第48卷 第3期
2010年7月

古脊椎动物学报
VERTEBRATA PALASIATICA

pp.247-261
figs.1-6

内蒙古上新世高特格地点的仓鼠化石[1)]

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摘要：对历年来采自高特格地点3个不同层位的共227件仓鼠类标本进行了分类描述和研究，这些标本可以归入2属3种，分别为进步中华仓鼠 *Sinocricetus progressus*，大中华仓鼠（新种）*S. major* sp. nov. 和蒙古微仓鼠 *Nannocricetus mongolicus*。作为内蒙古中部地区新近纪动物群序列中的最晚代表，上新世高特格动物群存在一些特有的进步的小哺乳动物种类，*S. major* 新种就是仓鼠类中的一例。大中华仓鼠新种特征为：个体显著大，齿冠高，下臼齿发育有较发达的（假）下中脊，其中m1的下中脊指向前内方向，m2的假下中脊（或称下原尖后臂）前内向与下后尖后壁连接。古地磁的测定表明，*Sinocricetus progressus* 和 *Nannocricetus mongolicus* 在高特格剖面上的年限大致为4.2～3.9 Ma，*S. major* 只出现于剖面下部，其年限约为4.2 Ma. *Sinocricetus*和 *Nannocricetus* 两属目前主要发现于中国北方晚中新世早期至最晚上新世的地层中，它们可能都是中国特有的新近纪仓鼠。对内蒙古中部地区最晚中新世二登图和哈尔鄂博、早上新世比例克和高特格地点的材料对比表明，*Sinocricetus* 牙齿特征可能存在如下演化趋势：M1-2原脊I发育频率逐渐增高，M1-2的中脊与后尖前壁连接的程度逐渐增高，m1下前脊从双支分别与唇舌两侧下前边小尖连接向单支与唇侧下前边小尖连接转变，以及m2的假下中脊与下后尖后壁发生连接的频率逐渐增高。*Nannocricetus* 在其演化中牙齿形态变化可能存在的趋势是：M1-2的牙根数由3增加到4，M1-2的后小脊II逐渐退化消失，m1的下前边尖逐渐收缩变窄和分裂，M2-3和m2-3的舌侧（下）前边脊逐渐退化消失，及m3下中脊出现频率逐渐增高。

关键词：内蒙古高特格，上新世，仓鼠

中图法分类号：Q915.873 **文献标识码**：A **文章编号**：1000-3118(2010)03-0247-15

NOTE ON THE CRICETIDS FROM THE PLIOCENE GAOTEGE LOCALITY, NEI MONGOL

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Abstract Representing the youngest in the sequence of Neogene mammalian faunas in central Nei Mongol, the Gaotege fauna contains some derived taxa hitherto not known in the area. A total of 227 specimens of cricetids collected from three different levels of the Gaotege section are described and referred to 2 genera and 3 species, i. e. *Sinocricetus major* sp. nov., *S. progressus* Qiu & Storch, 2000

1）中国科学院知识创新工程重要方向项目（编号：KZCX2-YW-120）、国家重点基础研究发展规划项目（编号：2006CB806400）、国家自然科学基金项目（编号：40730210，40702004）和现代古生物学和地层学国家重点实验室（中科院南京地质古生物研究所，编号：083106）资助。

收稿日期：2009-12-30

and *Nannocricetus mongolicus* Schaub, 1934. *S. major* sp. nov. is characterized by its large size, high crown with well-developed (pseudo) mesolophids on lower molars, and by having an anterolingually directed pseudomesolophid often connected to the posterior wall of the m2 metaconid. According to paleomagnetic correlation, *S. progressus* and *N. mongolicus* occur in the interval 4.2 ~ 3.9 Ma in the Gaotege section, whereas *S. major* sp. nov. occurs around 4.2 Ma. Thus far, *Sinocricetus* and *Nannocricetus* have been mainly found in the lower Upper Miocene to Upper Pliocene strata of northern China; they may therefore represent two endemic Neogene cricetini genera in China. In dental morphology, *Sinocricetus* exhibits the evolutionary trends of increasing frequencies of protoloph I development and connecting between mesoloph and anterior wall of metacone on M1-2, labially seated anterolophulid on m1, and connecting between pseudomesolophid and posterior wall of metaconid on m2. In *Nannocricetus*, several inconspicuous dental morphological changes were observed, which include the increasing of root number from 3 to 4 on M1-2, reducing of the metaloph II on M1-2 and the lingual anteroloph(id) on M2-3 and m2-3, narrowing and splitting of the anteroconid on m1, and increasing frequency of mesolophid on m3.

