metacarpal (Mc); Denizli-Kale-Sazak (DKS); Çanakkale-Gülpınar (ÇG); Muğla-Yatağan-Eski Bayırköy (MYB); Muğla-Yatağan-Salihpaşalar (MYS); Afyon-Sandıklı-Garkın (ASG); Uşak-Eşme-Akçaköy (UEA); Samos 5 (S), Pikermi (P), Saloniki (Sq), Halmyropotamos (H)-Greece; Upper Maragha-Persia (M); Fort Ternan-Kenya (F).

STRATIGRAPHY

Becker-Platen (1970) subdivided the Neogene deposits of southwest Anatolia into four major rock units, in ascending order: the Helvetian-Tortonian Turgut unit (limnic-fluviatile), the Sarmatian-Pontian Sekköy unit (limnic), the Pontian Yatağan unit (terrestrial-fluviatile), and the Dasian Milet unit (limnic). The Yatağan unit, which is widely exposed in southwest Anatolia, consists of two parts: a lower part of gray clayey limestone, interstratified tuffite and claystone, and an upper part of tuffite, brownish limny mudstone, conglomerate, claystone and gray limestone. The fossils of this study have been recovered from the brownish claystone layers in the upper part of the Yatağan unit.

The studied section of the Yatağan unit corresponds to Taner's (1975) early Early Pliocene deposits with *Radix (Adelinella) phrygovata* Oppenheim and late Early Pliocene strata with *Didacna (Pontalmyra) tosunlari* Taner, to Gökçen's (1982) Pannonian and Pontian deposits with *Cypria* sp. and *Darwinula* brew's Straub, to Atalay's (1980) Bayır member, and to Hakyemez's (1989) Yatağan formation.

PALEONTOLOGY

Order : Perissodactyla Owen, 1848
Suborder : Mesaxonia Marsh, 1884
Infraorder : Hippomorpha Wood, 1937
Superfamily :Equoidea Gray, 1821
Family :Equidae Gray, 1821
Subfamily :Equinae Gray, 1821
Tribe : Hippotheriini Bonaparte, 1850
Genus : Hipparion de Christol, 1832
Type species : Equus primigenius Von Meyer, 1829
Hipparion matthewi Abel, 1926
Pl. I,fig. 1,2

Material

Juvenile right mandibular fragment with DP_2-DP_4 (DKS-1); left astragalus (DKS-2); left calcaneum (distal part) (DKS-3).

Description

DP_2-DP_4.- The height of the ramus is 28 mm. under the middle of DP_2 and 37 mm under the middle of DP_4. The teeth are high-crowned. The external depression between the protoconid and the hypoconid is shallow. The enamel of the borders of the anterior and posterior fossetula is slightly crenellated. The protostylid and the ectostylid have not reached the occlusal surface. The cement and the enamel are thick.

Astragalus.-*The* astragalus is small. On the plantar view there are three facets for the calcaneum. Proximally the ectal facet meets the trochlea in an acute edge. There is a gap on the lateral part. The ectal facet meets the small and the long calcaneal facet in a blunt cret. The sustentacular facet is long and convex in proximo-distal direction. It extends all along the height of the astragalus. The distal surface is occupied by the navicular facet, which is convex in dorso-plantar direction. The cuboid facet is quadrate-shaped and small, it forms almost a right angle with the navicular facet. The medial tuber is rounded.

Calcaneum-The calcaneum and the astragalus belong to the same individual. The tuber calcanei is broken. On the dorsal view the sustentaculum tali forms an acute elbow. There are three articulation facets for the astragalus. The ectal facet is proximally convex, distally concave. The calcaneal facet is narrow and long towards the distal direction. The sustentacular facet is long and concave in proximo-distal direction. The distal facet (for the cuboid) is quadrate-shaped, ending rather abruptly in the plantar direction. The lateral surface of the calcaneum is rough.

