Middle Miocene Artiodactyla from the Northern Junggar Basin

by

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Abstract

The text describes seven genera, seven species of artiodactyls (including *Eotragus halamagaiensis* sp. nov.), in addition to recording three genera and three species of perissodactyls from the Halamagai Formation, northern Junggar Basin, Xinjiang Autonomous region. This fauna contains elements that approach the Tonggur fauna from eastern Inner Mongolia, although several taxa are more primitive. The fauna documents the first record of the genus *Eotragus* in China. The Halamagai Fm. clearly predates the Tunggur Fm. although the fauna is still assigned to the Middle Miocene Tunggurian land mammal age.

Forward

The Xinjiang Paleontological Expedition mounted by the Institute of Vertebrate Paleontology and Paleoanthropology was conducted twice in 1982 and 1984 to study the Tertiary sediments along the banks of the Ulungur He River where abundant fossil vertebrates are produced from the Halamagai Fm. Artiodactyls constitute the vast majority of specimens and are the most taxonomically diverse. This text documents five families, seven genera, and seven species of this order as follows:

Suidae:	*Kubanochoerus* sp.
Cervidae:	*Stephanocemas* aff. *thomsoni*
	Dicrocerus grangeri
Lagomerycidae:	*Lagomeryx* sp.
Giraffidae:	*Palaeomeryx* sp.
Bovidae:	*Eotragus halamagaiensis* sp. nov.
	Oioceros (?) *noverca*

Two families and three species of perissodactyls were also recovered from this horizon and include the following:

Equidae:	*Anchitherium* cf. *aurelianense*
Rhinocerotidae:	*Brachypotherium* sp.,
	?*Chilotherium* sp.

Specimen description

Artiodactyla Owen, 1848
Suidae Gray, 1821
Kubanochoerus sp.

Material: A portion of right ramus with m1-2 (V8614)

Locality and stratigraphic position: Middle Miocene Kekemaideng[?*] Mem. of the Halamagai Fm., Duolebulejin[?], Xinjiang Autonomous Region.

Description: The m2 is bunodont but high-crowned, rectangular, 37.0 mm in length, 26.2 mm in width, slightly narrower anteriorly, and four cusps are nearly equivalent in size with well developed tuberosities between them. A talonid basin is well developed with its height nearly two-thirds that of the principle cusps, a posterolabial cingulum is well developed but attenuates

[*] Translator's note: As precise Uygur spelling is unknown, geographical nomenclature is a direct transliteration from the Chinese text and is anotated as such.

ventral to the hypoconid. The m1 is 30.0 mm in length, 21.3 mm in breadth, moderately worn, and morphologically equivalent to the m2, only its labial cingulum is continuous and better developed.

Discussion: Specimen V8614 represents a large, bunodont listriodontine. To date, there are three Miocene species from various localities in China representing this form of suid: *Listriodon gigas* Pearson, 1928 from Yongdeng Co., Gansu Province; *Listriodon lantienensis* Liu and Lee 1963 from Koujiacun, Lantian Co., Shaanxi Province; and *Bunolistriodon minheensis* Qiu, Li, and Wang 1981 from Minhe Co., Qinghai Province. Outside of China there are three genera and three species of this subfamily: *Kubanochoerus robustus* (Gabunia 1955, 1958) from Belometchetskia, Kavkaz, Russia; and *Libycochoerus massai* (Arambourg 1961) and *Bunolistriodon khinzikebirus* (Wilkinson, 1976) both from Gebel Zelten, Libya. Long standing confusion and controversy exists regarding the taxonomy and nomenclature of bunodont listriodontines. Most recently, a set of complete skulls were recovered from localities in Tongxin Co., Ningxia Province, which clarifies some of the confusion. Upon describing these, Z.X. Qiu et al. (1988) conducted a comprehensive discussion of the bunodont listriodontines in which they explicitly recognized the two genera *Libycochoerus* and *Kubanochoerus* and further reassigned the three Chinese species to the genus *Kubanochoerus.* The Xinjiang specimens most closely approach those from Minhe Co. with their well developed labial cingulum. Although there is a large range of dental variation in the bunodont listriodontines, m1 and m2 interspecific variation is limited such that it is possible to assign specimen V8164 to the genus *Kubanochoerus.*

Cervidae Gray, 1821
Stephanocemas aff. *thomsoni* Colbert, 1936

(Plate II, Figs. 4-6)

Specimens: A total of twenty specimens of adult and juvenile antlers including: V8603.1-4, V8604.1-2, V8605.1-4, V8606, V8607, V8608.1-2.

Locality and stratigraphic position: Lower member of the Middle Miocene Halamagai Fm. from the localities of Buotamoyin[?], Buotamoyindong[?], Chibarwoi[?], Duolebulejin[?], Ganqikarxi[?], and Tiersihabahe[?].