Key words Gaotege, Nei Mongol; Pliocene; cricetids

The tribe Cricetini was once very prosperous during the Middle to Late Miocene with high diversity and widespread geographical distribution in Eurasia. However, it gradually declined since the end of Miocene. Hitherto, more than one hundred species of Cricetini have been described. Most of them retain relatively brachydont and bunodont molars, and are morphologically closely related to recent cricetids such as *Cricetus* or *Cricetulus* (Kälin, 1999). In these bunodont cricetids, three genera e. g. *Sinocricetus*, *Nannocricetus* and *Kowalskia* are commonly found in Neogene strata of China. They often co-occur at Neogene localities of northern China, such as Shala, Baogeda Ula, Ertemte, and Bilike of central Nei Mongol area, Lantian in Shaanxi, Lingtai in Gansu, and Nihewan in Hebei; stratigraphically they range from early Late Miocene to Late Pliocene (Qiu et al., 2006; Zheng and Zhang, 2001; Li et al., 2008; Zhang et al., 2008). Due to their rapid diversification, they are important markers for biostratigraphical correlation. Of the three genera, *Sinocricetus* and *Nannocricetus* are also found in Gaotege, which is the youngest in the sequence of Neogene mammalian faunas in central Nei Mongol (Li et al., 2003). Two hundred and twenty-seven specimens of cricetids from Gaotege are referred to 3 species, including a new species *Sinocricetus major*, and *S. progressus* Qiu & Storch, 2000 and *Nannocricetus mongolicus* Schaub, 1934.

The Pliocene Gaotege fossil locality is a small isolated hill situated ~5 km north of the Gaogesitai River, ~70 km southeast of Abaga Qi and southwest of Xilinhot city (Li et al., 2003). The locality was first discovered by French paleontologists Pierre Teilhard de Chardin and Emile Licent during their excursion in North China in 1924 (Teilhard de Chardin, 1924, 1926a, b). Teilhard de Chardin (1926b) briefly described the Pliocene "Gouochtock" (=Gaotege in Li et al., 2003) fauna including 16 and 4 species of large and small mammals, respectively. After a long hiatus in scientific exploration in the area, the Gaotege locality was successfully relocated by Dr. Wang Xiaoming from the Natural History Museum of Los Angeles County (NHMLAC) and his Chinese colleagues in 2000. From then on, the excavations and screen-washings were undertaken by them in Gaotege nearly every year until 2007. Materials collected in 2000 and 2002 were preliminarily reported by Li et al. in 2003. Thirty taxa were added to the fauna, in which the rodents known increased to 24 species and dominated the vertebrate fauna. The order Rodentia from Gaotege was chosen as the subject of the Ph. D. dissertation of the author and reexamined to be an assemblage that contained 24 genera and 30 species (Li, 2006).

On the basis of description by Teilhard de Chardin (1926a), the total ~70 m depth Gaotege section was divided into 8 layers (Li et al., 2003); for detailed description of the stratigraphic horizons of Gaotege see Li et al. (2003). The cricetids described in this paper were collected from layer 4 (DB02-1, 2, 3, 4) and the bottom (DB03-1) and top (DB03-2) of

layer 5 in field seasons of 2000, 2002, 2003 and 2007.

Family Cricetidae Fisher de Waldheim, 1817
Subfamily Cricetinae Fisher de Waldheim, 1817
Tribe Cricetini Simpson, 1945
Sinocricetus Schaub, 1930

Type species *Sinocricetus zdanskyi* Schaub, 1930.

Referred species *Sinocricetus progressus* Qiu & Storch, 2000; *Sinocricetus major* sp. nov.

Chronologic and geographic distribution Early Late Miocene to latest Pliocene, northern China.

Sinocricetus major sp. nov.

(Fig. 1)

2003 Cricetidae gen. et sp. indet., Li et al., p. 108, table 1

Holotype Left m2 (V 17022).

Type locality DB02-2, Gaotege, Nei Mongol Autonomous Region, China.

Age Early Yushean.

Paratypes DB02-2, 5 isolated teeth (1 M1, 1 M2, 1 m1, and 2 m3), V 17023.1-5.

Referred materials DB02-1, 1 right M3, V 17024.1 and 1 broken right m2, V 17024.2; DB03-1, 1 broken right M2 (V 17025.1) and 1 right m1 (V 17025.2).

Etymology Specific designation "major" refers to its large size.

Diagnosis Large size and high crowned teeth, mesolophid or pseudomesolophid well developed on lower molars, mesolophid on m1 anterolingually directed, pseudomesolophid (or posterior arm of protoconid) on m2 anterolingually connected to the posterior wall of metaconid.

Measurements See Table 1.

Table 1 Tooth Measurements of *Sinocricetus major* sp. nov. (mm)

Sites	Inventory No.	Molars	Length	Width
DB02-1	V 17024.1	M3	1.85	1.70
	V 17024.2	m2	2.16	1.75
DB02-2	V 17023.1	M1	2.75	2.10
	V 17023.3	m1	2.80	1.60
	V 17022	m2	2.10	1.75
	V 17023.4	m3	2.30	1.77
	V 17023.5	m3	2.20	1.60
DB03-1	V 17025.1	M2	2.05	1.80
	V 17025.2	m1	2.60	1.55

Description M1: the anterocone is wide and distinctly posteriorly and nearly symmetrically bilobate. Anterolophule is doubled, of which the lingual branch is stronger than the labial one. The protoloph is also doubled; and the protoloph II is stronger than the protoloph I. The mesoloph is strong, and fuses into anterior wall of metacone in half-way to the edge of tooth. No metaloph I is present. A small but distinct pit is present behind the metacone (Fig. 1). The tooth has four roots.

