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LATE MIOCENE MAMMALS FROM TAGHAR, KHURDKABUL BASIN, AFGHANISTAN

PAR

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Résumé. – Cette note décrit les restes de mammifères récoltés dans le gisement de Taghar en Afghanistan. Le niveau fossilifère se trouve dans les dépôts fluviatiles du bassin de Khurdkabul, à une cinquantaine de kilomètres au SE de Kabul. La faune contient dix espèces parmi lesquelles *Hipparion* cf. *H. molayanense*, *Palaeotragus* cf. *P. rouenii*, cf. *Cervavitus novorossiae* et *Tragoportax* sp. sont les mieux représentées. Le mauvais état de conservation des spécimens et l'insuffisance des connaissances sur les faunes similaires dans cette région ne permettent pas d'affiner les déterminations. Cependant, la position stratigraphique de Taghar situé 35 m sous le niveau de Molayan qui est un gisement exceptionnellement riche, ainsi que les ressemblances de certains taxons autorisent à attribuer cette faune au Turolien inférieur.

Abstract. – This paper presents the description of all mammalian remains from the locality of Taghar which is situated in the fluviatile deposits of the Khurdkabul basin, Afghanistan. This locality has yielded ten species of large mammals among which *Hipparion* sp. cf. *H. molayanense*, *Palaeotragus* sp. cf. *P. rouenii*, cf. *Cervavitus novorossiae* and *Tragoportax* sp. are of special interest. The fact that the specimens are often damaged, and because of the lack of

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knowledge concerning similar mammalian faunas from the surrounding regions, detailed systematic assignments of taxa are difficult. Nevertheless, the stratigraphic position of Taghar 35 m below the richest Afghani locality of Molayan, and also the comparison of some reliable taxa, allow the attribution of the Taghar fauna to the early Turolian (MN11).

INTRODUCTION

Between 1976 and 1979, French palaeontological expeditions have prospected some intramontane basins of Afghanistan, and discovered about twenty fossil mammal localities, all of late Miocene-Pliocene age. Before this, our knowledge of the Neogene faunas of Afghanistan was limited to few small mammal remains from the Bamian Basin (Lang & Lavocat, 1968 ; Flynn, 1983) and to some fragments of large mammals from the Jalalabad Basin (Raufi & Sickenberg, 1973 ; Heintz *et al.*, 1978a).

Among the mammal localities of Afghanistan, Molayan is by far the richest in terms of diversity and number of specimens (Heintz et al., 1978b ; Brunet et al., 1984). A few hundred meters away from it, and stratigraphically lower, is the locality of Taghar ; it was discovered and excavated in September 1978. The bones occur concentrated in a lenticular bed, at most one meter thick, composed of green-grey sands with some clay. This locality has yielded over one hundred specimens of large mammals. Small mammals have not been found in a test-sample.

The purpose of this paper is to describe all mammalian taxa from the locality of Taghar. The age of this locality is discussed and the fauna compared with similar mammal faunas from Afghanistan and the surrounding regions. The material is stored in the collections of the Institut de Paléontologie du Muséum National d'Histoire Naturelle, Paris.

GEOLOGY AND STRATIGRAPHY OF THE TAGHAR AREA

The Taghar mammal locality (34°.21' N and 39°.25' E) is situated in the southern edge of the intramonte basin of Khurdkabul. The corresponding 1:50.000 topographic map is number 510 E II. The geology of the area was studied by Mennessier (1968, 1974). Figure 1 partly reproduces the geology of this basin as published by this author.

The basement of the Khurdkabul Neogene Basin is formed by metamorphic rocks of the « Série de Kabul » in its southern border, and by limestones of the « Série de Khinguil » and the « Série de Katagae » in the west and south ; they are tentatively dated as Permian to Eocene (Mennessier, 1968).

In the southern part of the Khurdkabul Basin, the Neogene deposits are detrital sediments which are mainly greyish, pinkish or reddish coloured conglomerates, sands and clays, interpreted as channel fillings and flood-plain deposits. There are also some limestone intercalations indicating limited lacustrine environments ; their thickness in the area never exceeds one meter. Toward the center of the basin, near the villages of Malang, Dawrankhel and Khurdkabul, sediments are more clayey, their colors are blue-green or yellowish, and the limestones are thicker.

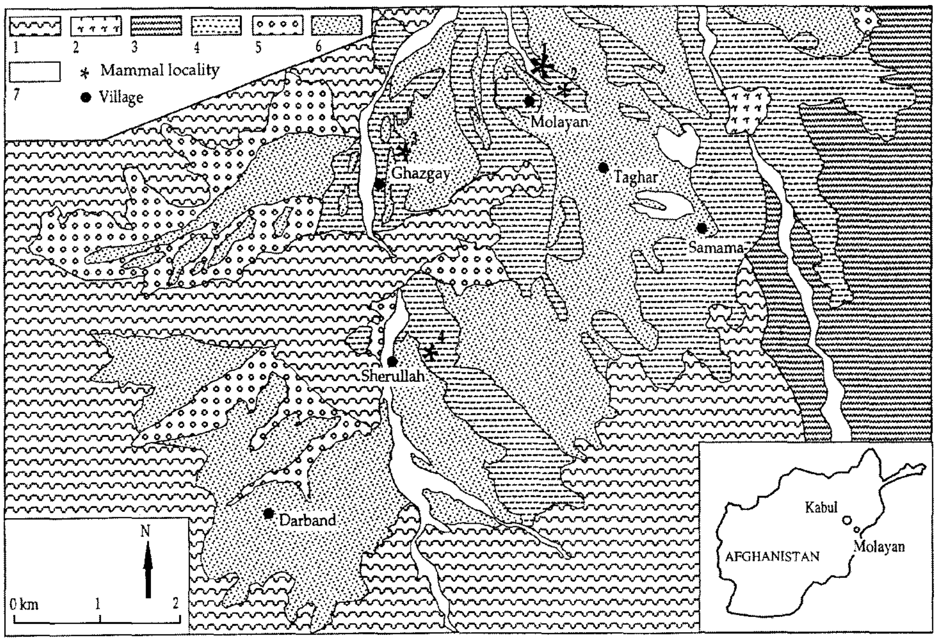

FIG. 1. Geological map of the southern part of the Khurdkabul Basin (after Mennessier, 1974, modified) and the location of some mammal localities. 1) Molayan, 2) Taghar, 3) Ghazgay and 4) Sherullah. Lithologic legend : 1) Metamorphic rocks of the «Série de Kaboul» ; 2) Diorits ; 3) Cretaceous schists of the «Série de Kotagae» ; 4) Neogene deposits of the «Série de Lataband» ; 5) old terraces and screes ; 6) new terracees and screes ; 7) recent alluvium.

Fig. 1. Carte géologique de la partie sud du bassin de Khurdkabul (modifiée d'après Mennessier, 1974) et la position de quelques gisements de mammifères. 1) Molayan, 2) Taghar, 3) Ghazgay, 4) Sherullah.

The Neogene deposits of the Khurdkabul Basin, as well as those from the neighbouring basins, east of Kabul, were grouped by Mennessier (1968) under the name of «Série de Lataband». Based on a few molluscs, he estimated its age as ranging from the early Miocene to the ? Pliocene. The lack of reliable biochronologic criteria was the main reason that hampered this author in his study of the stratigraphic units within the Khurdkabul Basin.

Due to the active Neogene and post-Neogene tectonics, the area was uplifted during Pliocene and Quaternary times. Consequently, the Neogene deposits are now situated at over 2000 m. The altitude of the Taghar mammal locality is about 2350 m.

Despite this, the Neogene deposits are horizontal or gently dipping (<4°) toward the northeast in the area of Taghar and Molayan. It is not clear if this gentle dip is synsedimentary or due to tectonic tilting.

In the southern part of the Khurdkabul Basin, the Neogene deposits are largely covered by recent sediments which occur as terraces, screes and alluvium ; these deposits are refection of the intense erosion of the surrounding massifs due to the general uplift of the area since Neogene times (Mennessier, 1968). In spite of the lack of vegetation, the Neogene deposits only outcrop in ravines and hills, while the flat surfaces are covered by recent sediments.

The mammal locality of Taghar is situated about 1.5 km NE of the small village of Taghar, and it is in fact closer to the village of Molayan (about 0.8 km NE) than to the village of Taghar ; however, as the name of Molayan was first used to define another mammal locality, the team of the 1978 expedition has decided to name the locality here concerned as Taghar.

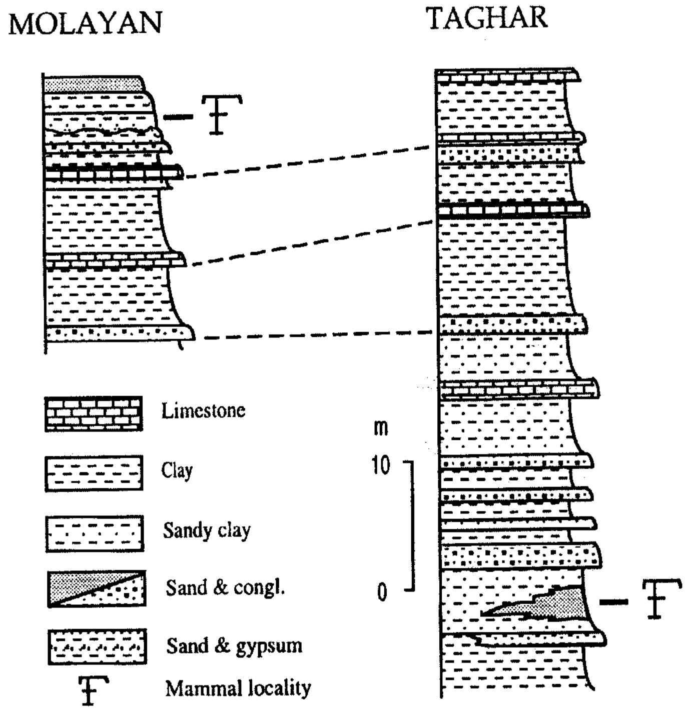

FIG. 2. Lithostratigraphy of two sections across the mammal localities of Taghar and Molayan, and their correlation.

Fig. 2. Lithostratigraphie de deux coupes au niveau des localités de Taghar et de Molayan et leur corrélation.

The mammal-bearing horizon crops out in a gully, about 400 m southeast of the hillock the top of which forms the Molayan mammal locality. This hillock is particularly prominent in the surrounding desertic landscape.

The lithostratigraphy of the section containing the Taghar mammal locality is given in Figure 2. The deposits show an alternation of sandstones and clays (silty) of fluviatile origin. The mammal remains are included in a lenticular sandy bed which has a grey-green colour. A few metres above the fossiliferous horizon, the alternation of sandstones and clays is more regular than elsewhere. In the upper part of the section, there are some thin and laterally continuous limestone intercalations (their thickness never exceeds one metre), which are used for correlation across the area. Thanks to these limestones, two sections could be correlated. The Molayan mammal locality is stratigraphically about 35 m above the Taghar locality (Fig. 2). The thin limestones which occur in the upper part of this section can be interpreted as having accumulated in temporary shallow lacustrine environments. So, through this section, it can be postulated that there was a shift from a dominant fluviatile sedimentation with rythmic seasonal deposits to a floodplain sedimentary environment in which temporary ponds were developed in parts of this basin.

MAMMAL FAUNA

Order : PERISSODACTYLA Owen, 1848

Family : Equidae Gray, 1821

Genus : *Hipparion* Christol, 1882

***Hipparion sp. cf. H. molayanense* Zouhri, 1992**

(Plate 1, Figs 1-5)

Material. – Right upper milk toothrow with dP^2-dP^4, AFG-1016 ; dP^2 sin, AFG-1017 ; dP^4 sin, AFG-1018 ; maxilla with both toothrows, AFG-1015 ; M^3 dex, AFG-1019 ; part of the mandible with dP_2-dP_4 sin and dP_3-dP_4 dex, AFG-1026 ; P_2 dex, AFG-1021 ; two astragali, AFG-1043, 1064 ; two pieces of calcaneum, AFG-1057, 1058 ; two naviculars, AFG-1047, 1048 ; two third metatarsals, AFG-1039, 1040 ; third phalanx, AFG-1066.

Measurements. – The measurements are given in Tables I-III ; they were taken according to the system proposed by Eisenmann *et al.* (1988).