Comparisons

In respect to the morphology and size of the teeth and bones, Hipparion matthewi from Sazak is similar to those from Samos 5 (Werhli, 1941; Sondaar, 1971), Saloniki (Arambourg and Piveteau, 1929; Forsten, 1968), Upper Maragha (Bernor, 1978), Gülpınar (Kaya, 1986) and Salihpaşalar (Kaya, 1991) (Table 1,2,3).

Table 1- Measurements of DP_2-DP_4 of ***Hipparion matthewi***

	DKS-1	Samos 5 Sondaar, 1971	Samos 5 Werhli, 1941
DP_2 length/width	27/9	-	-
DP_3 length/width	24/8	-	-
DP_4 length/width	26/6	-	
DP_2-DP_4 length	77	80 5	69

H. matthewi is a small Hipparion. The size of H. matthewi is close to H. gromovae Villalta and Crusafont from Valdecebro (Spain) (Sondaar, 1961: astragalus height 43.5 mm., astragalus breadth distal articulation surface 32.7 mm.) and *H. macedonicum* Koufos from Ravin des Zouaves (Greece) (Koufos, 1987a: astragalus height 41.5 mm., astragalus breadth distal articulation surface 32 mm.). *H. matthewi* is smaller than *H. elegans* Gromova from Pavlodar (Siberia) (Forsten, 1968: astragalus height 47.4 mm., astragalus breadth distal articulation surface 35 mm.). *H. matthewi* is different from very small-sized *H. periafricanum* Villalta and Crusafont from Valdecebro (Sondaar, 1961: astragalus height 30.5 mm., astragalus breadth distal articulation surface 22.6 mm.).

Suborder : Ceratomorpha Wood, 1937
Family : Rhmocerotidae Gray, 1821

Table 2- Measurements of astragalus of *Hipparion matthewi*, Samos5, Saloniki and Upper Maragha are taken from Forsten (1968)

	DKS 2	ÇG	MYS	S	Sq	M
a Maximum length	45	46	43	49 2	39 7	45 6
b Length at the internal trochlea	44	41	42	-	-	-
c Length at the external trochlea	39	31	38			-
d Maximum breadth	39	36	41		-	-
e Breadth of the distal facet	32	36	31	36 8	30 5	34 8
f Diameter of the distal facet	24	28	22			-
g Minimum breadth at the trochlea	19	21	20		-	-
$\frac{e}{a} \times 100$	71 1	78 2	72	74 7	76 8	76 3

Table 3- Measurements of calcaneum of *Hipparion matthewi*

	DKS-3	ÇG	MYS
a Distal breadth	34	-	34
b Distal diameter	38	37	36
c Diameter of the corpus	32	-	31
d Breadth of the corpus	13	14	13
$\frac{d}{c} \times 100$	40 6		41 9

Subfamily : Rhinocerotinae Gray, 1821
Tribe : Dicerotini Groves, 1983
Genus : Ceratotherium Gray, 1867
Type species : *Ceratotherium simum* (Burchell, 1817)
Ceratotherium neumayri (Osborn, 1900) Geraads, 1988
Pl. I, fig. 3, 4, 5

Material

Right carpal-4 (DKS-4), right metacarpal-III (DKS-5)

Description

Carpal-4.- The dorsal surface of the Sazak specimen is very large and flat. The ulnar facet slightly encroaches upon the dorsal surface. The posterior parts of proximal facets are free of grooves. The above mentioned characteristics belong to Rhinocerotini (Heissig, 1972).

The ulnar facet is convex in antero-posterior direction. It is lacking a volar appendix. An acute angle exists between the ulnar and intermedium facets. The intermedium facet is concave vertically, and separated from the carpal-3 facet by an acute ridge. There is a dorsal groove in medio-lateral direction in the middle of the dorsal surface.

On the medial view the carpal-3 facet is quadrate-shaped, smooth and deeper than it is wide.

The metacarpal-III facet is slightly concave and narrow in dorso-volar direction. The Mc-IV facet is convex transversely, and broad in front. It is narrow in dorso-volar direction. The Mc-V facet is concave and narrower than the Mc-IV facet in dorso-volar direction. The Mc-V facet is separated from the volar projection by a deep groove.