Description and comparison: These specimens are nearly identical to those from Tung Gur, Inner Mongolia. Among the specimens, V8604.1 is a relatively well preserved (?) right antler which is palmate with seven divergent tines that project slightly dorsally while radiating from a circular base. The (?) brow tine is broken off at its base. The posterior tine is relatively broad, lamelliform, and posteriorly expanded with a broken terminus, although it still possible to determine that the terminus diverges into two smaller tines. Although these are all fundamental synapomorphies for the genus, the Xinjiang specimens are all smaller (adult antler shedding scars are approximately 20 mm in diameter), tines are more dorsally expanded, basal pedicle is more distinctly columnar, range of variation is larger, cross-section of antler shedding scar alters from circular to elliptical, a vast majority of scars is not enclosed (see discussion on cervid shedding scars below), and each specimen is surficially coarsened and morphologically extremely irregular to the point that the antler and antler pedicle is unified. These characters, which differ noticeably from specimens at Tung Gur, more closely resemble *S. aralensis* from the Aral Sea region of the former Soviet Union and furthermore, approach several plesiomorphic characters of *S. elegantulus* from the Aragonian of Europe. Consequently, the Xinjiang specimens represent a more primitive lineage but maintain an intimate relationship with the taxa at Tung Gur. As the data from Xinjiang are restricted, there is a provisional assignment to *S. thomsoni*

Dicrocerus grangeri Colbert, 1936

(Plate II, Fig. 1)

Locality and stratigraphic position: A basal antler (V8610) from the Halamagai Mem. of Buotamoyin[?] and three damaged antlers from (V8611.1-3) from the Kekemaideng[?] Mem. of Duolebulejin[?].

Description and discussion: The antler is robust with a broad base, possesses a "pseudo" bracelet, is divided into two anterior and posterior tines separated at an approximate 50° angle, and the tines are laterally compressed with conspicuous longitudinal corrugations. V8611.2 maintains distinct anterior and posterior laminar crests. These characters all resemble *D. grangeri* from Tunggur. In 1936 when Colbert erected the nomenclature, he recognized several smaller taxa that he assigned as *Dicrocerus* sp. indet. based upon the smaller width of the basal antler and the presence of a short "spur" at the confluence of the tines. Colbert's illustrations (Figs. 8-9) indicate a large range of variation in *D. grangeri* and a distinctly reduced size for *D.* sp. indet. The numerous specimens of lagomerycid and stephanocemid cervids from Xinjiang indicate an extremely small proportion of juveniles to adults, the juvenile antlers are generally gracile, weak, extend more dorsally, and antler bases form more of a short pillar. It is thereby determined that Colbert's *D.* sp. indet. probably represents juvenile *D. grangeri.*

Lagomerycidae

Lagomeryx sp. Pilgrim, 1941

(Plate II, Figs. 1-3)

Specimens: A total of 18 adult and juvenile specimens (including V8609.1-10).

Locality and stratigraphic position: Lower portion of the Middle Miocene Halamagai Fm. Buotamoyin[?], Xinjiang.

Description and discussion: The antler pedicle is long, slightly anteriorly curved, circular in cross-section, and crown has three short divergent tines. On adult individuals the (?) posterior side is distinctly expanded and termini are forked. Specimens are small, or conspicuously smaller than *L. triacuminates,* as exemplified by their pedicle diameter which does not exceed 15 mm. Worthy of notation is the distinctly unenclosed shedding scar on a portion of the specimens. Also, the shedding scar position is inconsistent with the highest scar approaching the base of the crown and lowest placed at approximately 10 mm from the base of the crown. The absence of a shedding scar was initially a significant character for *Lagomeryx,* but among the Xinjiang specimens it is difficult to distinguish between specimens with or without shedding scars and hence these forms from the Halamagai Fm. may represent a transition stage. The characters of being small and the presence of a portion of the specimens with shedding antlers may also indicate a distinct species of *Lagomeryx* in Xinjiang. But because the data is restricted they are provisionally regarded as species indeterminate.

Prior literature regarding *Stephanocemas* specimens from Xinjiang documents two species with shedding scars. On a vast majority of specimens the basal antler shedding scars consist of ashallow circular depression with a rather precipitous margin, floor is relatively flat, and the surface is covered with sponge-like mammilary depressions. A second shedding scar morphology is present on V8606 in which the circular boundary is slightly projected, is enclosed, smooth, glossy, and lacks any mamillary depressions. As these two shedding scar morphologies are distinct, they are hereby recognized as "enclosed shedding scar" (Text Fig. 1A) and "unenclosed shedding scar" (Text Fig. 1B), the former representing a scar from a naturally shed antler and the

latter representing an antler shed due to the application of external stimulus or force. These two antler scar morphologies are also recognized in the Tung Gur specimens, although among the 10 specimens studied, only a single specimen displayed an unenclosed morphology, the remaining being enclosed, which is completely opposite to the sample in Xinjiang. Another interesting phenomenon lies in the fact that the majority of the sample are unshed antlers but a portion of the Xinjiang *Lagomeryx* specimens maintain shedding scars although all scars are unenclosed, which indicates that the population is beginning to shed antlers. It is thereby concluded that the unenclosed shedding scars represent shed antlers on archaic cervids and that this is the plesiomorphic condition for European *Stephanocemas* and other later cervids.