Description

1. Milk dentition (Pl. 1, Fig. 2 ; Tables I, II)

The length dP^2-dP^4 is 94.0 mm (AFG-1016). The fossettes are closed and unconnected, with moderate enamel plication ; the prefossette of dP^2 is more plicated than in the other teeth. The protocone is isolated and rounded with a straight lingual wall in dP^4. The pli-caballin is small and double ; in dP^2 AFG-1017 it is connected with the prefossette. The hypocone is elliptical with a deep distal hypoconal groove ; in dP^2 AFG-1017 there is a well-developed lingual hypoconal groove too, while in the very worn dP^2 AFG-1016 it has disappeared.

The length of dP_2-dP_4 is 87.7 mm (AFG-1026). The paraconid of dP_2 is elongated while the parastylid is strong and extended across the mesial border of the teeth. The metaconid and the metastylid are rounded in dP_2 ; in $dP_{3,4}$ the metaconid is elliptical. The entoconid is oval and the hypoconulid in $dP_{3,4}$ is large. The lingualflexid is shallow and open, U-shaped ; in dP_4 it is deeper. A small pli lingualflexid is clearly distinguished in dP_2. The ectoflexid is narrow and deep, especially in $dP_{3,4}$ where it reaches the lingualflexid. There is also a clear pli-caballinid and a well developed ectostylid which is double in dP_2. The enamel at the flexid's borders is simple.

TABLE I. – *Hipparion* sp. cf. *H. molayanense*, Taghar, upper cheek teeth measurements.
L_o = occlusal length, **B_o** = occlusal breadth, **L_p** = protocone length, **B_p** = protocone breadth, **E.F.** = enamel formula, **W.S.** = stage of wear.

TABLEAU I. – *Hipparion* sp. cf. *H. molayanense* de Taghar, mesures des dents jugales supérieures.
L_o = longueur occlusale, **B_o** = largeur occlusale, **L_p** = longuer du protocône, **B_p** = largeur du protocône, **E. F.** nombre de plis d'émail, **W. S.** = stade d'usure.

	AFG-1017	AFG-1018	AFG-1016			AFG-1015						AFG-1019
	dp^2	dp^4	dp^2	dp^3	dp^4	P^2	P^3	P^4	M^1	M^2	M^3	M^3
Lo dex	-	-	37.8	27.8	29.0	30.4	24.0	-	21.7	21.3	20.4	20.0
Lo sin	-	28.4	-	-	-	30.3	24.3	24.5	21.3	21.1	21.4	-
Bo dex	-	-	22.0	-	21.0	21.7	23.4	-	23.5	21.9	17.8	17.0
Bo sin	21.7	19.6	-	-	-	22.5	23.9	24.3	23.5	21.8	18.0	-
Lp dex	-	-	5.7	-	6.0	6.7	6.8	-	7.3	6.8	6.0	7.7
Lp sin	7.0	6.2	-	-	-	6.5	6.8	6.8	7.1	6.7	6.3	-
Bp dex	-	-	4.2	-	3.7	4.0	4.6	-	4.2	3.6	3.0	3.5
Bp sin	4.7	3.6	-	-	-	4.8	4.4	4.3	4.1	4.0	3.0	-
E. F. dex	-	-	4,4,2-/2 2,6,3,2/-2,6,3,2/3			3,5,1,1/11,5,4,1/11,4,2,1/11,6,2,1/11,6,3,1/11,6,21/1						-
E. F. sin	2,1,3,1/1	3,5,3,1/1	-	-	-	4,3,1,1/11,5,2,1/11,5,2,1/11,6,3,1/11,6,4,1/11,6,2,1/1						-
W.S.	-	-	-	-	-	III	III	III	III	III	III	II

2. Permanent dentition (Pl. 1, Fig. 1 ; Tables I, II)

The upper toothrow is medium-sized (P^2-M^3 = 142.5 mm, AFG-1015). The anterostyle of P^2 is short. The fossettes are closed and unconnected except those of P^2 which are connected. The enamel plication is moderate and the plis are short and narrow. The plication number is 9-12 for the premolars and 11-13 for the molars. The protocone is oval to elliptical and it is always isolated. The pli-caballin is very small to rudimentary and single except in the left P^3 and M^1 where it is double. The hypocone is oval with a deep distal hypoconal groove ; no lingual hypoconal groove except in M^3. The mesostyle is not very strong and it is similar to the parastyle. The available dentition belongs to an aged individual with worn teeth (III^d stage of wear), and thus the hypsodonty index cannot be calculated.

From the lower permanent dentition there is only one P_2 (AFG-1021). The paraconid is short and rounded. The metaconid is elliptical and the metastylid rounded. The enamel at the flexid's borders is simple. The lingual flexid is U-shaped, not very deep but it touches the anterior end of the postflexid which curves externally. The ectoflexid is deep and narrow ; its end reaches the posterior border of the preflexid. There is no pli-caballinid and ectostylid, indicating a well developed keel.

TABLE II. – *Hipparion* sp. cf. *H. molayanense*, Taghar, measurements of the lower cheek teeth.
L_0 = occlusal length, B_0 ant. = anterior occlusal breadth, B_0 post. = posterior occlusal breadth, L_{prfl} = preflexid length, L_{ptfl} = postflexid length, **E. F.** = enamel formula, **W. S.** = stage of wear.

TABLEAU II. – *Hipparion* sp. cf. *H. molayanense* de Taghar, mesures des dents jugales inférieures.
L_0 = longueur occlusale, **B_0 ant.** = largeur occlusale antérieure, **B_0 post.** = largeur occlusale postérieure, L_{prfl} = longueur du préflexide, L_{ptfl} = longueur du postflexide, **E.F.** = nombre de plis d'émail, **W.S.** = stade d'usure.

		AFG-1026			AFG-1021
		dp2	dp3	dp4	P2
Lo	dex	-	27.7	30.6	27.5
	sin	29.5	27.5	30.4	-
Bo ant.	dex	-	11.1	9.5	10.3
	sin	9.1	11.4	9.2	-
Bo post.	dex	-	11.2	9.2	12.3
	sin	11.7	11.4	9.5	-
Lprfl	dex	-	9	8.5	5
	sin	8.5	9.2	8.8	-
Lptfl	dex	-	11.3	10.8	12.3
	sin	12.3	12.6	11	-
E. F.	dex	-	0,0,0/1	0,0,0/1	0,0,0/0
	sin	0,0,0/1	0,0,0/1	0,0,0/1	-
W. S.		-	-	-	IV

TABLE III. – *Hipparion* sp. cf. *H. molayanense*, Taghar, measurements of the postcranial bones

Astragalus : 1. Maximum length (height) : articulation surface for navicular-top of the internal condyle ; **2.** Maximum diameter of the internal condyle ; **3.** Trochlear breadth : middle of the internal-middle of the external condyles ; **4.** Maximum breadth (in projection) ; **5.** Distal articular breadth ; **6.** Distal articular DAP ; **7.** Maximum DAP of the internal condyle. **Calcaneum : 1.** Maximum length ; **2.** Length of the proximal part : middle of tuber calcaneum-articulation surface below coracoid process ; **3.** Minimum breadth of the diaphysis ; **4.** Maximum breadth of the tuber calcaneum ; **5.** Maximum DAP idem ; **6.** Distal maximum breadth (in projection) ; **7.** Distal maximum DAP. **Navicular : 1.** Maximum DAP ; **2.** Breadth. **Third metatarsal : 1.** Maximum length ; **2.** Internal length ; **3.** Breadth of the diaphysis (in the middle) ; **4.** DAP idem at the level of 3 ; **5.** Proximal articular breadth ; **6.** Proximal articular DAP ; **7.** Maximum diameter of the articular facet for the cuneiform ; **8.** Diameter of the articular facet for cuboid ; **9.** Idem for cuneiform II ; **10.** Distal maximum supra-articular breadth ; **11.** Distal maximum articular breadth ; **12** Distal maximum DAP of the keel ; **13.** Distal minimum DAP of the lateral condyle ; **14.** Distal maximum DAP of the medial condyle. **Third phalanx : 1.** Length from the posterior edge of the articular surface to the tip of the phalanx ; **2.** Anterior length ; **3.** Maximum breadth ; **4.** Articular breadth ; **5.** Articular depth ; **6.** Maximum height ; **7.** Angle between the sole and the dorsal line ; **8.** « Circumference of the sole ».

TABLEAU. III. – *Hipparion* sp. cf. *H. molayanense* de Taghar, mesures des os postcrâniens.

Astragale : 1. Longueur maximale (hauteur) : de la surface articulaire pour le naviculaire au sommet du condyle interne ; **2.** Diamètre maximal du condyle interne ; **3.** Largeur de la trochlée : du milieu du condyle interne au milieu du condyle externe ; **4.** Largeur maximale (en projection) ; **5.** Largeur articulaire distale ; **6.** DAP articulaire distal ; **7.** DAP maximal du condyle interne. **Calcaneum : 1.** Longueur maximale ; **2.** Longueur de la partie proximale : du milieu du tuber calcaneum à la surface articulaire sous le processus coracoïde ; **3.** Largeur minimale de la diaphyse ; **4.** Largeur maximale du tuber calcaneum ; **5.** DAP maximal du tuber calcaneum ; **6.** Largeur distale maximale (en projection) ; **7.** DAP distal maximal. **Naviculaire : 1.** DAP maximal ; **2.** Largeur. **Troisième métatarsien : 1.** Longueur maximale ; **2.** Longueur interne ; **3.** Largeur de la diaphyse (au milieu) ; **4.** DAP de la diaphyse au même niveau ; **5.** Largeur de la face articulaire proximale ; **6.** DAP de la face articulaire proximale ; **7.** Diamètre maximal de la facette articulaire pour le cunéiforme ; **8.** Diamètre de la facette articulaire pour le cuboïde ; **9.** Diamètre de la facette articulaire pour le cunéiforme II ; **10.** Largeur distale maximale supra-articulaire ; **11.** Largeur distale maximale articulaire ; **12.** DAP distal maximal de la poulie ; **13.** DAP distal minimal du condyle latéral ; **14.** DAP distal maximal du condyle médial. **Troisième phalange : 1.** Longueur du bord postérieur de la surface articulaire au sommet de la phalange ; **2.** Longueur antérieure ; **3.** Largeur maximale ; **4.** Largeur de la face articulaire ; **5.** Hauteur articulaire ; **6.** Hauteur maximale ; **7.** Angle entre la face plantaire et la face dorsale ; **8.** Périmètre de la face plantaire.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
astragalus														
AFG-1043	57	54.0	24.5	53.7	44.5	30.0	[42]	-	-	-	-	-	-	-
AFG-1064	59.5	60.0	27.2	50.8	39.5	-	46.0	-	-	-	-	-	-	-
calcaneum	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AFG-1058	97.5	79.0	17.7	23.2	41.0	-	46.0	-	-	-	-	-	-	-
AFG-1057	-	77.0	18.5	26.0	41.8	-		-	-	-	-	-	-	-
navicular	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AFG-1047	38.0	44.0	-	-	-	-	-	-	-	-	-	-	-	-
AFG-1048	32.0	40.6	-	-	-	-	-	-	-	-	-	-	-	-
MT III	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AFG-1039	262.0	-	-	-	-	-	-	-	7.2	-	-	-	-	-
AFG1040	250.0	245.0	-	-	-	30.0	-	-	6.8		29.5?	31.5	24.7	28.8
Ph III	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AFG-1066	53.5	54.5	56.2	36.0	18.5	31.0	35°	150.0	-	-	-	-	-	-

3. Postcranials (Pl. 1, Fig. 3, 4, 5) and Table III)

Two complete but very distorted metatarsals are available. They are elongated and slender. The small index Distal breadth x 100 / Height is 11.9 and indicates a slender Mt_{III}. The keel index (Sen *et al.*, 1978) is 127.0.

Discussion

The available *Hipparion* material from Taghar (Afghanistan) is scarce, framentary and distorted by compaction of deposits, and does not allow the identification of diagnostic characters for a reliable species determination.

The only *Hipparion* described from Afghanistan is *Hipparion molayanense* Zouhri, 1992 from Molayan. Its main characters are : medium size (length of the toothrows 143-152.5 mm), moderate enamel plication (18 plis in $P^{3,4}$ and 20 in $M^{1,2}$), simple and rarely double pli-caballin, oval protocone, elongated and slender metapodials with well developed sagittal keel (Zouhri, 1992a, 1992b, 1996). Our material from Taghar has some of these morphological features.