M2: the lingual anteroloph is well developed. The protoloph is doubled; the protoloph I is as strong as protoloph II. The postero-labially directed mesoloph is connected to the anterior wall of the metacone through a short longitudinal ridge halfway along its length. Metaloph I is

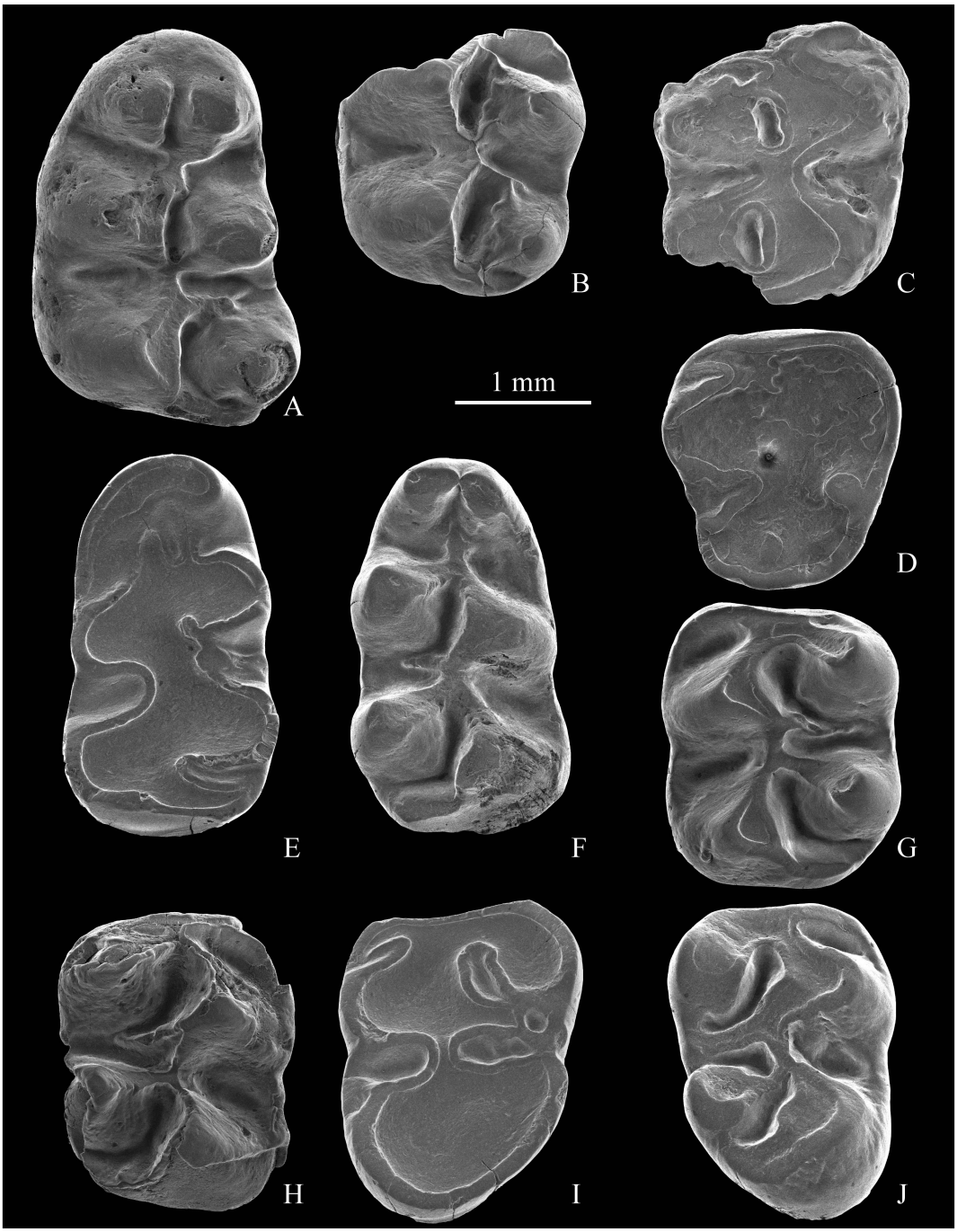

Fig. 1 Occlusal view of the molars of *Sinocricetus major* sp. nov.
A. left M1, V 17023.1; B. broken left M2, V 17023.2; C. broken right M2, V 17025.1; D. right M3, V 17024.1; E. left m1, V 17023.3; F. right m1, V 17025.2; G. left m2, V 17022, holotype; H. broken right m2, V 17024.2; I. left m3, V 17023.4; J. right m3, V 17023.5

absent. A large and distinct pit can be observed behind the posterior wall of metacone on V 17023.2 (Fig. 1).