The protuberance is broad and rounded proximo-distally as well as transversely. The volar projection ends bluntly.

The medial tuber is situated below the cret between the ulnar and intermedium facet, and well developed. The lateral tuber is slightly developed and situated on the farther lateral part of the dorsal surface.

Metacarpal-III- The carpal-4 and the metacarpal-III belong to the same individual. The proximal end is narrower than the distal one. The proximal tuberosities are flat. A shallow groove separates the tuberosities, The medial tuberosity spreads in the middle and lateral parts of the bone. The lateral tuberosity is small and situated below the cret between the carpal-3 and carpal-4 facets. The above mentioned characteristics belong to Rhinocerotini (Heissig, 1972).

The proximal mam facet for the carpal-3 is triangular-shaped and deep. It is narrow and concave -in medio-lateral direction. Its hind part is turned medially. There is a triangular-shaped hump between the volar Mc-IV facet and carpal-3 facet. The carpal-4 facet is convex and deep. It is separated from the carpal-3 facet by an acute cret.

On the lateral view, the Mc-IV facet consists of two separate facets. The distance between these facets is 9 mm. The dorsal Mc-IV, facet is vertical, triangular-shaped and concave. The volar one is rounded, concave and isolated.

Table 4- Measurements of carpal-4 of Dicerotini. ASG, MYB, *D. neumayri* (Heissig, 1975b); P, *Rhinoceros pachygnathus* (Gaudry, 1862); P. *Diceros pachygnathus* (Guérin, 1980)

	DKS-4	*ASG*	*MYB*	*P*	*P*
a Maximum breadth	71	69	70	67	71
b Height	42	56	52	58	47
c Diagonal diameter	82	81	.	96	95 75
d Diameter	57				71 75
e Br/dia of the intermedium facet	39/31	36/34	31 31		.
f Br/dia of the ulnar facet	26/27	44 34	32		.
g Br/dia of the Mc-III facet	22/18				.
h Br/dia of the Mc-IV facet	31/27	34	37		.
ı Br/dia of the Mc-V facet	22 17	23			.
$\frac{a}{c} \times 100$	86 5	85 1		69 7	74 1
$\frac{b}{c} \times 100$	51 2	69 1		60 4	49

Mc-II facet is deep in dorso-volar direction and narrow vertically.

A shallow groove with proximo-distal extension exists above the dorsal part of the distal trochlea. On the volar view the sagittal keel is sharp. The shaft is flat and rough on both sides. The volar part of the distal trochlea bears two vertical grooves.

Comparisons

The carpal-4 of *C.* neumayri from Sazak resembsles those of Diceros neumayri (Osborn) from Garkın and Eski Bayırköy (Heissig, 1975b), *Rhinoceros pachygnathus* Wagner from Pikermi (Gaudry, 1862), and *Diceros pachygnathus* (Wagner) from Pikermi (Guerin, 1980) in shape as well as in size (Table 4).

The carpal-4 from Sazak is larger than Rhinocerotini type 1 and 2 from Siwalik (Pakistan) (Heissig, 1972; type 1 breadth 51 mm., height 42 mm., diameter 54 mm.; type 2 breadth 57 mm., height 47 mm., diameter 62 mm.). The size of the Sazak material is intermediate between *Dicerorhinus sumatrensis* (Fischer) from Sumatra (Hooijer, 1966: maximum breadth 61 mm.) and *Dicerorhinus ringstroemi* Arambourg from Shansi (China) (Hooijer, 1966: maximum breadth 78 mm.).

The carpal-4 from Sazak is similar to Rhinocerotini type 1 by the presence of the narrow Mc-IV and Mc-V facets in dorso-volar direction, and by having a deep groove between the Mc-V facet and volar projection. The Mc-V and Mc-IV facets are deep in Rhinocerotini type 2 (Heissig, 1972). These facets are independent surfaces in *Brachypotherium brachypus* (Lartet) from Sansan (Klaits, 1973). *C. neumayri* is close to the Rhinocerotini type 2 by the absence of the volar appendix of the ulnar facet (Heissig, 1972).