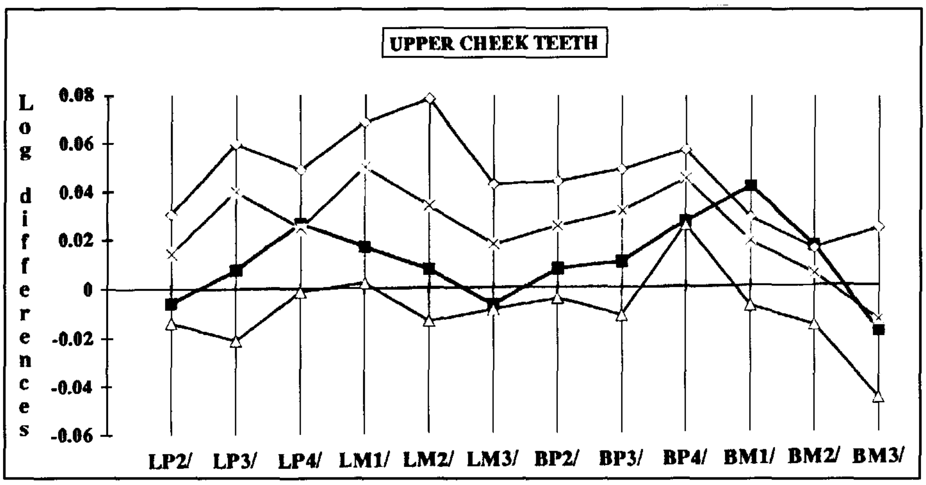

FIG. 3. Logarithmic ratio diagram comparing the upper cheek teeth of the Taghar *Hipparion* with those of *H. molayanense*. Standard = *H. mediterraneum*, Pikermi, n = 8-14 (Koufos, 1987a) ; ■ = *H.* sp. cf. *H. molayanense*, Taghar, n = 1-2 ; x = *H. molayanense*, Molayan, mean values, n = 3-8 ; Δ = *H. molayanense*, min values ; ◊ = *H. molayanense*, max values (Zouhri, 1992a).

Fig. 3. Diagramme logarithmique des dents jugales supérieures de l'*Hipparion* de Taghar et de *H. molayanense*. Standard = *H. mediterraneum*, Pikermi, n = 8-14 (Koufos, 1987a) ; ■ = *H.* sp. cf. *H. molayanense*, Taghar, n = 1-2 ; x = *H. molayanense*, Molayan, moyennes, n = 3-8 ; Δ = *H. molayanense*, valeurs min. ; ◊ = *H. molayanense*, valeurs max. (Zouhri, 1992a).

The upper cheek teeth have the main morphological features of *H. molayanense* and similar dimensions. The line for the upper cheek teeth of AFG-1015 is near the mean values and falls within the range of variation of *H. molayanense* (Fig. 3). The toothrow length at Taghar is 142.5 mm and very close to that of *H. molayanense* (143.0 mm). Moreover, the available upper and lower milk dentitions have similar dimensions to those of *H. molayanense* ; the upper toothrow length is 94.0 mm and the lower 87.7 mm versus 89.6-92.0 mm and 87.2-91.0 mm respectively for *H. molayanense*.

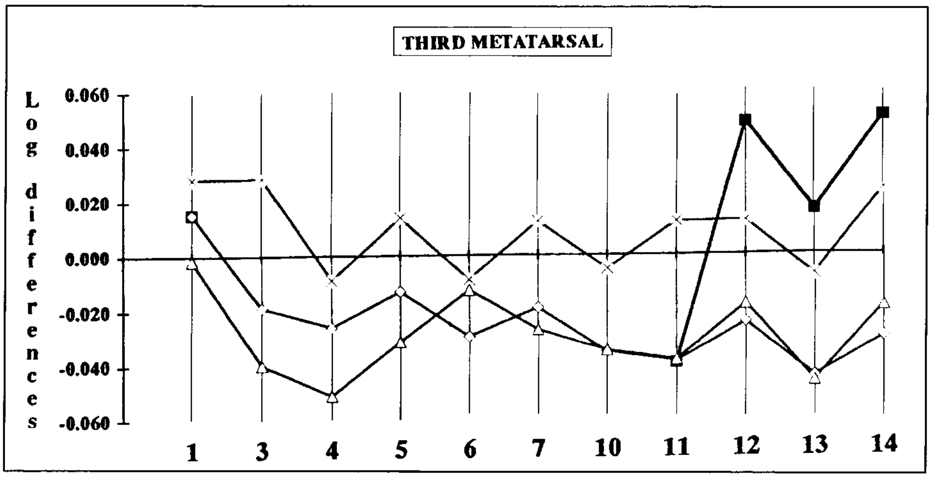

FIG. 4. Lorgarithmic ratio diagram comparing the third metatarsal of the Taghar *Hipparion* with other species. Standard = *H. mediterraneum*, Pikermi, n = 11-64 (Koufos, 1987a) ; ■ = *H.* sp. cf. *H. molayanense*, Taghar, n = 1-2 ; x = *H. molayanense*, Molayan, mean values, n = 8-12 (Zouhri, 1992a) ; ◊ = *H. dietrichi*, « Prochoma 1 », Macedonia, Greece (Koufos, 1987b) ; Δ = *H. dietrichi*, Vathylakkos, Macedonia, Greece (Koufos, 1988).

Fig. 4. Diagramme logarithmique du troisième métatarsien de l'*Hipparion* de Taghar et d'autres espèces. Standard = *H. mediterraneum*, Pikermi, n = 11-64 (Koufos, 1987a) ; ■ = *H.* sp. cf. *H. molayanense*, Taghar, n = 1-2 ; x = *H. molayanense*, Molayan, moyennes, n = 8-12 (Zouhri, 1992a) ; ◊ = *H. dietrichi*, « Prochoma 1 », Macédoine, Grèce (Koufos, 1987b) ; Δ = *H. dietrichi*, Vathylakkos, Macédoine, Grèce (Koufos, 1988).

The Taghar metatarsals belong to a medium-sized *Hipparion* with long and slender metapodials. Compared to *H. mediterraneum* Roth & Wagner, 1855 from Pikermi (Koufos, 1987a) and *H. dietrichi* Wehrli, 1941 from Axios Valley (Macedonia, Greece ; Koufos, 1987b, 1988) they have similar proportions, but they are more elongated and slender (Fig. 4). These species have similar proportions to those of the Molayan *Hipparion*. Their line is within the ranges of variation for *H. molayanense* (Fig. 5). The Taghar metatarsals seem to have a narrower distal articular facet but this is probably due to the fact that the studied metatarsal is transversally compressed and originally was broader. The remaining material from Taghar includes two astragali and two fragments of calcaneum. The proportions of the astragali fit well with those of *H. molayanense* but those of the calcaneum reach the two extremes of *H. molayanense* (Fig. 6). The length of the proximal part is significantly larger and the maximal antero-posterior diameter is remarkably smaller than those of *H. molayanense*.

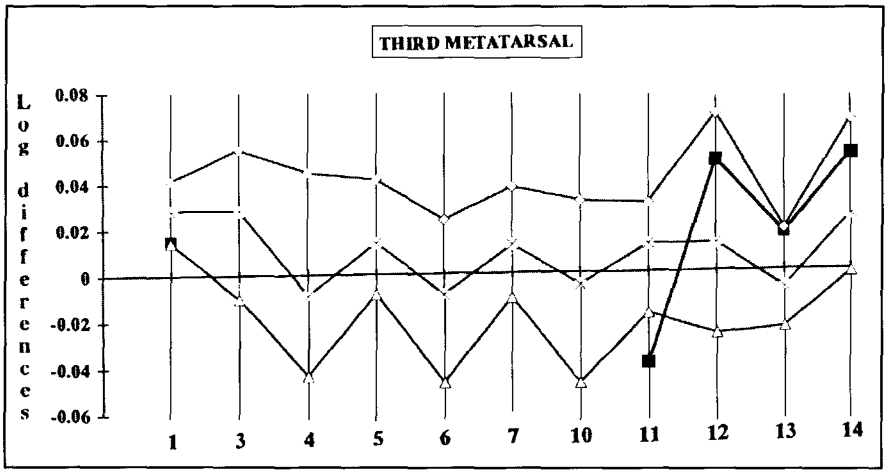

FIG. 5. Logarithmic ratio diagram comparing the third metatarsal of the Taghar *Hipparion* with *H. molayanense*. Standard = *H. mediterraneum*, Pikermi, n = 11-64 (Koufos, 1987a) ; ■ = *H.* sp. cf. *H. molayanense*, Taghar, n = 1-2 ; x = *H. molayanense*, Molayan, mean values, n = 8-12 ; Δ = *H. molayanense*, min values ; ◊ = *H. molayanense*, max values (Zouhri, 1992a).

Fig. 5. Diagramme logarithmique du troisième métatarsien de l'*Hipparion* de Taghar et de *H. molayanense*. Standard = *H. mediterraneum*, Pikermi, n = 11-64 (Koufos, 1987a) ; ■ = *H.* sp. cf. *H. molayanense*, Taghar, n = 1-2 ; x = *H. molayanense*, Molayan, moyennes, n = 8-12 ; Δ = *H. molayanense*, valeurs min. ; ◊ *H. molayanense*, valeurs max. (Zouhri, 1992a).

Three *Hipparion* species are known from the Siwaliks localities (Hussain, 1971). The differences in tooth morphology observed by Zouhri (1992a & b) between these species and *H. molayanense* also occur in the Taghar specimens. The comparison of the Taghar metatarsals with those of the Siwaliks is given in Fig. 7. The measurements of the Siwaliks metatarsals were taken by one of us (G. K.) on the material stored in the Bavarian State Museum for Palaeontology and Historical Geology, Munich. The size of the Taghar metatarsal proved close to those of H. *antilopinum* Falconer & Cautley, 1849 and *H. nagriensis* Hussain, 1971, although the former has a shorter metatarsal. From *H. nagriensis,* there is only a distal part of metatarsal in this collection ; it has a broader distal articular facet (measurement 14 in Fig. 7).

A number of *Hipparion* species is also known from the localities of Maragha (Bernor, 1985). Taxonomic statemens were based on the cranial and dental material,

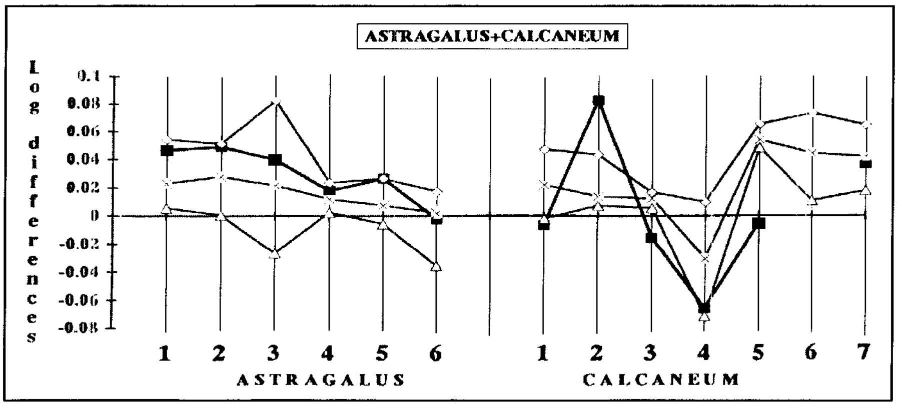

FIG. 6. Logarithmic ratio diagram comparing the astragalus and the calcaneum of the Taghar *Hipparion* with *H. molayanense*. Standard = *H. mediterraneum*, Pikermi, n = 6-27 (Koufos, 1987a) ; ■ = *H.* sp. cf. *H. molayanense*, Taghar, n = 1-2 ; x = *H. molayanense*, Molayan, mean values, n = 3-9 ; Δ = *H. molayanense*, min values ; ◊ = *H. molayanense*, max values (Zouhri, 1992a).

FIG. 6. Diagramme logarithmique de l'astragale et du calcanéum de l'*Hipparion* de Taghar et de *H. molayanense*. Standard = *H. mediterraneum*, Pikermi, n = 6-27 (Koufos, 1987a) ; ■ = *H.* sp. cf. *H. molayanense*, Taghar, n = 1-2 ; x = *H. molayanense*, Molayan, moyennes, n = 3-9 ; Δ = *H. molayanense*, valeurs min. ; ◊ = *H. molayanense*, valeurs max. (Zouhri, 1992a).