M3: the crown of V 17024.1 is highly worn. Its occlusal pattern is similar to that of M2 but the posterior portion is more pinched. The labial anteroloph is very strong. No mesoloph is present.

m1: the tooth is long and narrow. The anteroconid is wide. On the young individual V 17025.2, it is bifid both slightly anteriorly and deep posteriorly, while on the old individual V 17023.3, it is worn into a loph extending to the labial edge of crown. The anterolophulid is distinctly doubled and directed to the lingual and labial lobes of anteroconid on V 17023.3, respectively, whereas it is single and connected to the middle base of the anteroconid on V 17025.2 (Fig. 1). The metalophid is anterolabially connected to the anterior arm of protoconid. The mesolophid is strong and half-length to the edge of tooth on V 17025.2, whereas the same loph is slim, long and reaches the edge of tooth on V 17023.3. On V 17025.2, it is anterolingually directed towards, but free from, the posterior wall of the metaconid. The hypolophid is anterolabially joined to the posterior arm of protoconid. The posterosinusid is open. The tooth is two-rooted.

m2: the outline is nearly rectangular. The labial anterolophid is very strong, but the lingual one rather weak. The metalophid is joined with anterior arm of protoconid at the middle of anterolophid. Derived from the protoconid, the pseudomesolophid (or posterior arm of protoconid) is anterolingually curved and connected to the posterior wall of the metaconid on both two specimens. Its length is about 1/2 and 2/3 of the way to the edge of the teeth on V 17024.2 and on V 17022, respectively. The hypolophid has an anterolabially weak connection to the anterior arm of hypoconid.

m3: its occlusal pattern is similar to that of m2, but the posterior portion is much more pinched. The length of m3 is longer than that of m2. The labial anterolophid is well developed, while the lingual one is very weak. The pseudomesolophid is transversely oriented and reaches the edge of tooth on both two m3s, and is connected to the posterior wall of the metaconid on V 17023.4. The entoconid is not reduced. The posterior part of tooth is round.

Comparison The cricetids from Gaotege can be assigned into 3 groups by size and dental morphology, e.g. the development of mesoloph(id)s on molars and the structures of anterocone (id) on first molars. Thus far, 10 genera of cricetini with bunodont teeth are known in the Neogene and Pleistocene deposits of China, i.e. *Kowalskia*, *Sinocricetus*, *Nannocricetus*, *Allocricetus*, *Cricetinus*, *Bahomys*, *Chuanocricetus*, *Amblycricetus*, *Cricetulus* and *Cricetus*. The largest-bodied group from Gaotege is close to *Bahomys* in size, but differs in its distinct brachydont and more bunodont teeth, posteriorly split anterocone(id) on the first molars, and weaker connection of main cusps on molars. It is slightly smaller than *Amblycricetus* in size and differs in its brachydont teeth with simpler occlusal pattern and weakly developed mesoloph(id). It is smaller than *Cricetus* and remarkably larger than *Cricetulus* and *Nannocricetus* in size, and can be easily distinguished from them by its developed mesoloph(id) and posteriorly bilobed anterocone(id) on the first molars(Fig. 2). This large-bodied group neither can be contributed to *Kowalskia* nor *Chuanocricetus* by its larger size, higher crown, and weaker development of mesoloph on M1 and metaloph I on M1-2. It is larger than *Cricetinus* and *Allocricetus*, and differs from them in having developed mesoloph(id) on molars, and having posteriorly separated anterocone(id). Overall, these specimens of the largest group correspond closely to the morphology of *Sinocricetus* Schaub, 1930 emended by Wu (1991), i.e. the developed mesoloph(id)s, wide and posteriorly bilobed anterocone on M1, single lobed or posteriorly split anteroconid on m1 and elongated m3. The genus *Sinocricetus* hitherto only includes two species, *S. zdanskyi* Schaub, 1930 and *S. progressus* Qiu & Storch, 2000. The new taxon from Gaotege is remarkably larger than the two known species of *Sinocricetus*. In morphology, it has higher crown and stronger cusps and lophs. The most noticeable character of this group is that the antero-lingually directed pseudomesolophid connects to the posterior wall of the metaconids on m2. Therefore, it

is considered to represent a new and progressive member of *Sinocricetus*. For its distinctly larger size, it is named *S. major* sp. nov.

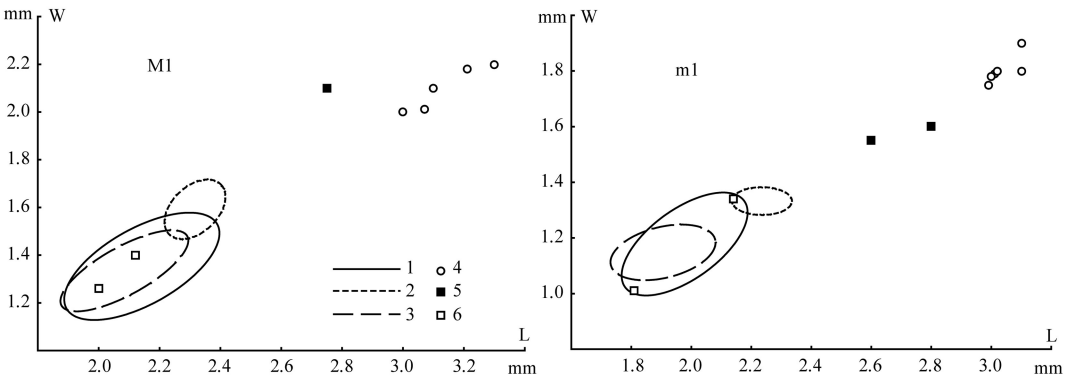

Fig. 2 Scatter diagram showing length (L) and width (W) of the molars of *Sinocricetus*
1. *Sinocricetus zdanskyi* (Ertemte); 2. *Cricetulus triton* (extant, IZ); 3. *S. progressus* (Bilike); 4. *Cricetus cricetus* (extant, IZ); 5. *S. major* sp. nov. (Gaotege); 6. *S. progressus* (Gaotege)