Stehlin (1937) described *Stephanocemas elegantulus* from Augsburg, Germany, in which he figured specimens with unenclosed shedding scars (Figs, 3,4,6) and enclosed shedding scars (Figs. 2,7). On later cervids, not only are shedding scars enclosed, but their surfaces are slightly convex and surrounded by an antler bracelet. Therefore the evolutionary tendency of antler shedding scar morphology is as follows: initiating with the primitive, shallowly convex, and unenclosed morphology to an enclosed and planar morphology. It then progresses from a shedding scar lacking a bracelet to a conspicuous bracelet. Finally, antler shedding probably adjusted from applying external stimulus to invariable natural shedding. This hypothesis still requires more data and systematic research for confirmation.

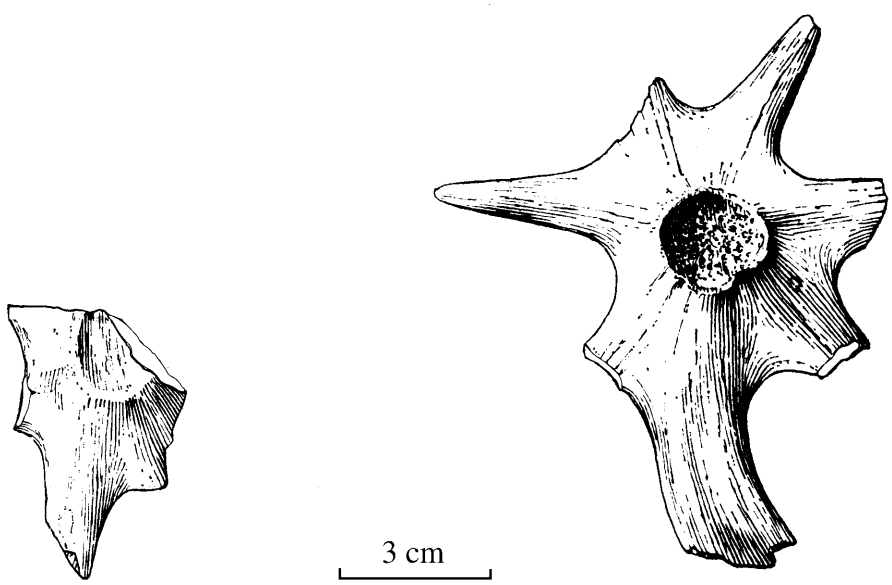


Figure 1A. Enclosed shedding scar on V8606 **Figure 1B.** Open shedding scar on V8604.1

Abundant individual cervid teeth are also represented within the Xinjiang collection, although none is associated with antlers. Three morphologies are recognized and assigned to the taxa described above based upon size, length-breadth ratio, degree of hypsodonty, and morphology. Reference is made to Filhol (1891) and Colbert (1940).

Stephanocemas* aff. *thomsoni

Specimens: 10 isolated upper molars: three ?M1 (V8587.1-3), four M2 (V8587.4-7), three M3 (V8587.8-10), and one fragmentary mandible with dp4 and m1 (V8588).

Locality and stratigraphic position: Middle Miocene lower portion of Halamagai Fm. at Buotamoyin[?], Chibarwoi[?], and Tiersihabahe[?].

Description and discussion: Upper molar breadth generally exceeds length, crowns are rather hypsodont for Cervidae, enamel surface is crenulated, labial wall is relatively flat, parastyle, mesostyle, and metastyle are well developed, paraloph rib is particularly projected, and anterior wing on protocone is elongated but posterior wing is short. Protocone spur is well developed with a bifurcated terminus and its posterior branch intersects with the anterior wing of the hypocone. Anterolingual cingulum is well developed and basal pillar is fused to the lingual cingulum. The M1 is relatively small and nearly square in outline, the M2 is slightly larger than the M1 with a breadth that exceeds its length, and the M3 is posteriorly reduced. The dp4 is relatively narrow, long, and trifoliate; *Paleomeryx* fold and cingulum are well developed; and basal pillar between protoconid and hypoconid constitutes a large proportion of the inflation on the labial cingulum.

Colbert's (1940, p. 3) description of the *Stephanocemas thomsoni* dentition included a summary of the five principle characters: 1) the dentition size and degree of hypsodonty approach *Dicrocerus elegans;* 2) well developed upper molar lingual cingulum; 3) small lower molar basal pillar; 4) m3 talonid posteriorly extended and enclosed to form a ring; and 5) well developed lower molar *Paleomeryx* fold. The Xinjiang specimens are damaged and thus character four cannot be recognized, although the remaining characters are all consistent. Colbert's measurements document that the Tung Gur *Stephanocemas* (M3 LxW as 13x18 mm) approaches *Lagomeryx* (Shanwang Loc. M3 as 12.3x13.0 mm) and *Dicrocerus* (*D. frucatus* M3 as 12.5x14.5 mm). The conspicuously broad upper molar should also be regarded as a diagnostic character for the genus. As the Xinjiang specimens also bear additional characters they are regarded with the provisional assignment of *S*. aff. *thomsoni*.

Dicrocerus grangeri

Material, localities, and stratigraphic position: Four fragmentary mandibles (V8589.1-4), 23 isolated teeth (V8589.5-27) including ten m1, eight m2, and 13 m3 produced from Buotamoyin[?]; a single right m3 (V8592) from Duolebulejin[?]; and a fragmentary right mandible with p3 and p4 (V8590) from Buotamoyindong[?]. All specimens were produced from the Halamagai Mem. with the exception of V8592, which was produced from the Kekemaideng[?] Mem.