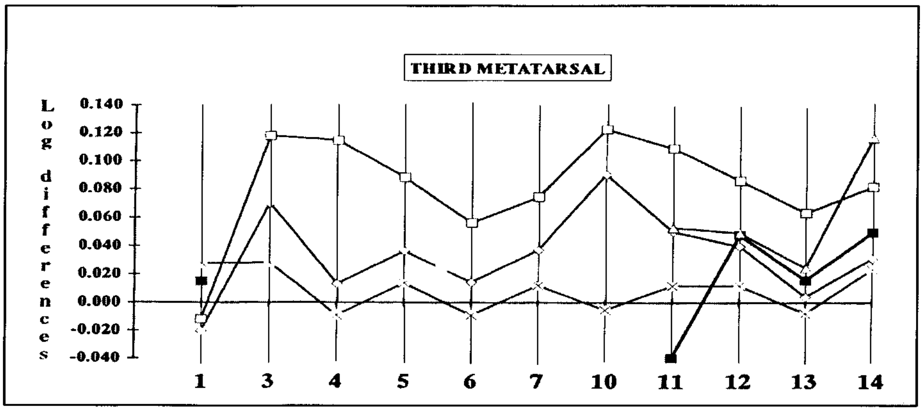

FIG. 7. Logarithmic ratio diagram comparing the third metatarsal of the Taghar *Hipparion* with other species. Standard = *H. mediterraneum*. Pikermi, n = 11-64 (Koufos, 987a) ; ■ = *H.* sp. cf. *H. molayanense*, Taghar, n = 1-2 ; x = *H. molayanense*, Molayan, mean values, n = 8-12 (Zouhri, 1992a) ; ❑ = *H. theobaldi*, Siwaliks, n = 3-20 (original measurements) ; ◊ = *H. antilopinum*, Siwaliks, n = 2-3 (original measurements) ; Δ = *H. nagriensis*, Siwaliks, n = 1 (original measurements).

Fig. 7. Diagramme logarithmique du troisième métatarsien de l'*Hipparion* de Taghar et d'autres espèces. Standard = *H. mediterraneum*, Pikermi, n = 11-64 (Koufos, 1987a) ; ■ = *H.* sp. cf. *H. molayanense*, Taghar, n = 1-2 ; x = *H. molayanense*, Molayan, moyennes, n = 8-12 (Zouhri, 1992a) ; ❑ = *H. theobaldi*, Sivaliks, n = 3-20 (mesures G. Koufos) ; ◊ = *H. antilopinum*, Sivaliks, n = 2-3 (mesures G. Koufos) ; Δ = and the *H. nagriensis*, Sivaliks, n = 1 (mesures G. Koufos).

metapodials were not considered. A metrical comparison with the Taghar *Hipparion* is not possible. Zouhri (1992a) compared the skull from Molayan with the Maragha species and observed its great similarities with *H. gettyi* Bernor, 1985, except that a better developed preorbital fossa occurs in the latter one.

The comparison of the Taghar *Hipparion* shows that it is much more similar to *H. molayanense* than to any other species. However, in the Taghar material the enamel plication is weaker, and the calcaneum does not fit metrically with that of the Molayan *Hipparion*. These differences, as well as the poorness and the fragmentary state of our material cannot allow a certain assignment of the Taghar *Hipparion* which is consequently referred to as *Hipparion* sp. cf. *H. molayanense*.

Family : Rhinocerotidae Owen, 1845

Rhinocerotidae g. and sp. indet.

AFG 1198 is a crusched fragment of an upper jugal tooth. There is a closed medifossette, which is unlike *Gaindatherium* Colbert, 1934 of the Siwaliks, and this tooth recalls more the Eastern Mediterranean two-horned rhinos.

AFG 1072 and AFG 1074 are two right and left calcanei. Their only clear morphological characters are the absence of fibular facet and the small tibial facet. Overall length : 144 mm.

AFG 1068 is a much flattened talus, probably of the same individual as the calcanei. The external lip of the trochlea is very angular, and much higher than the internal one. The fibular facet is long and narrow.

AFG 1067 is a long Mt II, without distal part, possibly also of the same animal. Its complete length would have been about 170 mm. The anterior facet for Mt III is large, not subdivided, and far from the posterior facet, which is set in a different plane.

AFG 1073 is a proximal scapula ; the maximum diameter of the articular cavity is 82 mm.

These bones are much larger than those of aceratheres, and also much more slender than those of *Chilotherium* Ringström, 1924, the most widespread late Miocene genus. The astragalus is very different from those of elasmotheres, which have almost equal external and internal lips (Gaudry & Boule, 1888 for *Elasmotherium* Fischer, 1808 ; Cerdeño & Alberdi, 1983 for *Hispanotherium* Crusafont & Villalta, 1947). On the whole, these bones are not much different from those of the large horned rhinoceroses of the Eastern Mediterranean (*Ceratotherium neumayri* (Osborn, 1900) and *Dicerorhinus pikermiensis* (Toula, 1906)) but the scant material which is crushed, prevents any formal identification.

Order : ARTIODACTYLA Owen, 1848

Family : Suidae Gray, 1821

Suidae g. and sp. indet.

A lower left canine indicates the occurrence of a large sized suid at Taghar (Pl. 2, Fig. 2). The curved shape and the hypsodonty of this open rooted tooth show that it cannot belong to a *Microstonyx* Kaup, 1833 which was mentioned in Molayan (Brunet *et al.*, 1984). For a more detailed determination this specimen is insufficient.

Family : Giraffidae Gray, 1821

Genus : *Palaeotragus* Gaudry, 1861

***Palaeotragus sp. cf. P. rouenii* Gaudry, 1861**

Several post-cranial remains of a giraffid have been numbered AFG 1074 but, since one Rhino calcaneus also bears this number, we cannot conclude that they belong to a single individual. They consist of a proximal and a distal radius (unconnected), a distal tibia and a distal humerus, as well as a complete femur. They are all strongly crushed and deformed. Their size and slenderness, especially those of the complete femur, fit *Palaeotragus rouenii* of the Eastern Mediterranean, close to the Chinese *P. microdon*.

Length of the femur AFG 1074	=	ca 400 mm
P. rouenii : MNHNP N° PIK 1688	=	382 mm
MNHNP N° KTD 52	=	390 mm (Geraads, 1994)
P. microdon (Loc. 116)	=	348 mm (Bohlin, 1926)

Small and slender-limbed giraffids of the *P. rouenii*-group are well known in China, Eastern Mediterranean and the Afro-Arabian plate, but have not been reporterd from the Indian subcontinent. This difference supports the hypothesized occurence of a geographical barrier between the latter area and the rest of Eurasia (Brunet et al., 1984 ; Beden & Brunet, 1986).

Family : Cervidae Gray, 1821

***Cervid indet., cf. Cervavitus novorossiae* Khomenko, 1913**

AFG 1104 is a left cervid antler, with the pedicel and a fragment of the frontal bone ; AFG 1105 and AFG 1106 are probably fragments of their right counterparts (Pl. 2, Fig. 1).

The pedicel is long, but not extremely so ; its anterior face is almost in the same plane as the forehead, and it extends onto the frontal bone in the form of a thick ridge.

The antler itself stands more upright than the pedicel, on which it is therefore angled. The first tine is in fact no more than a short spine, pointing inwards and forwards, inserted just above the burr. Above, the shaft is obliquely flattened (its greatest diameter is perpendicular to the plane containing the first fork), and widens about 9 cm above the burr, into what seems to be the base of a growing fork, perhaps weathered.

The presence of an internal basal tine resembles the Recent genus *Muntiacus* Rafinesque, 1815, from which this specimen can be distinguished by the presence of a second fork, the shorter pedicle, and less strong ridge on the frontal bone. Among the few cervids known in this part of Asia, *Metacervulus capreolinus* Teilhard de Chardin and Trassaert, 1937, from the lower Pliocene of S.E. Shansi looks much like the Taghar fossil. The specimens described by these authors (Teilhard de Chardin & Trassaert, 1937 : 13) have shorter and thicker pedicels, but these differences might be due to their younger ontogenic age (cf. Heintz, 1970). The poorly known *Metacervulus mongoliensis* Vislobokova, 1983, may be distinguished by the absence of a basal tine.

Zdansky (1925) has referred to *Cervocerus novorossiae* Khomenko, 1913 (the type locality of which is Taraklia) two antlers from the late Miocene of China ; they probably belong to young animals, with a short (anterior ?) tine, but without second fork. The Taghar specimen is very similar to them and to the slightly ontogenically older antler from Taraklia. *Cervocerus novorossiae* is close to *Procervus variabilis* Alexejev, 1913 from Novo Elisavetovska, and they look different at the species level. A species from the Pliocene of Kazakhstan, *Cervavitus flerowi* Aubekerova, 1974, differs because the first tine is always far from the burr (Aubekerova, 1974 : fig. 2).

It would be unwise to identify the Taghar material with one of these species, given its incompleteness, but it should be stressed that it is certainly different from *Pliocervus* Hilzheimer, 19922, which has antlers with a first fork set very high above the burr, and is the most commonly mentionned cervid in these levels, e.g. in France (Gaudry, 1873), Greece (Gaudry, 1867 ; Melentis, 1967, 1968), southern Russia (Khomenko, 1913) and Maragha (Tobien, 1980).

Measurements :	length of the pedicel	= 40 mm
	transverse diameter of the pedicel	= 20 mm
	antero-post. diameter of the pedicel	= 17 mm
	length of the first tine	= 17 mm
	length of the first segment	= 20 mm
	length of the 2nd segment	≥ 80 mm

Family : Bovidae Gray, 1821

Bovids form the highest percentage of the mammal specimens found in the locality of Taghar. These specimens are mainly dental remains : there are about twenty largely complete jaws and some isolated teeth, but very few horn cores (a few fragments and only one complete but crushed horn core) and some postcranial bones. Although the samples are of a relatively poor quality, their wide taxonomical variety enables five different bovids to be distinguished amongst them.

1°) Medium-sized Bovidae

The medium-sized Bovidae belong to two taxa which are very unequally represented.

Tragoportax sp.

Referred material (measurements in Tables IV and V)

TABLE. IV. – Measurements in millimeters on lower dentitions of *Tragoportax* sp. and *Protoryx* ? sp. from Taghar. L : length, W : width.

TABLEAU IV. – Mesures en millimètres des dentitions inférieures de *Tragoportax* sp. et *Protoryx* ? sp. de Taghar. L : longueur, W : largeur.

		Tragoportax sp			? *Protoryx*
		N	Min – Max	M	
P/2	L	4	11,3 – 11,9	11,6	11,1
	W	4	6,2 – 6,6	6,4	7,2
P/3	L	4	14,1 – 15,1	14,6	15,7
	W	4	8 – 8,8	8,4	9
P/4	L	4	14,5 – 15,7	15,3	15,8
	W	4	8,8 – 9,4	9,1	9,7
M/1	L	3	16,5 – 17,3	16,9	17,2
	W	3	12 – 12,7	12,2	12,7
M/2	L	3	19,5 – 20	19,7	19,2
	W	3	12,7 – 13,5	13,2	13,5
M/3	L	3	26,5 – 27,5	27,1	27,3
	W	3	12,7 – 13,4	13	13,6
P/2-P/4	L	4	40 – 43,5	41,8	42,4
M/1-M/3	L	2	63 – 65,4	64,2	65,4
P/2-M/3	L	1	105,5		107,6

TABLE V. – Measurements in millimeters on upper dentitions of *Tragoportax* sp. from Taghar. L : length, W : width.

TABLEAU V. – Mesures en millimètres des dentitions supérieures de *Tragoportax* sp. de Taghar. L : longueur; W : largeur.

		N	Min – Max	M
P2/	L	6	14 – 17,2	16
	W	6	11,3 – 12,5	12
P3/	L	6	14 – 16,7	15,5
	W	5	14,6 – 16	15,5
P4/	L	6	12,4 – 13,3	12,6
	W	6	16,9 – 17,6	17,2
M1/	L	4	15,6 – 18	17,2
	W	4	18,8 – 19,8	19
M2/	L	5	18,7 – 21,1	20
	W	5	21,4 – 22,4	21,7
M3/	L	5	21,2 – 21,8	21,5
	W	4	21,1 – 21,6	21,5
P2/-P4/	L	3	41,5 – 46	44
M1/-M3/	L	2	57,5 – 61,3	59,4
P2/-M3/	L	1	103,4	

– Crushed cranium with right and left P^3-M^3 (AFG 1075)
– Right and left maxillae with P^2-M^3 (AFG 1076)
– Left maxilla with P^2-M^3 (AFG 1078)
– Left maxilla with damaged P^2, P^3-M^1, damaged M^2-M^3 (AFG 1079)
– Right mandible with I_1-M_3 (AFG 1088)
– Left mandible with P_2-M_3 (AFG 1097)
– Left mandible with P_2-M_3 (AFG 1098)
– Left mandibular fragment with P_2-P_4, damaged M_1-M_2.

The most common bovid in the Taghar fauna is a Boselaphini which may be assigned to *Tragoportax* Pilgrim, 1937.