The dorsal surface of carpal-4 is very large and flat, whereas it is small and flat in Elasmotherini, and it is very narrow and high in Aceratherini (Heissig, 1976; Yan and Heissig, 1986).

The Mc-III from Sazak resembles *C. neumayri* from Salihpaşalar, *D. neumayri* from Garkın (Heissig, 1975b), and *D. pachygnathus* from Pikermi (Guenn, 1980) in shape as well as in size (Table 5). The Sazak specimen is larger than *D. neumayri* from Eşme-Akçaköy (Heissig, 1975b) (Table 5).

Table 5- Measurements of metacarpal-III of Rhinocerotinae. MYS, *C. neumayri*; ASG, UEA, *D. neumayri* (Heissig, 1975b); P. *D. pachygnathus* (Guerin, 1980); H, *D. orientalis* (Melentis, 1970); F, *P. mukirii* (Hooijer, 1968)

	DKS-5	MYS	ASG	UEA	P	H	F
a	195	-	181		-	-	-
b	178	-	164		188,4	170	152
c	64	67	72	(62)	63,2	58	56
d	47	47	59	49	53,5	53	43
e	41	46	46	38	-	-	-
f	45	43	58	47	-	-	-
g	25	20	26	24	-	-	-
h	26	24	29	27	-	-	-
i	53	58	59	-	62,5	51	42
j	17	19	22	-	24,4	22	21
k	66	-	76	-	70,5	63	52
l	51	-	56	-	55,0	-	47
m	34	-	50	-	46,9	40	37
$\frac{i}{b} \times 100$	29,7	-	35,9	-	33,1	30	-
$\frac{k}{b} \times 100$	37,0	-	46,3	-	37,4	37	-

a- Maximum length, b- median length, c- proximal breadth. d- proximal diameter, e- breadth of the carpal-3 facet, f- diameter of the carpal-3 facet, g- breadth of the carpal-4 facet, h- diameter of the carpal-4 facet, i- breadth in the middle of the shaft, j- diameter in the middte of the shaft, k- distal breadth, l - breadth at the trochlea. m- diameter at the trochlea

The Sazak material is longer than *Dicerorhinus orientalis* (Schlosser) from Halmyropotamos (Melentis, 1970) and *D. sumatrensis* (Hooijer, 1966: median length 158 mm, distal breadth 59 mm). The measurements of the proximal and distal ends are similar (Table 5). The Mc-III of C. *neumayri is* shorter than that of *D. orientalis* from Shansi (Ringström, 1924: median length 187 mm., distal breadth 68 mm.). The Mc-III from Sazak is relatively longer than that of *Paradiceros mukirii Hooijer* (Hooijer, 1968) from Fort Ternan (Table 5).

PALEOECOLOGY

The fossils occur in lenticular masses of brownish claystones. The bones have been accumulated by fluviatile transport. The connected skeletal parts may suggest slight water movements, or a short fluviatile transport.

H. matthewi is a steppe species: (Forsten, 1968). Its teeth structure and gracile bones are indicative of adaptation to a xerophytic environment. *C. neumayri* (Heissig, 1975a) and the other faunal elements, *Pachytragus* sp. and *Gazella* sp. (Berg, 1975) suggest, as a whole, a habitat of open country and shrub. The paleoecologic characteristics of the fossils suggest a steppe environment with patches of bushes.

The above environmental evaluation is compatible with the steppe-like to semi-arid conditions proposed by Benda and Meulenkamp (1990) for the Turolian in western Anatolia on the basis of Kızılhisarpollenassociation.