Description and discussion: The labial wall of the p3 is highest at the protoconid and is convexly inflated, posterior of which there is a shallow reentrant which is located between the protoconid and hypoconid. The lingual wall is incomplete, but a relatively broad valley is present between the paraconid and metaconid, metaconid-protoconid and entoconid-hypoconid are each linked by a crest and the posterior portion of the tooth is composed of two small anteroposteriorly aligned rings. The p4 morphology resembles the p3 but is larger and the reentrant between the protoconid and hypoconid is more conspicuous.

Lower molars are rather hypsodont, enamel crenulation is relatively well developed as are the anterior stylid on the lingual wall, medial stylid, and anterior and posterior ribs, although the basal portion is relatively flat. A *Paleomeryx* fold and basal pillar are well developed as is a m3 talonid which extends posterolabially and resembles the two anterior portions, its labial side is relatively high, and lingual side is correspondingly relatively low and distinctly crenulated. Frequently present is an enamel projection that resembles a basal pillar between the hypoconulid and hypoconid, and which has a large range of variation.

A vast majority of the 40 specimens assigned to *D. grangeri* are isolated teeth, but credibility of the assignment is supported by the four mandibles bearing dentition. V8590 only

possesses two premolars but resembles the specimen described by Filhol (1891, Plate XXXII, Fig. 4) as "*Cervus dicroceros*" from the Sansan Basin, France. The Xinjiang isolated molars are also consistent with this publication, only the labial wall is slightly flattened, slightly narrowed transversely, making the teeth thereupon slightly longer and narrower. It is worthy of note that the m3 in the sample has a talonid that is labially projected and a lingual wall that is folded, which are characters noted by Colbert (1940, p. 27) to occur in the European *D. furcatus* and *D. elegans* and allows its distinction from *Stephanocemas.* Therefore the Xinjiang specimens are assigned to *Dicrocerus grangeri.*

Lagomeryx sp.

Material, locality, and stratigraphic position: A fragmentary left ramus with m2 and m3 (V8591.1) and associated but damaged right m1 and m2 (V8591.2) from Buotamoyin[?]; a left m3 (V8593) from Qikaierxi[?]. All specimens are derived from the lower section of the Middle Miocene Halamagai Fm.

Description and discussion: Specimens are small and brachydont with crenulated enamel and an undulating lingual wall. Parastylid and two ribs are well developed, mesostylid is distinctly projected, and labially there is a basal pillar and *Paleomeryx* fold. The m3 metastylid is conspicuous and talonid projects posteriorly.

Currently in China, there is only one specimen of *Lagomeryx* from Shanwang that has a dentition associated with antlers. The Xinjiang specimens are morphologically close to this specimen, particularly in their small size, brachydonty, undulating lingual wall, particularly well developed mesostylid, distinct metastylid, and posteriorly extended m3 talonid. These characters are also quite distinct from *Stephanocemas* and *Dicroceros.* The dental differentiation of the three Xinjiang cervids is illustrated in Table 1.

Table 1. Comparison of Xinjiang cervid lower molar characters.

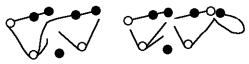
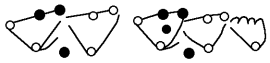
Stephanocemas aff. *thomsoni*	*Lagomeryx* sp.	*Dicrocerus grangeri*
m1 	m2 m3 	m2 m3 
Size large	Size small	Size rather large
High crowned	Low crowned	High crowned
Distinct labial cingulum	Labial cingulum absent	Labial cingulum absent
Labial basal pillar absent	Well developed labial basal pillar	Well developed labial basal pillar
Lingual wall rather flat	Undulating lingual wall, well developed mesostylid	Well developed cusps and ribs
	m3 talonid posteriorly extended	m3 talonid labially extended, lingual wall crenulated

Table 2. Comparison of Xinjiang cervid dental measurements (mm).

	Stephanocemas aff. *thomsoni*	*Lagomeryx* sp.	*Dicrocerus grangeri*
M1 LxW	13.4-14.3x13.8-16.2	—	—
M2 LxW	12.1-13.0x15.0-16.3	—	—
M3 LxW	13.8-14.0x17.0-17.5	—	—
m1 LxW	15.0x9.0	11.0x9.0	11.9-13.0-8.3-9.0
m2 LxW	—	12.0x8.2	14.7-15.5x10.0-12.0
m3 LxW	—	16.2-16.3x8.0-8.2	19.7-20.0x9.0-9.5

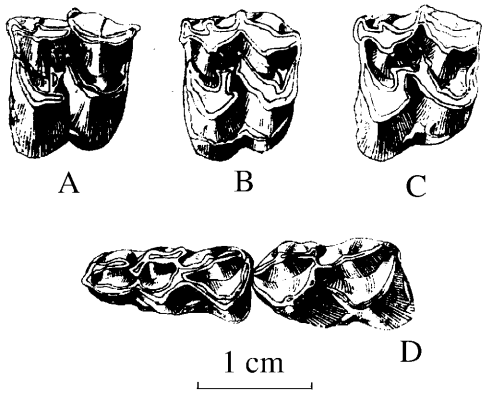


Figure 2. *Stephanocemas* aff. *thomsoni*
A. Left M1 (V8527.2); B. Left M2 (V8527.4); C. Left M3 (V8527.9); D. Left dp4 and m1 (V8588)