The medial walls of the lower molars (Pl. 3, Fig. 1) are strongly outbowed and have a small lingual column on two of the M_2. On three molars there is a small goat fold and a strong basal pillar. The P_4 paraconid is directed backward and meets the metaconid, thus closing the anterior valley. I_1 is enlarged, I_2 is a little larger than I_3, and the canine is enlarged into a spatula shape as in all *Tragoportax*. The medial lobes of the upper molars (Pl. 3, Fig. 2) remain unfused with one another until fairly late in wear. The upper molars have basal pillars usually associated with a weak basal cingulum. The paracone rib and the styles are pronounced. The only cranial remain is very crushed. Apart from the existence of strong parietal ridges, no features can be observed on this specimen.

In Europe and Asia Minor, *Tragoportax* is divided into two distinct groups according to size, the length of the premolar row in relation to that of the molars, the pattern of P_4 and the presence/absence of horns on females. The Afghanistan form is close to the *T. rugosifrons – T. amaltheus* group by its size, its P_4 with a closed anterior valley and its rather shorter premolars compared to molars.

The material from Taghar differs from *T. rugosifrons* (Schlosser, 1904) from the lower Turolian of Greece only by its slightly smaller size, the slightly more outbowed medial walls of the lower molars and the more regular closure of the anterior valley of P_4 (but the number of P_4 present at Taghar is very low).

In China, Boselaphini are very rare. Several species were established by Schlosser (1903), but on insufficient material (isolated teeth) which precludes any comparison.

In the Siwalik deposits, on the other hand, Boselaphini are very common. Besides the type species of *Tragoportax*, *T. salmontanus* Pilgrim 1937, the dentition of which is virtually unknown, several species have been described, some of them solely based on horn cores. The best known species, *T. punjabicus* (Pilgrim, 1910) (= *T. browni* Pilgrim, 1937), seems to be akin to *T. rugosifrons*. The Taghar fossils are only distinguishable from the latter species by their slightly stronger basal pillars.

In the absence of horn cores it is thus impossible to provide a specific determination for the Taghar *Tragoportax*. Nevertheless, it is close to the *T. rugosifrons – T. amaltheus – T. punjabicus* group.

Protoryx ? sp.

Referred material and measurements in mm (see also Table IV).

– Left damaged P^2-P^4, M^1-M^3 (AFG 1080) ; M^1 : 19.5 x 20 ; M^2 : 22.9 x 21.7 ; M_3 : 23.2 x 21.8
– Right M_3 (AFG 1091) : 27 x 13.9
– Left M_2 (AFG 1091) : 19.7 x 13.4
– Right M_1 (AFG 1093) : 17.3 x 12.5
– Left mandible with P_2-M_3 (AFG 1099) ; measurements see Table IV.
– Left I_1 (AFG 1099) : 7.8 x 5.6

The size of this bovid is comparable to that of *Tragoportax* described above, but its morphological characters are not. The proportions of the premolars are different. P_3 has the same length as P_4, but P_2 is more reduced. P_4 has a transversal paraconid in relation to the axis of the tooth and a cylindrical metaconid (Pl. 4, Fig. 1). The lingual walls of the lower molars are noticeably flatter than in *Tragoportax.* There are small basal pillars on the three molars as well as very strong goat folds, especially on M_3. A small I_1 could belong to this group.

The upper molars assigned to ? *Protoryx* differ from those of *Tragoportax* by the absence of any basal pillars and basal cingulum. The styles are also less developed.

The small size of P_2, the flat medial walls of the lower molars and the bulbous shape of the P_4 metaconid argue in favour of comparison of these specimens with *Palaeoryx* or *Protoryx. Palaeoryx* is larger in size. A mandible from Maragha was illustrated by Mecquenem (1924, Pl. IV, fig.4) as *Protoryx carolinae.* This specimen differs from the mandible AFG 1099 only by its less pronounced goat folds. Several species have been referred to *Protoryx* or to a genus close to it, *Paraprotoryx* Bohlin, 1935 from the late Miocene of China. These taxa have been defined according to their skull and horn core structure. Their dentitions are generally not known.

In Central Asia, several species of *Protoryx* have been described (*Protoryx heinrichi* Vekua 1972, *Protoryx paralaticeps* Dmitrieva, 1977). *Protoryx tadzhikistanica* was established by Dmitrieva (1977) for a complete skull from the upper Miocene (?) of Cor (Tadjikistan). The lower dentition on this specimen is unfortunately not known. The upper dentition is of slightly smaller size than that of Taghar ; the figures given by Dmitrieva do not allow any morphological comparison.

No *Protoryx* or genus akin to it has been found in the Siwaliks.

2) Small-sized Bovidae

Although the small-sized bovids are poorly represented in our sample, the morphological and metrical variation of the mandibles points at the presence of two or three species.

Prostrepsiceros ? sp.

Referred material and measurements (in mm)

– Left P_2-P_3 (AFG 1128) ; P_2 : 6.1 x 3.5 ; P_3 : 8.5 x 4.8.

– Right P_3-P_4 and damaged M_1 (AFG 1130) ; P_3 : 7.3 x 4.0 ; P_4 : 8.9 x 4.8.

– Right M_3 (AFG 1133) : 19.0 x 8.2 ; h = 20.4.

– Left mandible with P_3-M_3 (AFG 1140) ; P_3 : 7.3 x 3.8 ; P_4 : 9.2 x 4.9 ; M_1 : 10 x 6.4 ; M_2 : 12.8 x 7.6 ; M_3 : 17.3 x 8.5.

The premolars are short and narrow (Pl. 5, Fig. 1). P_3 has no parastylid ; a lingual ridge comes down from the main cusp and joins the posterior side of the tooth. P_4 has a distinct paraconid and parastylid, a very small metaconid which is set further back in relation to the protoconid, and a postero-labial groove. The molars are hypsodont (M_3 hypsodonty index : 107.4). There are no basal pillars. The goat fold is pronounced, especially on M_3, the medial walls are flat. The back lobe of M_3 is formed from a single cusp. All of these characteristics (in particular the high hypsodonty, the small size of the premolars and the presence of a pronounced goat fold) lead us to compare these mandibles from Taghar with those of *Prostrepsiceros*. This genus, found in Greece, Iraq and Iran, has not been recorded in China or in Central Asia. A species, aff. *Helicotragus vinayaki*, was created by Pilgrim (1939) for a horn core found in the Siwaliks (Dhok Pathan). This species was assigned to *Prostrepsiceros* by Thomas, 1984.

Bovidae indet. 1 (aff. « **Gazella** » **lydekkeri***)*

Referred material and measurements (in mm)

– Left P_2, P_3, P_4, M_1, M_2, M_3 same individual ? (AFG 1116 to 1121) ; P_2 : 5.6 x 3.2; P_3 : 8.6 x 5.3 ; P_4 : 9.5 x 5.7 ; M_1 : 11.5 x 7.4 ; M_2 : 14.1 x 9 ; M_3 : 17.8 x 8.4.

– Right mandible with P_2-M_2 (AFG 1138) ; P_2 : 5.5 x 3.6 ; P_3 : 8.6 x 5.2 ; P_4 : 10 x 5.2 ; M_1 : 11.1 x 7.2 ; M_2 : 13.2 x 8.5.

– Right mandibular fragment with damaged M_1 and M_2-M_3 (AFG 1141) ; M_2 : 13.4 x 8.4 ; M_3 : 16.5 x 7.6.

P_2 widens out towards the back and has two slight postero-lingual ridges ; P_3 is long ; the paraconid and parastylid are well separated ; the metaconid links up with the entoconid to close the distal valley (Pl. 5, Fig. 3). P_4 ressembles P_3 with a more pronounced metaconid and a posterolabial groove. The lower molars have outbowed medial walls, pronounced basal pillars and prominent goat folds. The back lobe of M_3 is formed from a single cusp (Pl. 5, Fig. 2). The anterior part of the mandible AFG 1138 is preserved ; it is short and strong (Pl. 5, Fig. 3). The mandibular symphysis is long.

Because of their size and their morphological characteristics, these mandibles from Taghar resemble those of «*Gazella*» *lydekkeri* Pilgrim, 1937 from the Dhok Pathan formation of Siwaliks. However, several features of this species prevent its inclusion in the genus *Gazella* ; consequently, it seems that *Gazella* was absent in the late Miocene of the Indian subcontinent.

Bovidae indet. 2

Referred material and measurements (in mm)

– Damaged left P_2, P_3 (AFG 1129) ; P_3 : 8.1 x 4.9.

– Right P_4 (AFG 1137) : 9.0 x 4.0.

– Right mandibular fragment with damaged P_4, M_1-M_3 (AFG 1139) ; M_1 : 10.2 x 7.4 ; M_2 : 11.3 x 8.2 ; M_3 : 16.1 x 7.5.

P_2 is very small. P_3 shows no parastylid. The metaconid of P_4 is directed backward, and the entoconid is strong. The lower molars have strongly outbowed medial walls, small goat folds and very small basal pillars on M_1. The rear lobe of M_3 consists of one cuspid.

It is possible that these few specimens belong to the previously described group (Bovidae indet. 1), although they have a more pronounced undulation on the medial walls of the molars.

Horn cores are unfortunately almost totally lacking from the samples collected at Taghar. Several small fragments (AFG 1145, 1146, 1147, 1148) belong to a spiralled horn core. A left horn core (AFG 1144) is preserved along its entire length but has undergone strong post-mortem lateral compression (Pl. 5, Fig. 2). This horn core is straight, quite short (L= 130-140 mm), and has a very convex anterior side ; it rapidly narrows toward the top. There seems to be a groove on the posterior side. The horn core is set above the orbit ; the intercornual frontal bone is thick. The shape of the cross section cannot be observed because of the compression, the antero-posterior diameter of the base must have been about 32 mm, but the transverse diameter cannot be estimated. This specimen may only be distinguished from the gazelle horn core by the greater thickness of the intercornual frontal bone. Furthermore, no mandible which could belong to this taxon has been found at Taghar. If the horn core is from a gazelle, then it belongs to the group with thick and highly curved horn cores such as *Gazella rodleri* Pilgrim and Hopwood, 1928, *G. paotehensis* Teilhard de Chardin and Young, 1931, *G. sinensis* Teilhard de Chardin and Piveteau, 1930, etc.

In spite of the small size of the Taghar sample, the bovids are relatively diverse. Although it is so far impossible to fix accurately taxonomic identifications, this fauna apparently contains two genera (*Tragoportax* and *Protoryx*) with a wide geographic range ; we may add to them *Gazella* with some reserve. Among the small bovids, there is a form close to *Prostrepsiceros* and another one which has similarities with «*Gazella*» *lydekkeri* Pilgrim, 1937.

CONCLUSIONS

The preliminary faunal list of Taghar is as follow :
Hipparion sp. cf. *H. molayanense* Zouhri, 1992
Rhinocerotidae indet.
Suidae indet.
Palaeotragus sp. cf. *P. rouenii* Gaudry, 1861
Cervidae indet. cf. *Cervavitus novorossiae* Khomenko, 1913

Tragoportax sp.
Protoryx ? sp.
Prostrepsiceros ? sp.
Bovidae indet. 1 (aff. «*Gazella*» *lydekkeri* Pilgrim, 1937)
Bovidae indet. 2

This list obviously indicates an incomplete faunal spectrum since several orders and/or families, such as carnivores, proboscideans, hyracoids, chalicotheres, etc, which are common in late Miocene Eurasian localities, are absent. It should also be emphasized that the ruminants (bovids, giraffids and cervids) are predominant as they represent seven species out of ten recognized at Taghar.

The faunal list contains several taxa incompletely identified at the specific or generic levels. This is due to the following reasons. One is that in the case of suids, cervids and rhinocerotids, the diagnostic elements, such as cranial or limb bones, are scarce or missing ; moreover the bones are often crushed and deformed, thus preventing detailed observations, precise measurements and comparisons. Another reason concerns the limited information on the late Miocene mammal faunas from Afghanistan and surrounding regions. In Afghanistan, some large mammals have been described from the localities of Molayan (*Mesopithecus* and *Hipparion*) and Pul-e Charkhi (*Kabulicornis*) only, although several other taxa have been mentioned in preliminary faunal lists. In the surrounding countries, well documented late Miocene faunal successions are known from the Siwaliks of the Potwar Plateau (Pakistan), but elsewhere the documentation is fragmentary and/or based on preliminary determinations. Toward the west, the nearest late Miocene localities are in the Maragha area in Western Iran, some 3000 km from Taghar.

Brunet *et al.* (1981, 1984) gave the biochronology of 10 main mammal localities so far known in Afghanistan, and they tentatively correlated this succession with the European Neogene Mammal Chronology on the one hand and with the Siwaliks chronology on the other. They suggested an early Turolian age for the Taghar fauna ; their arguments were mainly stratigraphic (the Taghar locality is situated below the middle Turolian locality of Molayan, the richest mammal locality known in Afghanistan), and also palaeontological (the occurence of some similar taxa in the two localities).