AGE

In western Anatolia, the strata with *H. matthewi* (e.g. Mahmutgazi-Denizli; Eski Bayırköy, Bayırköy, Salihpaşalar, Şerefköy, Akkavak-Muğla; Kemiklitepe-Uşak; Karain, Taşkınpaşa-Nevşehir; Ebiç-Kayseri; Kavakdere, Evciköy-Ankara) are of Turolian age (Becker-Platen et al., 1975; Atalay, 1980; Kaya, 1991). The above mentioned faunas have usually been considered to be correlative of the Kınık fauna group (MN 12) (Staesche and Sondaar, 1979; Kaya 1991). The Upper Maragha and Samos 5 faunas with *H. matthewi* were assigned to Middle-Late Turolian MN 12, MN 13, respectively) by Steminger et al. (1989). *H. matthewi* has also been recorded from the Pontian of Ploski Blagoevradsko, from the Meotian of Ezerovo (Bulgaria), and'from the Turolian of Beluska and Vozarzi (Macedonia) (Forsten, 1978a; Forsten and Garevski, 1989).

C. neumayri is known in Late Miocene (Vallesian and Turolian) faunas (Heissig, 1975a), and exhibits an increase in size in its evolutionary trend. The small specimens occur in the Vallesian of Eşme-Akçaköy and the Lower Torulian of Kayadibi, and the large-sized ones are present in the Lower Turolian of Garkın and the Middle Turolian of Kınık. Strong specimens are known in the Late Turolian Amasya fauna.-The measurements of the Sazak specimens indicate a Middle-Late Turolian age.

In conclusion, the Perissodactyla of Sazak may indicate a Middle Turolian age.

RESULTS

-The Perissodactyla in Sazak, which are recognized in the upper part of the Yatağan unit, include *Hipparion matthewi* Abel and *Ceratotherium neumayri* (Osborn). *H. matthewi* is similar to those of Çanakkale, Muğla, Samos 5 and Upper Maragha. *C. neumayri* resembles those of Afyon, Muğla and Pikermi. The size of *C. neumayri* indicates a high evolutionary level. These fossils are of a late Late Miocene age (Middle Turolian). The paleoecological characteristics are indicative of a steppe environment with patches of bushes.

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REFERENCES

Abel, O.. 1926, Die Geschichte der Equiden auf dem Boden Nordamenkas: Verh. zool. Ges. Wien, 74-75, 159-164.

Arambourg. C. and Piveteau, J., 1929, Les vertebres du pontien de Salonique: Ann. Paleontol., XVIII, 59-138.

Atalay, Z., 1980, Muğla-Yatağan ve yakın dolayı karasal Neojen'inin stratigrafi araştırması: TJK Bull, C 23, 93-99, Ankara.

Becker-Platen, J.D., 1970, Lithostratigraphische untersuchungen in Kanozoikum Sudwest-Anatolians (Turkei): Beih. Geol. Jb., 97, 1 -244.

———; Sickenberg, O. and Tobien, H., 1975, Die Gliederung der Kanozoischen Sedimente der Turkei nach Vertebraten-Faunengruppen: Geol. Jb., B 15, 1-100.

Benda, L. and Meulenkamp, J.E., 1990, Biostratigraphic correlations in the eastern Mediterranean Neogene: Newsl. Stratigr., 23, 1,1-10.

Berg, D.E., 1975, Miozane Boviden (excl. Ovibovinen) aus der Turkei: Geol. Jb. B 15, 157-158.

Bernor, L., 1978, The mammalian systematics biostratigraphy and biochronology of Maragha and its importance for understanding Late Miocene Hominoid zoogeography and evolution: Ph. D. Univ. California, 314.

Forsten, A.M., 1968, Revision of the Palearctic *Hipparion:* Acta Zool. Fennica, 119, 1-134, Helsingfors.

———, 1978a, A review of Bulgarian *Hipparion:* Geobios, 11 (1), 31-41.

Forsten, A. and Garevski, R., 1989, Hipparions/ mammalia, Penssodactyla from Macedonia/ Yugoslavia: Geol. maced., T 3, Nr. 2, 1 59-206.

Gaudry, A., 1862, Animaux fossiles et geologie de l'Attique: F. Savy., LXXV, 476, Paris.

Geraads, D., 1988, Revision des Rhinocerotinae (Mammalia) du Turolien de Pikermi. Comparaison avec les formes voisines: Ann. Pal., 74, 1, 13-41.

Gökçen, N., 1982, Denizli ave Muğla çevresi Neojen istifinin ostrakod biyostratigrafisi: Yerbilimleri, 9, 111-131, Ankara.