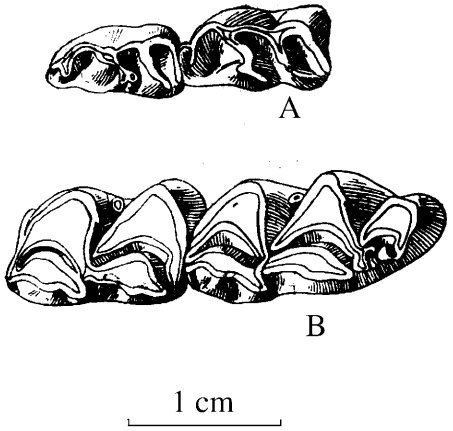


Figure 3. *Dicrocerus grangeri*
A. Right p3 and p4 (V8590); B. Right m2 and m3 (V8589.3).

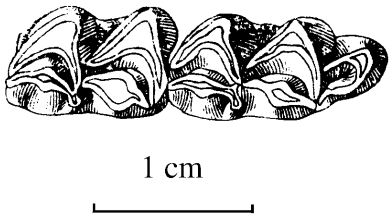


Figure 4. Occlusal view of *Lagomeryx* sp. right m2 and m3 (V8591.1).

Giraffidae Gray, 1821
***Palaeomeryx* sp.**

Material: A single left m2 (V8594.1) and a single left m1 (V8594.2)

Locality and stratigraphic position: Buotamoyin[?], Middle Miocene lower member of the Halamagai Fm.

Description and discussion: The m2 has a length of 22 mm and width of 18.5 mm, is brachydont, and has highly crenulated walls. The lingual wall undulates, the paralophid conspicuously overlaps the metalophid, two ribs, a mesostylid, and *Palaeomeryx* fold are well developed, the anterior wing of the protocone is slightly thickened anterolabially with its apex

slightly anteriorly directed, and a basal pillar is present. The m1 is small, has a length of 22 mm and breadth of 17.2 mm, is more heavily worn than the m2, but is morphologically similar.

In 1985, Qiu et al. described more complete data of *Palaeomeryx tricornis* from Shanwang, Shandong Province, and conducted a systematic discussion of the diagnostic characters and their implications toward giraffid phylogeny. Three apomorphies unite this genus with the long necked giraffids which make it the most primitive member of the lineage and isolates it from the main stem of the Ruminani. Its size also indicates the Shanwang Fauna to correlate to MN4 or MN5. Shanwang specimens also indicate that the male *Palaeomeryx* posseses ossicones, which is a significant synapomorphy for the Giraffidae. The Xinjiang specimens share fundamental morphological characters with the Shanwang specimens although they are distinctly larger, slightly more brachydont, lingual walls are relatively more convexly rounded, and their basal pillar is a projected inflation off the cingulum. The size of the Xinjiang specimens approaches specimens from Sansan (MN6).

Bovidae Gray, 1821
Eotragus halamagaiensis sp. nov.

(Plate I, Figs. 1-6; Text Fig. 5)

Type: A single left horncore (V8595.1).

Paratype: A portion of left mandible with m1-3 missing its rostral end and ascending ramus (V8599); and 13 slightly damaged horncores (V8595.2-9, V8596.1-3, V8597.1-2).

Locality and stratigraphic position: All specimens were produced from the base of the Middle Miocene Halamagai Fm. V8595 was derived from Buotamoyin[?]; V8596 and V8597 were derived from Chibarwoi[?], and V8597 was derived from Tiersihababe[?].

Etymology: From the stratal nomenclature Halamagai Formation.

Diagnosis: A relatively circular horncore with basal cross-section breadth/length index of 79.0-96.4% which is larger than both *Eotragus sansaniensis* and *E. haplodon.* Lower molars are larger than *E. artenensis,* dentition is more hypsodont than *E. haplodon* and more equivalent to *E. sansaniensis* although it is longer and narrower. The m2 is distinctly longer than on any known species.

Description: Horncores are straight, long, curve very slightly anterolaterally, lack any spiraling, and surficially maintain longitudinal striations while they lack distinct longitudinal ribs or grooving. They are also very slightly laterally compressed, are elliptical in cross-section, and basal diameter breadth is approximately 90% of length. The horncore gradually attenuates from base to apex. Its position lies relatively close to the lateral margin of the orbit, and supraorbital fossae are positioned low.

Lower molars are high crowned but are still brachydont for the family, enamel surface is smooth and glossy, and *Paleomeryx* fold is absent. The m1 is nearly rectangular in occlusal view, lingual and labial walls are not parallel, a basal pillar is well developed, and the lingual wall undulates. The m2 is larger than the m1 with anterolingual and anterolabial folds present, the basal pillar is weaker, and metastylid is conspicuous. The m3 is narrow and long with an even weaker basal pillar; parastylid, metastylid, and ribs are all distinct; talonid basin is high, large, unenclosed, and maintains on open lingual mouth.