Sinocricetus progressus Qiu & Storch, 2000

(Fig. 3)

Materials 25 isolated teeth: DB02-1, 10 teeth (1 M1, 1 M2, 3 M3, 2 m1, 1 m2 and 2 m3), V 17026.1-10; DB02-2, 4 teeth (1 M1, 1 M2, 1 M3 and 1 m2), V 17027.1-4; DB02-3, 5 teeth (1 broken M1, 1 broken M2, 1 M3, 2 m2), V 17028.1-5; DB02-4, 1 broken m1 and 1 broken m2, V 17029.1-2; DB03-1, 2 M2 and 1 broken M3, V 17030.1-3; DB03-2, 1 m1, V 17031.

Measurements See Table 2.

Table 2 Measurements of molars of *Sinocricetus progressus* (mm)

	Length		Width		
Tooth	Average	Range	Average	Range	Number
M1	2.06	2.00 ~ 2.12	1.33	1.26 ~ 1.40	2
M2	1.55	1.50 ~ 1.65	1.29	1.24 ~ 1.31	4
M3	1.19	1.10 ~ 1.35	1.14	1.04 ~ 1.25	5
m1	1.98	1.81 ~ 2.14	1.18	1.01 ~ 1.34	2
m2	1.48	1.40 ~ 1.55	1.15	1.10 ~ 1.20	4
m3	1.42	1.35 ~ 1.50	1.14	1.02 ~ 1.25	2

Description M1: the anterocone is wide and distinctly bilobed posteriorly. A shallow depression can be observed on the anterior wall of anterocone on 2 of 3 M1s. The anterolophule is single, strong and connected to the lingual anterocone. The spur of anterolophule is well developed and long on 2 of 3 M1s. On V 17026.1, it is connected to the posterior wall of labial anteroconule through a short longitudinal ridge and reaches the edge of tooth, while on V 17027.1, it is directly connected to labial anteroconule and extends posterolabially but does not reach the edge. The protoloph I is well developed and as strong as protoloph II on V 17027.1 and another unfigured broken M1, but which is absent on V 17026.1 (Fig. 3). The mesoloph is strong but

short and postero-labially directed. On V 17027.1, it fuses into the anterior wall of the metacone. No metaloph I is present. A distinct pit formed by metaloph II and posterloph is seated behind the metacone on 2 observable specimens. The tooth has four roots.

M2: both labial and lingual branches of the anteroloph are well developed. The protoloph is doubled on all 4 observable teeth. The short and posterolabially directed mesoloph is connected directly or through a short ridge to the anterior wall of the metacone on all 3 observable specimens. The distinct posterosinus is present on all 3 observable specimens. This tooth is four-rooted.