Taghar is stratigraphically situated 35 m below Molayan. From Molayan, only two taxa (*Mesopithecus pentelicus* Wagner, 1839 and *Hipparion molayanense*) were described, although the preliminary faunal list contains 24 mammalian species (Heintz *et al.*, 1978b ; Brunet *et al.*, 1984). *M. pentelicus* (type locality Pikermi) is characteristic of the middle Turolian (MN12) in the chronologic succession of faunas in the Aegean area (Bonis *et al.*, 1990). However, Bernor *et al.* (1996) suggest a late MN11 correlation for the classic Pikermi fauna based on its correlation with radiometrically dated faunal sequences from Maragha and Samos.

Among the common taxa, the Taghar *Hipparion* seems more primitive than the Molayan one because of its less plicated upper cheek-teeth. According to Zouhri (1992a, 1992b, 1996), *H. gettyi* from the Lower Maragha is closely related to *H. molayanense*, although it has several more primitive features. The fossiliferous level of the Lower Maragha was radiometrically bracketed between 8.2 and 9.0 Ma, and should consequently be correlated to the early Turolian (Swisher, 1996 ; Bernor *et al.*, 1996).

The occurence of several bovids and a giraffid (*Tragoportax*, *Protoryx*, *Prostrepsiceros*, *Gazella* and *Palaeotragus*) was also mentioned at Molayan. Unfortunately, a detailed comparison between the specimens of Taghar and Molayan is not possible since the Molayan material has not yet been studied. The Taghar fauna is different from that of Molayan by having a cervid and a suid different from *Microstonyx*, which is found at Molayan. The stratigraphical ranges of the bovids of Taghar are restricted to the late Miocene, which does not contribute to a more precise correlation of our fauna. The cervid from Taghar is the first to be found in Afghanistan. It has some similarities with *Cervavitus novorossiae* from the Meotian of Taraklia (Moldavia). Cervids have not been recorded in late Miocene and early Pliocene faunas from the Siwaliks.

Molayan has also yielded the remains of three rodents (*Hystrix*, *Parapelomys* and *Pseudomeriones*) which are under study by one of us (S. Sen). They all represent new species ; but one of them, *Pseudomeriones*, has a wide geographic range at generic level, and thus allows comparisons with other localities. The evolutionary stage of the Molayan *Pseudomeriones* is more primitive than that of Ertemte (late Turolian), Inner Mongolia, and of Quarry S of Samos, Greece. The Samos locality is radiometrically date at 7.52 ± 0.16 Ma, and correlated to MN12 (Weidmann *et al.*, 1984 ; Bernor *et al.*, 1996). This genus is also known from Monasteri and Ano Metochi 3 (Northern Greece), both correlated with the late Turolian ; the specimens from these localities show several derived characters that allow comparison with the early Pliocene species *P. rhodius* from Maritsa. Other localities with *Pseudomeriones* are all of Pliocene age, and their species are more evolved. We conclude that the fauna of Molayan is of middle Turolian age, confirming the age assignment of Brunet *et al.* (1984). The stratigraphical position of the Taghar locality relative to Moloyan and the differences in stage-of-evolution suggest that the Taghar fauna is of early Turolian age.

Late Miocene mammal faunas are well documented in the Siwaliks of the Potwar Plateau, Pakistan. Brunet *et al.* (1984) and Beden and Brunet (1986) analysed in detail similarities and differences between the late Miocene faunas from Afghanistan (including Taghar and Molayan) and from the «U Sandstone» of the Nagri Formation. They concluded that «At present it is impossible to be certain that even one species is common to both faunas», as a result of «the biogeographical isolation of the Indian subcontinent» (Brunet *et al.*, 1984 : 37). The study of the Taghar fauna seems to confirm this hypothesis.

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REFERENCES

AUBEKEROVA P. A. (1974). – Pliocene artiodactyls from southeastern Kazakhstan. *Paleont. Journ.*, 4 : 522-529.

BEDEN, M., BRUNET, M. (1986). – Faunes de mammifères et paléobiogéographie des domaines indiens et péri-indiens au Néogène. 61-87. *In* P. LE FORT, M. COLCHEN & C. MONTENAT (eds). *Évolution des domaines orogéniques d'Asie méridionale (de la Turquie à l'Indonésie). Mémoires Sciences de la Terre*, **47**, Paris, 429 p.

BERNOR R. L. (1985). – Systematic and evolutionary relationships of the hipparionine horses from Maragheh, Iran (late Miocene, Turolian age). *Palaeovertebrata*, **15** : 173-269.

BERNOR R. L., SOLOUNIAS N., SWISHER III C. C. & VAN COUVERING J. A. 1996 – The correlation of three classical « Pikermian » mammal faunas – Maragheh, Samos and Pikermi – with the European MN unit system. In BERNOR R. L., FAHLBUSCH V. & MITTMANN H. W. (eds) : *The Evolution of Western Eurasian Neogene Mammal Faunas.* Columbia University Press : 137-156.

BOHLIN B. (1926). – Die Familie Giraffiadae. *Palaeont. Sin.*, **C, 4** *(1)* : 1-178.

BOHLIN B. (1935). – Cavicornier der Hipparion-Fauna Nord Chinas. *Palaeont. Sin.*, **C, IX**, *(4)* : 1-166.

BONIS L. DE, BOUVRAIN G., GERAADS D; & KOUFOS G. (1990). – New remains of *Mesopithecus* (Primates, Cercopithecoidea) from the late Miocene of Macedonia (Greece), with the description of a new species. *Journ. Vert. Paleont.*, **10** *(4)* : 473-483.

BRUNET M., HEINTZ E. & BATTAIL B. (1984). – Molayan (Afghanistan) and the Khaur Siwaliks of Pakistan : an example of biogeographic isolation of late Miocene mammalian faunas. *Geol. Mijnbouw*, Amsterdam, 63 : 31-38.

BRUNET M., HEINTZ E. & SEN S. (1981). – Datations paléontologiques et séquence biochronologique dans le Néogène continental d'Afghanistan. *C. R. Acad. Sc. Paris*, sér. 3, **293** : 305-308.

CERDEÑO E. & ALBERDI M. T. (1983). – Estudio descriptivo des esqueleto postcraneal de *Hispanotherium matritense* del yacimiento mioceno de Torrijos (Toledo). *Estudios geol.*, **39** : 225-235.

DMITRIEVA E. L. (1977). – Neogene Antelopes of Mongolia and adjacent territories. *The Joint Soviet-Mongolian Paleontological Expedition*, **6** : 1-116 (in Russian).

EISENMANN V., ALBERDI M. T., GIULI C. DE & STAESCHE U. (1988). – Methodology. *In* WOODBURNE M. & SONDAAR P. (eds) « *Studying fossil horses* ». Brill, Leiden, p. 1-70.

FLYNN L. J. (1983). – Sur l'âge de la faune de vertébrés du Bassin de Bamian, Afghanistan. *C. R. Acad. Sci. Paris*, II, **297** : 687-690.

GAUDRY A. (1867). – Animaux fossiles et géologie de l'Attique. *Savy*, Paris, 474 p.

GAUDRY A. (1873). – Animaux fossiles du Mont Lubéron. *Savy*, Paris, 175 p.

GAUDRY A. & BOULE. M. (1888). – Matériaux pour l'histoire des temps quaternaires. III, l'*Élasmotherium*. p. 83-104. *Savy*, Paris.

GERAADS D. (1994). – Les gisements de Mammifères du Miocène supérieur de Kemiklitepe, Turquie : 8. Giraffidae. *Bull. Mus. natn. Hist. natur.*, 4e sér., C, **16** (1) : 159-173.

HEINTZ E. (1970). – Les Cervidés villafranchiens de France et d'Espagne. *Mém. Mus. natn. Hist. natur.*, C, **22**, vol. 1 : 1-303 ; vol. 2 : 1-206.

HEINTZ E., GINSBURG L. & HARTENBERGER J. L. (1978a). – Mammifères fossiles en Afghanistan : état des connaissances et résultats d'une propection. *Bull. Mus. natn. Hist. natur.*, **69** : 101-119.

HEINTZ E., BRUNET M. & CARBONNEL J. P. (1978b). – Découverte du premier grand gisement à Mammifères fossiles d'Afghanistan. *C. R. Acad. Sc. Paris*, **D-286** : 945-947.

HUSSAIN T. S. (1971). – Revision of *Hipparion* (Equidae, Mammalia) from the Siwalik Hills of Pakistan and India. *Bay. Akad. Wiss. Math. Nat. Klasse*, **147** : 1-68.

KHOMENKO J. (1913). – La faune méotique du village Taraklia du district de Bendery. *Ann. géol. minér. Russie*, **15** *(4-5)* : 107-143.

KOUFOS G. D. (1987a). – The Pikermi hipparions. Part I : Generalities and taxonomy. *Bull. Mus. nat. Hist. natur.*, Paris, 4e sér., **9**, sect. C, *2* : 197-252. Part II : Comparisons and odontograms. *Bull. Mus. nat. Hist. natur.*, Paris, 4e sér., **9**, sect. C, *3* : 327-363.

KOUFOS G. D. (1987b). – Study of the Turolian hipparions of the lower Axios valley (Macedonia, Greece). 2. Locality « Prochoma-1 » (PXM). *Paläont. Z.*, **61** : 339-358.

KOUFOS G. D. (1988). Study of the Turolian hipparions of the lower Axios valley (Macedonia, Greece). 3. Localities of Vathylakkos. *Paleont. i Evolucio*, **22** : 15-39.

LANG J. & LAVOCAT R. (1968). – Première découverte d'une faune de Vertébrés dans le Tertiaire d'Afghanistan et la datation de la série de Bamian. *C. R. Acad. Sci. Paris*, **D-266** : 79-82.

MECQUENEM R. de (1924-1925). – Contribution à l'étude des fossiles de Maragha. *Ann. Paléont.*, Paris, **13** : 135-160 ; **14** : 1-36.

MELENTIS J. K. (1967). – Studien über fossile Vertebraten Griechenlands. 19. Die Pikermifauna von Halmyropotamos. *Ann. Géol. Pays héllen.*, **19** : 183-411.

MELENTIS J. K. (1968). – Zur Morphologie und systematische Stellung von *Pliocervus pentelici* (Gaudry) aus der Pont von Attika. *Praktika Akad. Athen.*, 43 : 5-16.

MENNESSIER G. (1968). – Étude tectonique des montagnes de la région de Kabul. *Notes et Mémoires sur le Moyen Orient, IX, Mus. Natn. Hist. natur.*, Paris, 185 p.

MENNESSIER G. (1974). – Carte géologique de l'Afghanistan au 1/50 000. Feuille de Ghazgay. *Ministère des Mines et de l'Industrie*, Kabul.

PILGRIM G. (1910). – Notices of new mammalian genera and species from the Tertiary of India. *Rec. Geol. Surv. Ind.*, **40** : 63-71.

PILGRIM G. (1937). – Siwaliks Antelopes and Oxen in the American Museum of natural History. *Bull. Am. Mus. Nat. Hist.*, **72**(*7*) : 729-874.

PILGRIM G. (1939). – The fossil Bovidae of India. *Palaeont. Ind.*, n.s., **26**(1) : 1-356.

RAUFI F. & SICKENBERG O. (1973). – Zur Geologie und Paläontologie der Becken von Lagman und Jalabad. *Geol. Jb.*, **3** : 63-99.

SCHLOSSER M. (1903). – Die fossilen Säugethiere Chinas nebst einer Odontographie der recenten Antilopen. *Abh. Math. Phys. Cl. Konig. Bayer. Akad. Wiss.*, **22** : 1-221.

SEN S., SONDAAR P. Y. & STAESCHE U. (1978). – The biostratigraphical applications of the genus *Hipparion* with special reference ot the Turkish representatives. *Proc. Koninkl. Nederl. Akad. Wetensch.*, Amsterdam, B, **81**(2) : 370-385.

SWISHER III C. C. 1996 – New $^{40}Ar/^{39}Ar$ dates and their contributiion toward a revised chronology for the late Miocene of Europe and West Asia. *In* BERNOR R. L., FAHLBUSCH V. & MITTMANN H. W. (ed.) : *The Evolution of Western Eurasian Neogene Mammal Faunas. Columbia University Press*, pp. 64-77.

TEILHARD DE CHARDIN P. & TRASSAERT M. (1937). – The Pliocene Camelidae, Giraffidae and Cervidae of South-Eastern Shansi. *Palaeont. Sin.*, N. S. **C, 1** *(102)* : 1-69.