Table 3. Dental measurements of *Eotragus* (mm).

		M1	M2	M3	m1	m2	m3
E. halamagaiensis	L	—	—	—	10.3	13.3	17.3
V8599	W	—	—	—	7.3	8.2	7.3
E. artenensis	L	10.2-11.3	11.5-12.0	11.4	—	11.5	15.0
(from Ginsburg, 1968)	W	10.2-10.5	11.5-12.3	11.6	—	7.8	7.9
E. haplodon	L	11.0-11.3	12.4-12.5	12.2-13.5	10.5-11.4	12.0-12.8	15.0-16.4
(from Thenius, 1952)	W	13.0-13.0	13.6-14.8	13.5-13.8	7.8	8.9-9.4	8.8-9.1
E. sansaniensis	L	10.0-10.4	12.0	12.8-13.0	10.3-10.4	11.1-11.3	15.0-17.6
(from Thenius, 1952	W	11.8-13.0	13.9-14.0	13.9-14.0	7.0-7.3	8.2-8.4	7.5-8.8

Table 4. Comparison of *Eotragus* basal horn core measurements (mm).

		V8595.1	V8595.5	V8595.7	V8595.8	V8595.9	V8596.1
	L	23.8	19.5	24.0	21.5	19.1	24.0
E. halamagaiensis	W	22.0	18.8	20.4	17.0	17.0	22.0
	W/L	92.4%	96.4%	85.0%	79.0%	89.0%	91.6%
		Leoben					
E sansaniensis		I	II	III	Locle	Veltheim	Sansan
(from Thenius, 1952)	L	23.1	23.0	21.0	22.0	21.0	22.0
	W	16.2	16.5	16.0	17.3	—	14.0
	W/L	70.0%	71.7%	76.0%	78.6%	—	63.0%
		Goriach		Gamlitz			Sansan
		I	II	I	II	III	I
E. haplodon	L	25.6	24.6	27.7	23.0	27.2	25.3
(after Thenius, 1952)	W	20.6	19.1	18.0	17.0	17.3	19.2
	W/L	80.4%	77.6%	65.0%	73.9%	63.6%	75.9%

Discussion: The horncores and mandibles from Xinjiang are morphologically consistent with *Eotragus* from Europe, as they are straight, gracile, and very slightly anterolaterally curved, while the tooth crowns are not hypsodont and maintain characters for both the Bovidae and Cervidae.

Eotragus is the most primitive bovid recognized to date. The oldest representative of the genus is *E. artenensis* from the middle Burdigalian of Artenay, France, which is a slightly smaller species than others in the genus (Ginsburg and Heintz, 1968). *E. haplodon* from the Middle Miocene (MN6) locality of Göriach, in the Steirmark Basin of Austria, is relatively larger, has an oval horncore cross-section, horncore abruptly attenuates from base to apex, lower premolars are relatively elongated, and molars are slightly brachydont with a basal pillar. *E. sansaniensis* from the MN6-MN7 localities in the Sansan Basin of France in addition to Leoben in the Steirmark basin of Austria, is a rather derived species with a size that approaches *E. haplodon,* horncores are more laterally compressed and gradually attenuate dorsally, dentition is more hypsodont than the former two species, basal pillar is absent, and lower molars are more narrow.

The Xinjiang specimens are undoubtedly close to *E. sansaniensis* with their horncores being straight, long, equivalent degree of lateral curvature, nearly consistent dorsal attenuation, and molar size and hypsodonty nearly equivalent. However, the Halamagai specimens are distinct in being relatively broad and basal cross-section is circular to the point of being more symmetrical than on the primitive *E. haplodon.* Furthermore, the lower molars of the Xinjiang specimens, from one aspect, retain the primitive basal pillar and possess an unenclosed m3 talonid, while from another aspect their tooth crowns are higher, narrower, and longer than *E. sansaniensis.* Particularly worthy of note is that the m2 length exceeds 13.3 mm which far exceeds the length of all European species. Despite the clear distinctions between *E. halamagaiensis* and *E. sansaniensis,* their similar horncore morphology, narrow dentition, and crown height are regarded as synapomophies when compared to more primitive taxa, and therefore they are regarded as being generally contemporaneous.

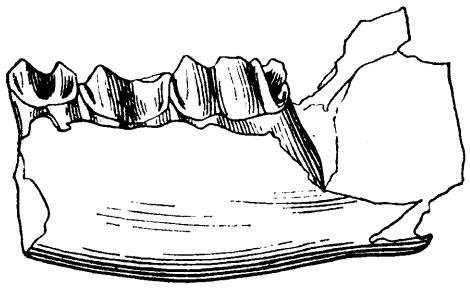


Figure 5. Lingual view of *Eotragus halamagaiensis* sp. nov. (V8599) right mandible fragment.

Oioceros (?) *noverca* Pilgrim

(Plate III, Figs. 2-4)

Material: A pair of mandibles, the left of which is relatively complete with p2 (damaged)-m3 a right mandible which bears p2 roots and damaged p3-m3 and has suffered compressional distortion deforming the ramus, and breaking the ascending ramus (V8612.1), and fragmentary mandible with m1-3 (V8612.2).