Gromova, V., 1952, Le genre *Hipparion:* Inst. Paleont. Acad. Sci. URSS 36. Translated from Russam by St. Aubin., C.E.D.P;. 12, 1-288.

Guerin, C., 1980, Les Rhinoceros (Mammalia, Perissodactyla) du Miocene terminal au Pleistocene superieur en Europe occidentale, comparaison avec les especes actuelles: Doc. Lab. Geol. Fac. Sci., 79, 1-421, Lyon.

Hakyemez, H.Y., 1989, Geology and stratigraphy of the Cainozoic sedimentary rocks in the Kale-Kurbalik area, Denizli, Southwestern Turkey: MTA Bull., 109, 1-14, Ankara.

Heissig, K., 1972, Palaontologische und geologische Untersuchungen im Tertiar von Pakistan. 5. Rhinocerotidae (Mamm.) aus der unteren und mittleren Siwalik-Schichten. Abh. Bayer. Akad. Wiss. Math. Nat. Kl. N.F., Heft 152, 1-112, München.

———, 1975a, Rhinocerotidae aus dem Jungtertiar Anatoliens: Geol. Jb., B 15, 145-151.

———, 1975b, Rhinocerotidae aus dem Jungtertiar Anatoliens. 600 p.,(unpublished), Münih.

———, 1976, Rhinocerotidae (Mammalia) aus der *Anchitherium-Fauna* Anatoliens: Geol. Jb., B 19, 3-121.

———, 1989, The Rhinocerotidae: 399-417. In Prothere, D.R. and Schoch, R.M. (eds). The evolution of Perissodactyls, Oxford Univ. 537p.

Hooijer, D.A., 1966, Miocene Rhinoceroses of East Africa: Bull. Brit. Muş 13, 2(Foss. Mamm. Afr. 21) 117-190,London.

———, 1968, A Rhinoceros from the Late Miocene of Fort Ternan, Kenya: Zoologische Mededelingen, Deel, 43, 6, 77-92.

Kaya, T., 1986, Çanakkale ve çevresi Perissodactyla fosilleri: Doktora Tezi, 229p. (unpublished), Izmir.

———, 1991, Muğla yöresindeki Genç Miyosen yaşlı memeli faunasındaki Perissodactyla bulguları: Suat Erk Sempozyumu, Ankara.

Klaits, B.G., 1973, Upper Miocene rhinoceroses from Sansan (Gers.) France: The manus: Jour. Paleontology, 47, 315-327, Kansas.

Koufos, G.D., 1987a, Study of the Turolian Hipparions of the lower Axios valley (Macedonia, Greece). Geobios, n. 20, 3, 293-312.

Mein, P., 1975, Resultats du Groupe de travail des Vertebres: In Senes, J., (ed), "Report on Activity of R.C.M.N.S. Working Group", Reg. Comm. Med. Neogene Stratigraphy, 78-81.

Melentis, J.K., 1970, Die Pikermifauna von Halmyropotamos (Euboa, Griechenland): Ann. Geol. Des. Pays, Hellen, I serie, 19, 283-411, Athen.

Nebert, K., 1956, Denizli-Acıgöl mevkiinin jeolojisi. 1/100.000'lik Denizli 105/1, 105/2 ve Isparta 106/1 paftalarının sahası içinde yapılan jeolojik harita çalışmaları hakkında rapor: MTA Rep., 2509, 107p. (unpublished) Ankara.

Osborn, H.F., 1900, Phylogeny of the Rhinoceroses of Europe: Bull. Amer. Muş Nat. Hist., 8, 229-267, New York.

Prothero, D.R. and Schoch, P.M., 1989, Classification of the Perissodactyla: In Prothero, D.R. and Schoch, R.M. (eds). The evolution of Perissodactyls, Oxford Univ., 537p.

Ringstrom, T.J., 1924, Nashorher der Hipparion-Fauna Nord-Chinas: Pal. Sinica, C, 1, 1, 1-159, Peking.