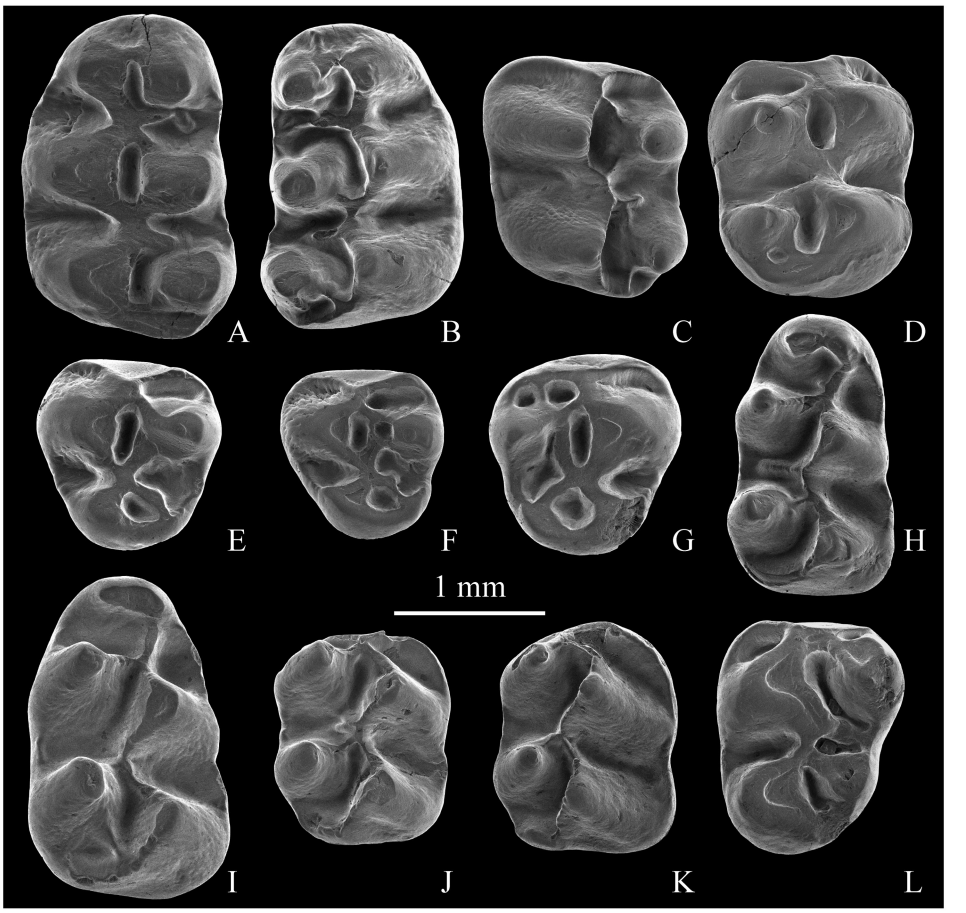

Fig. 3　Occlusal view of the molars of *Sinocricetus progressus*
A. left M1, V 17027.1; B. right M1, V 17026.1; C. left M2, V 17027.2; D. right M2, V 17030.1; E. left M3, V 17026.3; F. left M3, V 17028.3; G. right M3, V 17026.5; H. right m1, V 17026.7; I. right m1, V 17031; J. right m2, V 17028.5; K. right m2, V 17026.8; L. left m3, V 17026.9

M3: the outline of M3 is subtriangular. Its occlusal pattern is similar to that of M2, but with much reduced posterior portion. The metacone is reduced into a tiny lobe on the posterior edge of the tooth. The lingual anteroloph is as strong as the labial one. An extra short longitudinal ridge is developed in the parasinus on V 17026.5 and between protoloph I and II on V 17028.3, respectively (Fig. 3). The protoloph is always doubled. The connection between the anterior and posterior main cusps is present as an "X" pattern. This tooth is three-rooted.

m1: the anteroconid is gently narrowing, single-lobed (1/3) or slightly bifid posteriorly (2/3). The anterolophulid is always single and labially seated. The mesolophid is absent (1/2) or developed in half-length (1/2). An extra ridge is present as the connection between posterolophid and posterior wall of entoconid in the posterosinusid on V 17031 (Fig. 3I). This tooth is two-rooted.

m2: the lingual anterolophid is absent (1/3) or weak but distinct (2/3). The pseudomesolophid is present on 3 of 5 observable teeth, in which one (V 17028.5) is short and the other two are long to the edge of teeth. The pseudomesolophid is connected to the posterior wall of metaconid on 2 teeth (2/5).

m3: the outline is long and sub-triangular. The lingual anterolophid is very weak on both m3s. The pseudomesolophid is well-developed and free from metaconid, and reaches the edge of tooth on both specimens.

Comparison The moderately sized sample of hamster from Gaotege is characterized by the presence of mesoloph(id or pseudomesolophid) of variable lengths on molars, distinct posteriorly bifid anterocone and presence of spur of anterolophule on M1, and elongated m3, which correspond to the diagnostic features of *Sinocricetus*. The Gaotege taxon can be easily distinguished from *S. major* sp. nov. by its distinctly smaller size and lower crown, weakly developed protoloph I on M1 and pseudomesolophid on m2. It is similar to *S. zdanskyi* from Ertemte and Harr Obo (Wu, 1991) in size (Fig. 2), but differs from the latter in having lower crown, higher frequency of protoloph I and connection between mesoloph and anterior wall of metacone on M1–2, of single anterolophulid connected to the labial anteroconulid on m1, and of connection between pseudomesolophid and posterior wall of metaconid on m1–2. The former also can be distinguished from *Sinocricetus* sp. from Shengou, Qaidam Basin (Qiu and Li, 2008) by its larger size and wider anterocone(id), but is identical with the *S. progressus* from Bilike both in size and dental morphology. On observing the materials of "*Sinocricetus zdanskyi*" from Lingtai, Gansu Province (Zheng and Zhang, 2001), the author noticed that part of the material from Zones IV and V have lower crown, more developed protoloph I, and higher frequent presence of the connections between mesoloph and anterior wall of metacone on M1–2 and between pseudomesolophid and posterior wall of metaconid on m1–2. Based on these characters, they are rather suitably referred to *S. progressus*, which is also found from the Late Pliocene strata in the Nihewan Basin (Li et al., 2008), and would imply that this species occurred during the entire Pliocene epoch.

Nannocricetus Shaub, 1934

Type species *Nannocricetus mongolicus* Schaub, 1934.
Referred species *Nannocricetus primitivus* Zhang et al., 2008.

Nannocricetus mongolicus Schaub, 1934

(Fig. 4)

Materials 190 specimens. DB02–1: 2 maxillary and 2 mandibular fragments and 69 isolated teeth (15 M1, 16 M2, 6 M3, 9 m1, 14 m2, 9 m3), V 17032.1–73; DB02–2: 2 maxillary and 1 mandibular fragments and 26 isolated teeth (4 M1, 5 M2, 2 M3, 7 m1, 3 m2, 5 m3), V 17033.1–29; DB02–3: 1 maxillary and 2 mandibular fragments and 23 isolated teeth (4 M1, 4 M2, 4 M3, 3 m1, 7 m2, 1 m3), V 17034.1–26; DB02–4: 7 isolated teeth (1 M1, 3 M2, 1 m1, 1 m2, 1 m3), V 17035.1–7; DB03–1: 2 mandibular fragments and 17 isolated teeth (3 M1, 1 M2, 2 M3, 5 m1, 2 m2, 4 m3), V 17036.1–19; DB03–2: 36 isolated teeth (8 M1, 5 M2, 1 M3, 8 m1, 7 m2, 7 m3), V 17037.1–36.