Locality and stratigraphic position: Middle Miocene Kekemaideng? Mem. of the Halamagai Fm. at Duolebulejin?.

Description and discussion: The anterior p2 has been broken, preserving only the posterior section. The p3 is extremely worn but it is still evident that it is composed of an anterior and posterior wing and on the labial wall one-third of the distance from the posterior end there is a distinct longitudinal groove descending to the base of the crown. The p4 resembles the p3 only it is larger. Molars are hypsodont with very weakly crenulated enamel, there is a well developed fold on the anterolingual and anterolabial side, while posteromedially there is only a very weak fold. A basal pillar is well developed on the m1 and m2 but is rather weak on the m3. When the m3 is relatively deeply worn the talonid is narrow and triangular.

The basic characters of the specimens described above do not differ markedly from *Oioceros* from Tung Gur described by Pilgrim (1934). *O.* (?) *grangeri* was also documented in this publication, being distinguished from the former by being 1.6 times larger, having a shorter premolar dentition, the presence of a convexly inflated frontoparietal suture line, a more triangularly shaped basioccipital, and a more simplified p2. The publication's plates also indicate that the *O.* (?) *noverca* orbit constitutes a larger proportion of the skull and its supraorbital fossa is located at the more basal portion of the horncore than on *O. grangeri.* More worthy of discussion, despite the resemblance of the two horncore morphologies noted by Pilgrim, are the cranial discrepancies which may warrant the erection of a new genus.

Perissodactyla Owen, 1848
Equidae Gray, 1821
Anchitherium cf. *aurelianense*

Material: A damaged left upper medial cheek tooth (V8615) and distal ends of a third and lateral carpal (or tarsal) (V8616).

Locality and stratigraphic position: Lower member of the Middle Miocene Halamagai Fm. at Chibarwoi? and Tiersihababe?.

Discussion: The tooth is relatively small, with maximum length/breadth measurements of 20.4 and 25.0 mm, which are less than *A. gobiense* measurements (20.0-22.0x25.5-28.5) from the Tung Gur Fm. of Inner Mongolia and more closely approach the Middle Miocene European *A. aurelianense* . Morphologically, the tooth also approaches the European form by exhibiting a sinuous instead of angularly formed posteroloph and lacks a lingual cingulum. A more significant problem to be resolved is the limbs, which are significantly smaller and more gracile than *A. gobiense,* also more closely approaching the European species. The Halamagai specimen is distinctly smaller than the Inner Mongolian taxon, particularly in its limbs, although dental and limb morphology are not distinctly derived.

Table 6. Comparison of *Anchitherium* limb elements (mm).

		V8616	*A. aurelianense*	*A. gobiense*
Mc (or Mt) III	Shaft breadth	19.0	20.5-24.0	30.0
	Distal breadth	28.5	27.5-32.0	—
Lateral Mc (or Mt)	Shaft diameter	12.4	12.0-12.6	18.0

Rhinocerotidae Owen, 1845
Brachypotherium sp.

Material: Anterior halves of left and right mandibles from the same individual and bearing p2-p4 and p1-p4 (V8617.1) and a posterior portion of mandible with roots of m2 and m3 (V8617.2).

Locality and stratigraphic position: Middle Miocene Kekemaideng? Member of the Halamagai Fm. at Duolebulejin?.

Discussion: These specimens are assigned to the genus *Brachypotherium* due to the relative hypsodonty of the teeth and shallow groove on their labial wall. Within the Rhinocerotidae it is only the genus *Brachypotherium* which possesses this derived character. This genus has never been reliably documented in China, and as such, comparisons must be conducted with specimens outside of the country. The Xinjiang specimen's degree of apomorphy approaches the European *B. brachypus,* the African *B. heinzellini,* and *B. perimense* from the Indian Subcontinent in being rather large and displaying the near loss of the longitudinal groove on the labial dentition. However, the Xinjiang specimen has a relatively well developed labial cingulum which is clearly a plesiomorphic character.

?*Chilotherium* sp.

Material: A right M2 or M1 (V8618), a right m1 (V8619), a left p3 (V8620), and several limb elements (V8621).

Locality and stratigraphic position: The three isolated teeth were derived from the Middle Miocene lower member of the Halamagai Fm. at Wuzunkabake?, Chibarwoi?, and Kanqikairxi?, while the limb elements were derived from the Kekemaideng? Member at Duolebulejin?.

Discussion: Although the data is extremely fragmentary and insufficient for a precise diagnosis, it nevertheless still undoubtedly represents an undescribed species. Upper molar characters are distinctly attributed to *Chilotherium* including the crown height (M2 exceeding 7 cm), the extremely well developed antechrochet which extends into the mouth of the medial valley, the thin and gracile parastyle fold that is extremely close to the parastyle, well developed lingual cingulum, and the presence of a small pillar at the mouth of the medial valley. However, the labial wall is undulating and not flat and straight as on younger *Chilotherium* and as such the Halamagai specimens appear to be closer to "*Diceratherium*" *tsaidamense* described by Bohlin from the Caidam Basin. The African genus *Chilotheridium* approaches the Xinjiang specimens in size, morphology, and degree of hypsodonty, but the limb proportions are quite distinct, as the Xinjiang McIV length is 14 cm while on *Chilotheridium* and the Caidam specimens they are distinctly shorter, thicker and do not exceed 12 cm. This same element on *Chilotherium* from the Baode Stage is only 8.5 cm. Most recently the Caidam Basin "*Diceratherium*" specimens have been synonymized with subgenus *Acerorhinus,* and as such the Xinjiang specimens are hereby provisionally assigned.