THOMAS H. (1984). – Les Bovidés anté-Hipparions des Siwaliks inférieurs (Plateau du Potwar, Pakistan). *Mém. Soc. géol. France*, n. s., **145** : 1-68.

TOBIEN H. (1980). – Cerviden-Reste (Ruminantia, Mammalia) aus dem Obermiozän von Maragheh (Iran). *Ann. Naturhist. Mus. Wien*, **83** : 329-341.

VEKUA A. (1972). – La faune de Vertébrés aktschagyliens de Kvabebi (Géorgie). *Nauka*, Moscou : 1-350 (in Russian).

VISLOBOKOVA I. A. (1983). – The fossil deer of Mongolia. *Nauka*, Moscow : 1-75 (in Russian).

VISLOBOKOVA I.A. (1990). – The fossil deer of Eurasia. *Nauka,* Moscow, 208 pp. (in Russian).

WEIDMANN M., SOLOUNIAS N., DRAKE R.E. & CURTIS G.H. (1984). – Neogene stratigraphy of the eastern basin, Samos Island, Greece. *Geobios*, Lyon, **17** *(4)* : 477-490.

ZDANSKY O. (1925). – Fossile Hirsche Chinas. *Palaeont. Sin.*, ser. **C, 2** (3) : 1-90.

ZOUHRI S. (1992a). – Hipparion molayanensis *(Mammalia, Perissodactyla) du Turolien (Miocène supérieur) de Molayan (Afghanistan). Description, Comparaison et Systématique. Doct. Thesis. Univ. Paris VII,* 148 p. (unpublished).

ZOUHRI S. (1992b). – *Hipparion molayanense* n. sp. (Perissodactyla, Equidae) du Turolien de Molayan (Afghanistan) et une nouvelle typologie des Hipparions turoliens de l'Ancien Monde. *C. R. Acad. Sci. Paris*, sér. II, 315 : 1555-1560.

ZOUHRI S. (1996). – Un nouvel Equidé, *Hipparion molayanense* nov. sp., dans le gisement Turolien de Molayan en Afghanistan. *Geobios*, **29** (4), 437-454.

PLATE 1

HIPPARION SP. CF. *H. MOLAYANENSE* Zouhri, 1992.

FIG. 1. Left (a) and right (b) upper tooh-row P^2-M^3 of the same individual (AFG 1015), occlusal view.

FIG. 2. Right tooth row dP^2-dP^4 (AFG 1016), occlusal view.

FIG. 3. Left astragalus (AFG 1043), anterior view.

FIG. 4. Third phalanx (AFG 1066), dorsal view.

FIG. 5. Third metatarsal (AFG 1040), anterior view.

Scale bars in cm.

PLANCHE 1

HIPPARION SP. CF. *H. MOLAYANENSE* Zouhri, 1992.

FIG. 1. Vue occlusale des rangées dentaires P^2-M^3 gauche (a) et droite (b) d'un même individu (AFG-1015).

FIG. 2. Rangée dentaire droite dP^2-dP^4 (AFG-1016).

FIG. 3. Astragale gauche (AFG 1043), vue antérieure.

FIG. 4. Troisième phalange (AFG 1066), vue dorsale.

FIG. 5. Troisième métatarsien (AFG 1040), vue antérieure. Échelle en cm.

PLATE 2

FIG. 1. Cf. *Cervavitus novorossiae* Khomenko, 1913, incomplete left antler and pedicel (AFG 1104), a) medial view ; b) anterior view ; c) posterior view.

FIG. 2. Suidae gen. and sp. indet. (AFG 1101), lower left canine. Scale bars in cm.

PLANCHE 2

FIG. 1. Cf. *Cervavitus novorossiae* Khomenko, 1913, bois gauche incomplet (AFG 1104), a) vue médiale ; b) vue antérieure ; c) vue postérieure.

FIG. 2. Suidae gen. et sp. indét. (AFG 1101), canine inférieure gauche. Échelle en cm.

PLATE 3

FIG. 1. *Tragoportax* sp. (AFG 1098) left mandible with P_2-M_3. a) medial view ; b) lateral view ; c) occlusal view.

FIG. 2. *Tragoportax* sp. (AFG 1078) left maxilla with P^2-M^3. Occlusal view. Scale bars in cm.

PLANCHE 3

FIG. 1. *Tragoportax* sp. (AFG 1098) mandibule gauche avec P_2-M_3. a) vue médiale ; b) vue latérale ; c) vue occlusale.

Fig. 2. *Tragoportax* sp. (AFG 1078) maxillaire gauche avec P^2-M^3. Vue occlusale. Échelle en cm.

PLATE 4

FIG. 1. *Protoryx* ? sp. (AFG 1099) left mandible with P_2-M_3. a) medial view ; b) lateral view ; c) occlusal view.

FIG. 2. Bovidae indet 1 aff. «*Gazella*» *lydekkeri* (AFG 1141) right mandible with M_1-M_3. a) lateral view ; b) medial view.

Scale bars in cm.

PLANCHE 4

FIG. 1. *Protoryx* ? sp. (AFG 1099) mandibule gauche avec P_2-M_3. a) vue médiale ; b) vue latérale ; c) vue occlusale.

FIG. 2. Bovidae indet 1 aff. «*Gazella*» *lydekkeri* (AFG 1141) mandibule droite avec M_1-M_3. a) vue latérale ; b) vue médiale. Échelle en cm.

PLATE 5

FIG. 1. *Prostrepsiceros* ? sp. (AFG 1140) left mandible with P_3-M_3. a) medial view ; b) lateral view.

FIG. 2. *Gazella* ? sp. (AFG 1144) left horn core, medial view.

FIG. 3. Bovidae indet. 1 aff. «*Gazella*» *lydekkeri* (AFG 1138) right mandible with P_2-M_2. a) lateral view ; b) medial view.

Scale bars in cm.

PLANCHE 5

FIG. 1. *Prostrepsiceros* ? sp. (AFG 1140) mandibule gauche avec P_3-M_3. a) vue médiale ; b) vue latérale.

FIG. 2. *Gazella* ? sp. (AFG 1144) cheville gauche, vue médiale.

FIG. 3. Bovidae indet. 1 aff. «*Gazella*» *lydekkeri* (AFG 1138) mandibule droite avec P_2-M_2. a) vue latérale ; b) vue médiale. Échelle en cm.

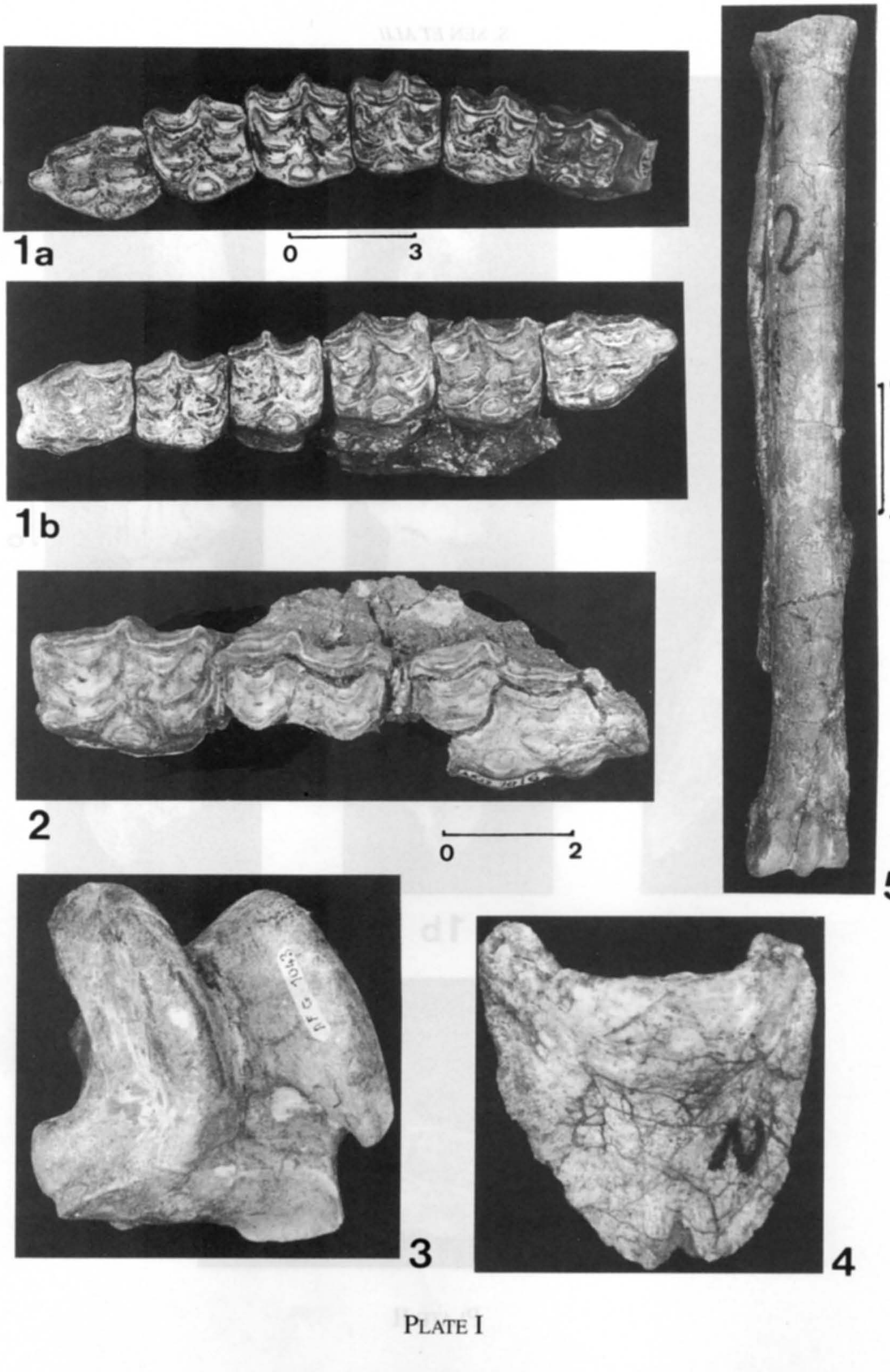
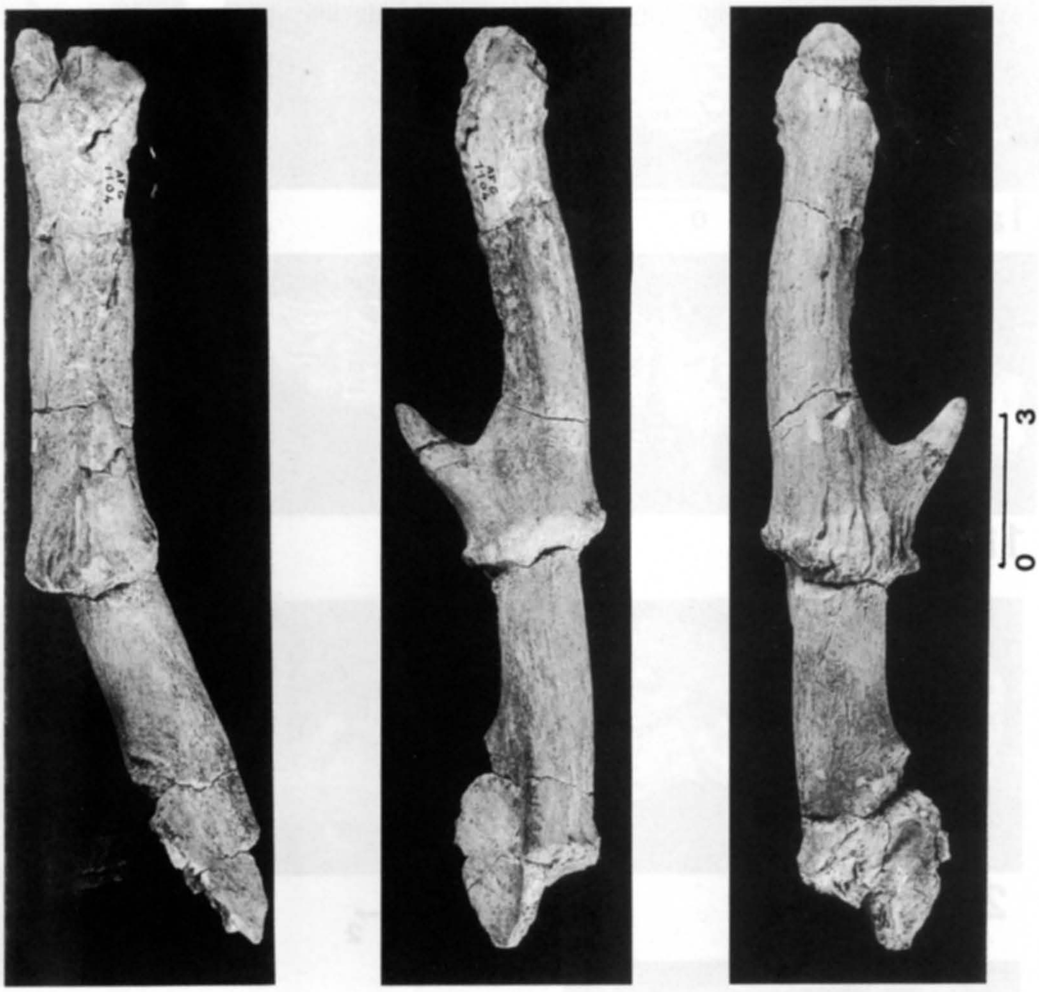