Measurements See Table 3.

Table 3　Measurements of molars of *Nannocricetus mongolicus* (mm)

Tooth	Length		Width		Number
	Average	Range	Average	Range	
M1	1.76	1.47 ~ 2.00	1.16	1.07 ~ 1.25	28
M2	1.32	1.14 ~ 1.45	1.10	0.95 ~ 1.21	32
M3	1.05	1.00 ~ 1.12	0.96	0.85 ~ 1.05	15
m1	1.62	1.45 ~ 1.75	1.01	0.94 ~ 1.15	32
m2	1.29	1.15 ~ 1.40	1.06	0.92 ~ 1.20	35
m3	1.22	1.10 ~ 1.35	0.94	0.82 ~ 1.21	25

Description　Maxilla: the posterior edge of incisive foramen is at the same level as the anterior wall of M1.

Mandible: the tip of incisor is nearly at the same level as the alveoli. The mental foramen is seated beneath the anterior root of m1 and anteriorly below the apex of the masseteric crests (Fig. 4Nc). See Table 4 for relevant measurements of mandibles.

Table 4　Mandible measurements of *Nannocricetus mongolicus* (mm)

Inventory No.	Sites	Length of diastema	Depth between alveolar line and			
			Bottom of diastema	Mandibular foramina	Masseteric apex	Bottom of mandible
V 17032.50	DB02-1	—	1.94	2.19	1.80	—
V 17033.20	DB02-2	—	1.90	1.90	—	—
V 17034.14	DB02-3	—	1.99	2.60	—	—
V 17034.15	DB02-3	—	1.58	1.95	—	—
V 17036.13	DB03-1	2.94	1.85	1.96	1.35	3.54

M1: the anterocone is relatively wide and distinctly bilobed anteriorly. The connection between anteroconules and protocone is present as a "Y" type. The protoloph I is often absent (26/31), but weakly developed on 5 specimens (5/31). The protoloph II is always present. The mesoloph is reduced and always posterolabially connected to the anterior wall of the metacone. The metaloph I is absent in all specimens. The metaloph II is absent in most of the specimens, but present as a pit behind the metacone on 4 specimens (4/22). The tooth is four-rooted.

M2: the lingual anteroloph is weak (6/28) or as strong as the labial one (22/28). The protoloph I is usually well-developed and nearly as strong as the protoloph II, but absent in 2 of 29 observable teeth. The protoloph II is always developed. The remnant mesoloph is usually present and connected to the anterior wall of the metacone, but absent in one tooth V 17032.21 (Fig. 4C). The metaloph I is absent in all teeth. Metaloph II is also absent in most of the specimens, but when present is a small pit seated behind metacone (5/28). The tooth is four-rooted.

M3: the occlusal outline is sub-triangular. The posterior portion is highly reduced with weakly developed hypocone and metacone. The labial anteroloph is well developed, while the lingual one is weak (6/13) or nearly absent (7/13). The protoloph is usually doubled, but with a broken protoloph II in 2 of 13 specimens (Fig. 4F, I). The tooth is three-rooted.

m1: the anteroconid is very narrow. In young individuals, it is normally slightly bifid anteriorly and deeply bifid posteriorly. The anterolophulid is absent in 1, doubled in 2 and singular in 29 of 32 observable specimens. In the singular condition, the anterolophulid is connected to the labial anteroconulid (19/29) or the lingual anteroconulid (9/29) or the middle base of anteroconid (1/29). The metalophid and hypolophid are distinctly anterolabially oblique. The mesolophid is absent in all teeth. The posterosinuid is nearly open.