The age of the Halamagai Formation

The Halamagai Formation may be subdivided into two distinct lithologic units: The upper Kekemaideng? member which produces five taxa of mammals including *Dicrocerus grangeri, Oioceros* (?) *noverca, Kubanochoerus* sp., ?*Chilotherium* sp., and *Brachypotherium* sp. The lower member produces seven genera and seven species including *Dicrocerus grangeri,*

Lagomeryx sp., *Stephanocemas* aff. *thomsoni, Palaeomeryx* sp., *Eotragus halamagaiensis* sp. nov., ?*Chilotherium* sp., and *Anchitherium* cf. *aurelianense.* Although *Brachypotherium* sp. and *Oioceros* (?) *noverca* are not documented in the lower member, they co-exist with the taxa of the lower member in other faunas, and consequently it is assumed there is no great chronological discrepancy between the upper and lower members. Therefore, this text provisionally regards both members as producing a single fauna.

The formation produces seven families, ten genera, and ten species. The artiodactyls and perissodactyls are unquestionably close to those produced from the Inner Mongolian locality of Tung Gur and between them they share seven genera and three species (there are 11 genera and 14 species currently documented at Tung Gur). However, distinctions between the two faunas lie in the following: 1) *Anchitherium*: Current European data indicates a first appearance in the middle Burdigalian (Wintershof-West, MN3) as a small form which then becomes slightly larger at Sansan (MN6) and Steinheim (MN7), is represented by the relatively typical *A. aurelianense,* and finally becomes extinct in the Vallesian (Wissberg). The European record commonly includes this species. The species *A. gobiense* is more derived than the type of *A. aurelianense* whereas the Xinjiang specimens are closer to the European species indicating a more primitive nature. 2) *Kubanochoerus*: This genus appears in the MN6 locality of Belometchetskia, Kavkaz, Russia and in China is produced from Yongdeng, Gansu; Lantian, Shaanxi; Minhe, Qinghai; and Tongxin, Ningxia. Most recently an I3 has been recovered from Tung Gur, which according to Qiu et al. (1988) should post-date the Northwest China specimens. The Xinjiang specimens are nearly equivalent in size to specimens from Russia and other northwest localities of China, but are slightly smaller than the specimen from Tung Gur. 3) *Stephanocemas grangeri*: Although the Xinjiang specimens nearly resemble the Tung Gur specimens, they are slightly smaller, have distinct bracelets, tines extend and expand dorsally, and shedding scars are unenclosed, indicating that they are a more primitive group. 4) *Lagomeryx*: This genus is present in Europe from the Burdigalian to the Vallesian. And although the Xinjiang specimens are smaller than those from Tung Gur and tine bifurcations are simple, they nevertheless possess antler shedding scars representing the most derived character for the genus. It is currently unknown whether *L. triacuminutus* from Tung Gur shares this character and as such it is currently impossible to determine a precise phylogenetic relationship between the two. 5) *Palaeomeryx*: The earliest record of this genus in Europe is the MN3 locality of Neuville Chilleurs. Ginsburg and Heintz (1966) suggested the genus had an evolutionary tendency to increase in size and the Xinjiang specimens are closest to specimen number Sa 4399 from the MN6 locality of Sansan. Therefore, if these two specimens are regarded as the same lineage then the age of the Halamagai sediments cannot predate MN6. 6) *Eotragus*: The earliest record of this genus is from the French MN4 locality of Artenay and the latest record is from the Austrian ?MN7 locality of Leoben. This is the first record of the genus in China and as such its biogeographic and chronological history are vague. In horncore morphology, *E. halamagaiensis* sp. nov. most closely resembles "*Antilope*" *sansaniensis* from Sansan, while dentally it most closely resembles *E. sansaniensis* from Leoben, Austria, and therefore its age is most probably constrained to MN6-MN7.

In summary, there are two major distinctions between the artiodactyls and perissodactyls from Xinjiang and Tung Gur, Inner Mongolia: Several species from Xinjiang are distinctly more primitive and there are several European taxa attributed to MN6-7. Hence the Halamagai Fm. is considered to predate the Tung Gur Fm. In 1984 Li et al. proposed five subdivisions for the Miocene of China among which the Middle Miocene stage was recognized as the Tunggurian and correlated generally to the European Astaracian Stage. The Tunggurian Stage encompassed the chronofaunas represented from Dingjiargou, Tongxin Co. to Tung Gur. Currently, there is a tendency to correlate the Tung Gur Fauna to the European MN8 and the Tongxin fauna to MN6 (Qiu et al., 1988). The fauna from the Halamagai Fm. clearly predates Tung Gur and post-dates Tongxin, however, more advanced work is required prior to attempting a correlation with the European MN7.

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