PLATE I



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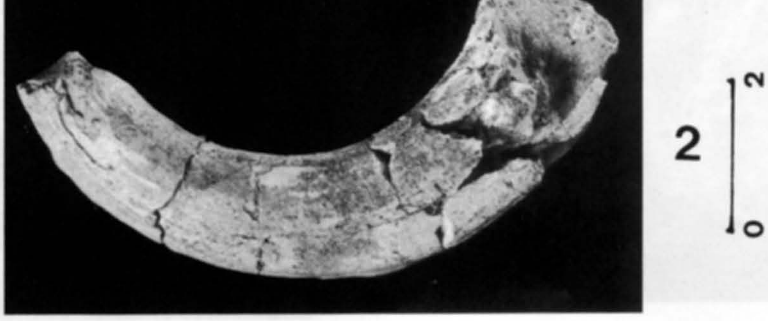

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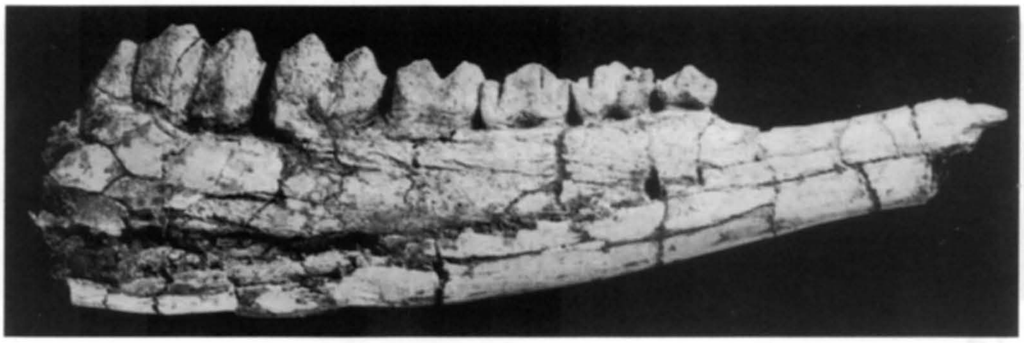
PLATE II



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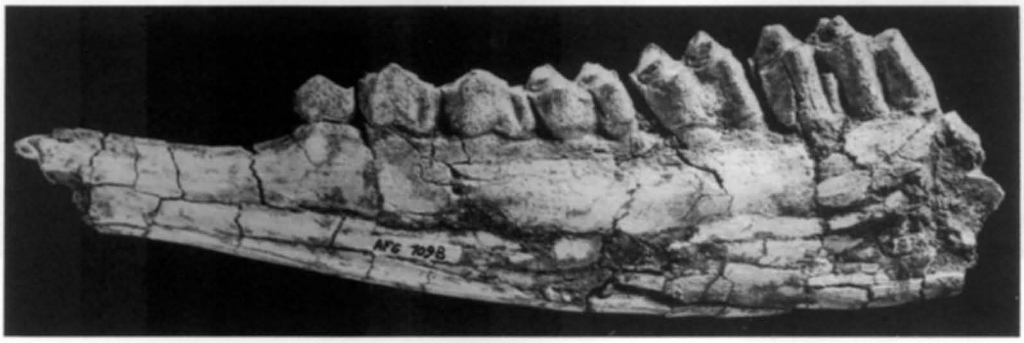

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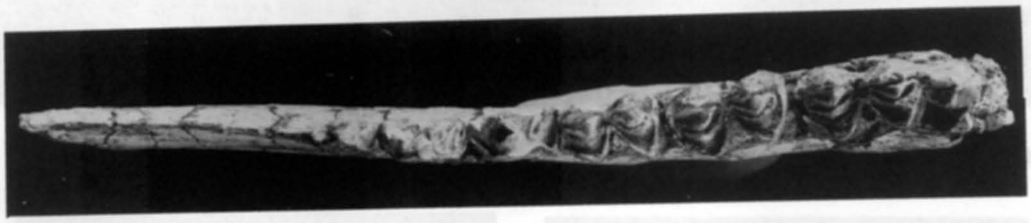

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PLATE III

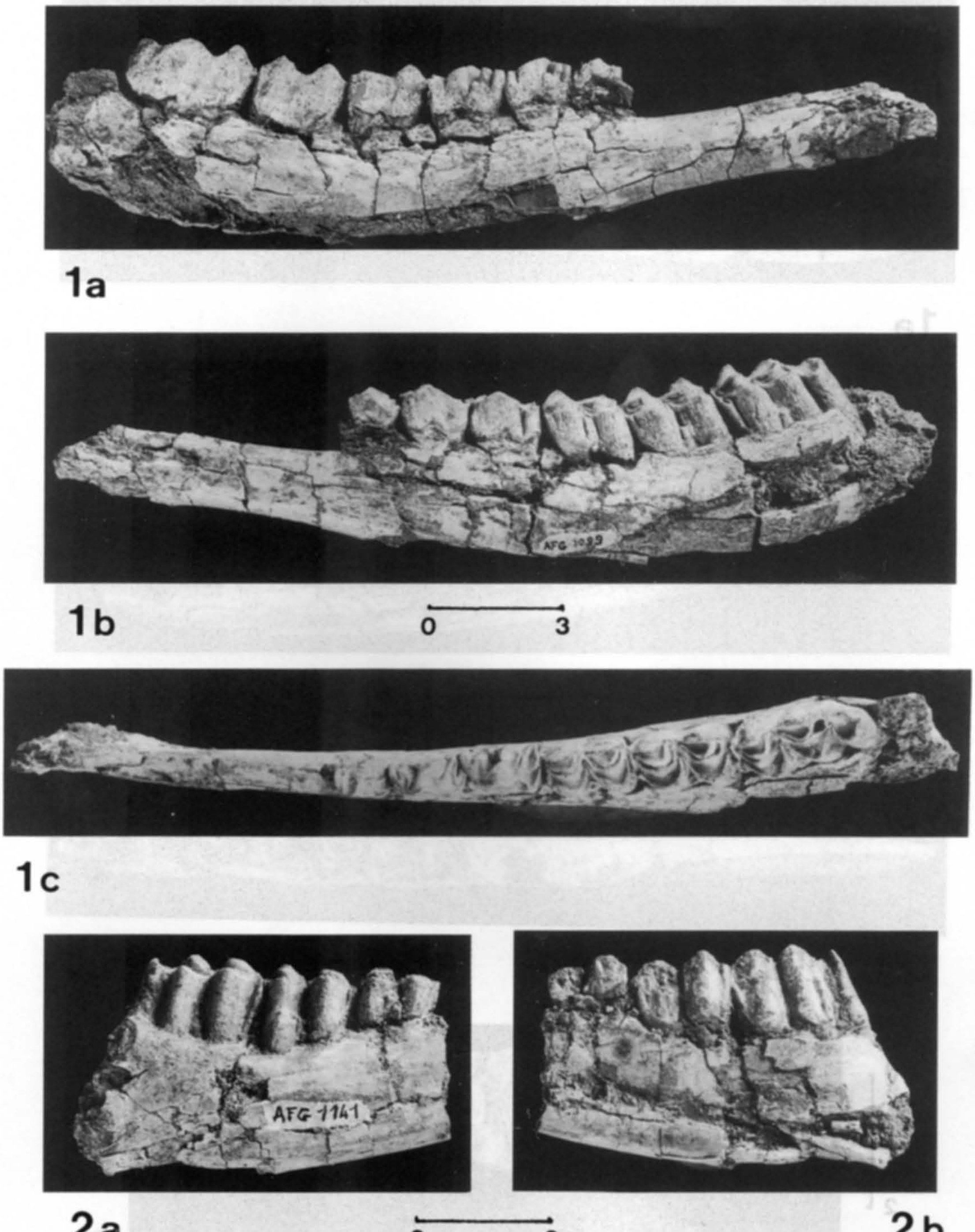

PLATE IV

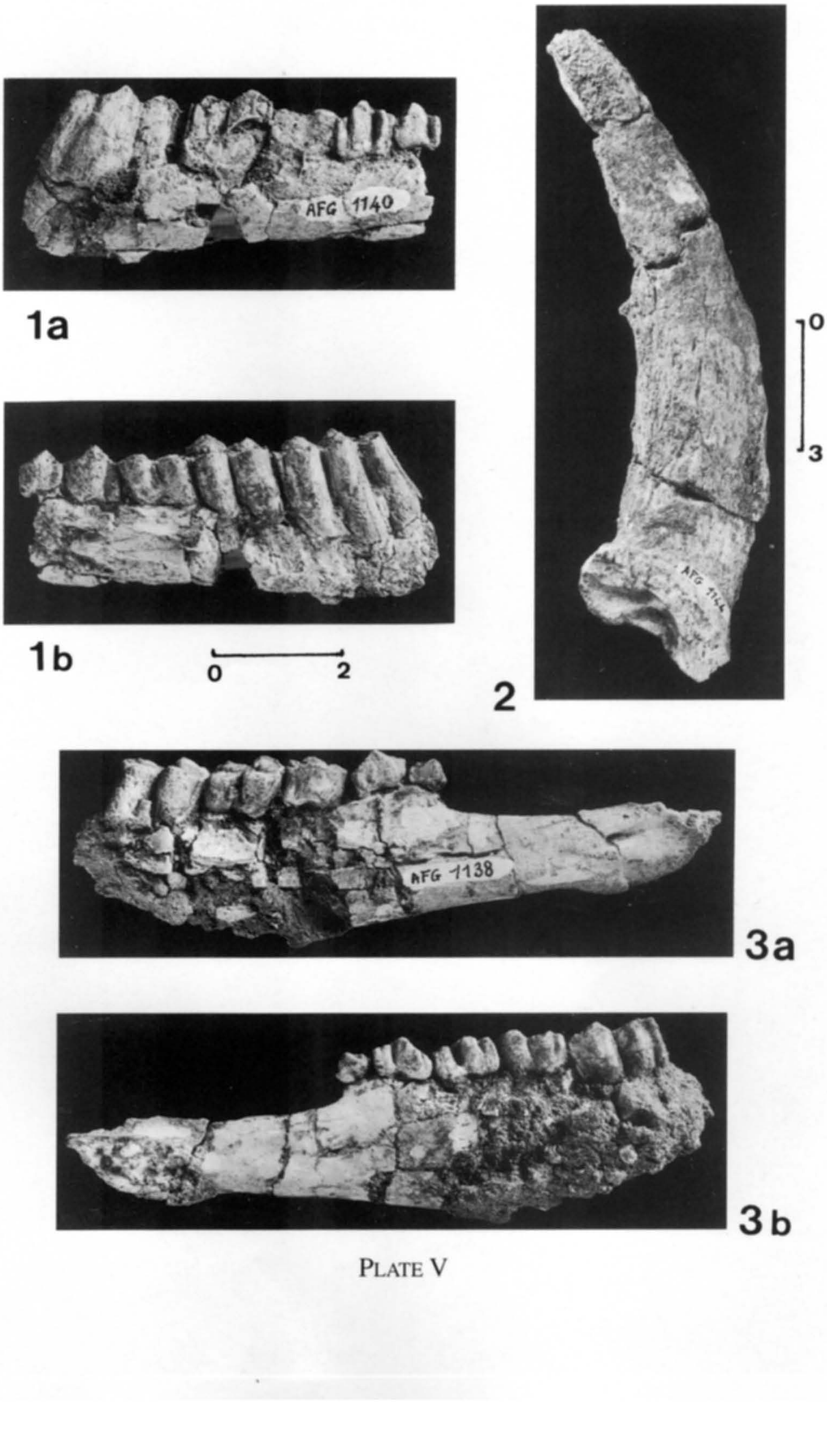

PLATE V