Sondaar, P.Y., 1961, Les *Hipparion de* l'Aragon meridional: Estudios Geol., 17, 209-305, Madrid.

Sondaar, P.Y., 1971,The Samos *Hipparion:* Proc. Kon. Neder.Akad.Wetensch.,B74,4,417-441,Amsterdam.

Staesche, U. and Sondaar, P.Y., 1979, *Hipparion* aus dem Valesium und Turolium (Jungtertiar) der Turkei: Geol. Jb., B 33, 35-79, Hannover.

Steininger, F.F.; Bernor, R.L. ve Fahlbush, V., 1989, European Neogene marine/continental chronologic correlations: European Neogene mammal chronology, 15-46, New York.

Taner, G., 1975, Denizli bölgesi Neojeninin paleontolojik ve stratigrafik etüdü lll: MTA Bull., 85, 45-66, Ankara.

Werhli, H., 1941, Beitrag zur Kenntniss der Hipparionen von Samos: Pal., Zeitschr., Bd., 22, 321-386, Berlin.

Yalçınlar, I., 1951, 1961 yazında arazi çalışmalarına ait rapor: MTA Rep., 3261 (unpublished), Ankara.

Yan, D..and Heissig.K., 1986, Revision and autopodial morphology of Chinese-European Rhinocerotid genus *Plesiaceratherium* Young 1937: Abh. Bayer. Staatsslg.Palaont.hist.Geol.,14,81-110.Zitteliana.

PLATE

PLATE-I

Hipparion matthewi Abel 1926

Fig. 1- Juvenile right mandibular fragment with DP_2-DP_4 (DKS-1) (occlusal view) (X1)

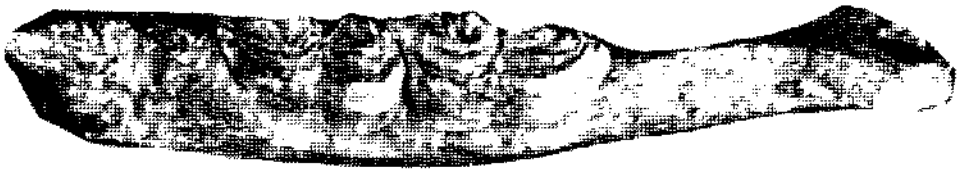
Fig. 2- Left astragalus+calcaneum (DKS-2, DKS-3) (dorsal view) (X1)

Ceratotherium neumayri (Osborn, 1900) Geraards, 1988

Fig. 3- Right carpal-4 (DKS-4) (distal view) (X1)

Fig. 4- Right metacarpal-III (DKS-5) (dorsal view) (X1/2)

Fig. 5- Right metacarpal-III (DKS-5) (volar view) (X1/2)



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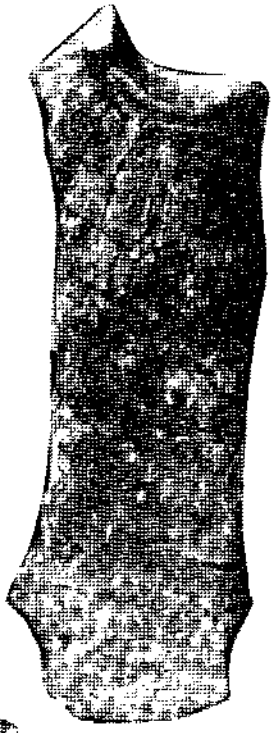

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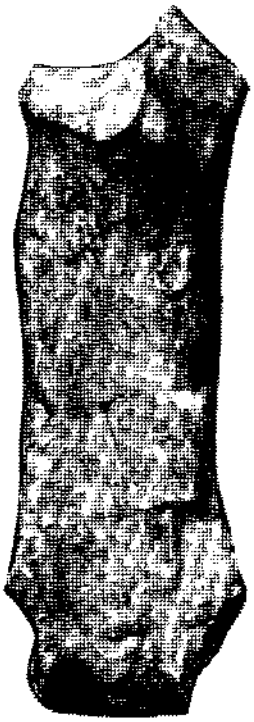

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