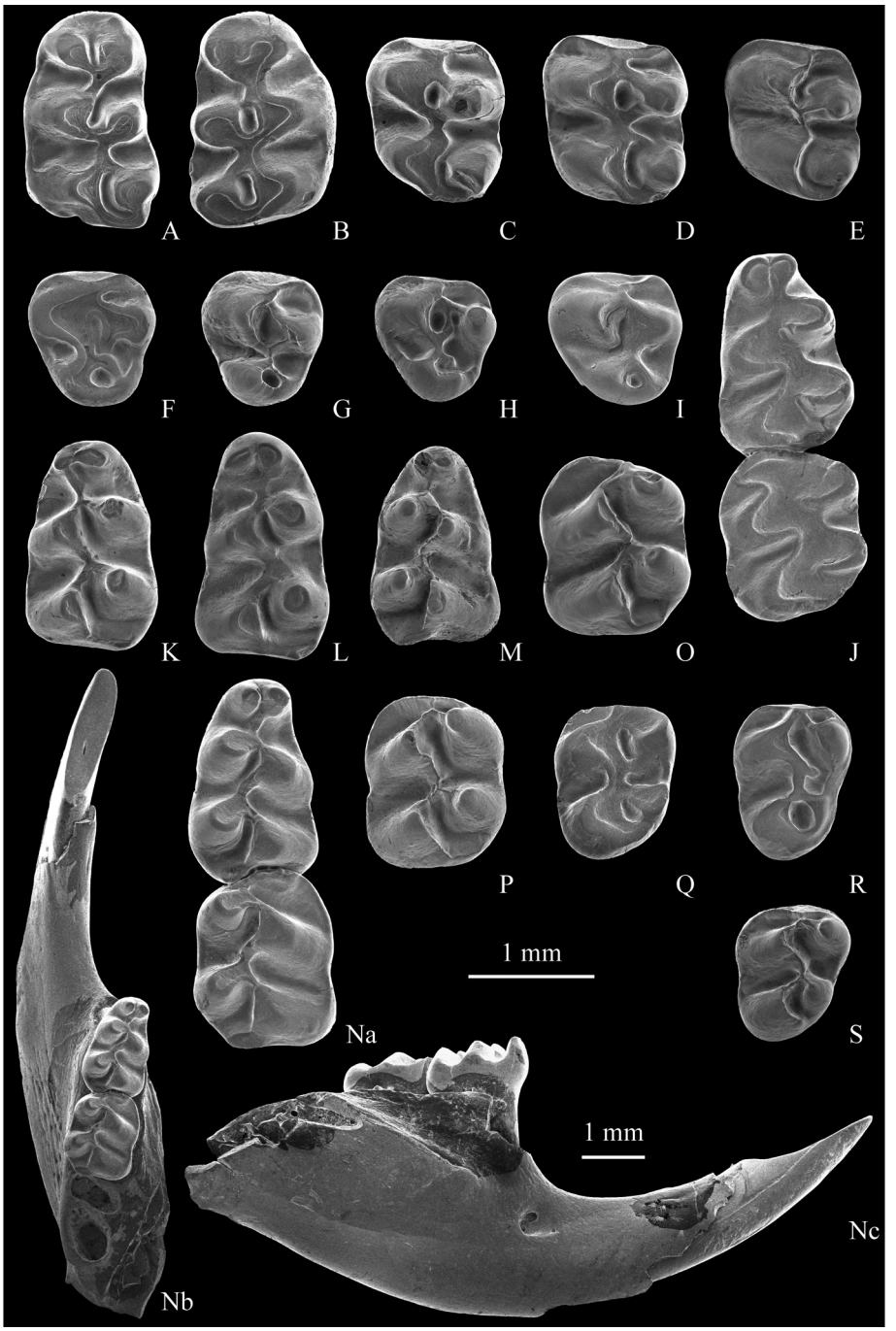

Fig. 4 Teeth and mandible of *Nannocricetus mongolicus*

A. left M1, V 17032.9; B. right M1, V 17032.14; C. left M2, V 17032.21; D. left M2, V 17032.22; E. left M2, V 17032.23; F. left M3, V 17032.34; G. left M3, V 17032.35; H. left M3, V 17032.36; I. left M3, V 17032.37; J. left m1–2, V 17032.40; K. left m1, V 17037.16; L. left m1, V 17036.10; M. left m1, V 17036.12; O. left m2, V 17034.19; P. left m2, V 17032.52; Q. left m3, V 17033.25; R. left m3, V 17033.26; S. left m3, V 17037.33, all in occlusal view; N. broken mandible with m1–2, V 17036.13, Na. occlusal view of dentition; Nb. occlusal view of mandible; Nc. labial view of mandible

m2: the labial anterolophid is well developed and extended to the anterior wall of the protoconid, while the lingual one is very weak (11/34) or absent (23/34). The mesolophid is absent in all teeth. The posterolophid is well developed and curved posterolingually; a distinct concave behind the posterior arm of the hypoconid can be observed.

m3: the posterolingual portion of tooth is pinched with small entoconid. The labial anterolophid is well developed, but the lingual one is very weak (14/22) or absent (8/22). The mesolophid is either absent (17/26) or present (9/26). In the latter condition, the mesolophid is free or connected to the anterior wall of the metaconid, and in half-way length (6/9) to the edge of tooth, or longer (3/9).

Comparison This small size group can be easily referred to *Nannocricetus* Schaub, 1934 by having the following characters: lacking mesoloph(id)s on most of teeth, distinctly anteriorly bilobed anterocone on M1, remarkably narrow anteroconid on m1. Thus far, the genus *Nannocricetus* includes only two species *N. mongolicus* Schaub, 1934, and *N. primitivus* Zhang et al., 2008. The material from Gaotege is similar to those of *N. primitivus* from Lantian, Shaanxi (Zhang et al., 2008) and Shengou, Qinghai (Qiu and Li, 2008) in size, but differs in having more elongated molars, more cuspate anteroconid on m1 and four-rooted M1-2. The taxon is basically identical to *N. mongolicus* from Ertemte, Harr Obo (Schaub, 1934; Wu, 1991) and Bilike (Qiu and Storch, 2000), Nei Mongol, in morphology. Its size range overlaps the upper and lower part of those of *N. mongolicus* from Bilike and Ertemte, respectively (Fig. 5). Minor differences between the former and the latter two are in the former having more reduced lingual anterloph(id) on M2-3 (m2-3) and the higher frequency of mesolophid presence on m3. These differences could be interpreted as derived characters of the genus *Nannocricetus*.

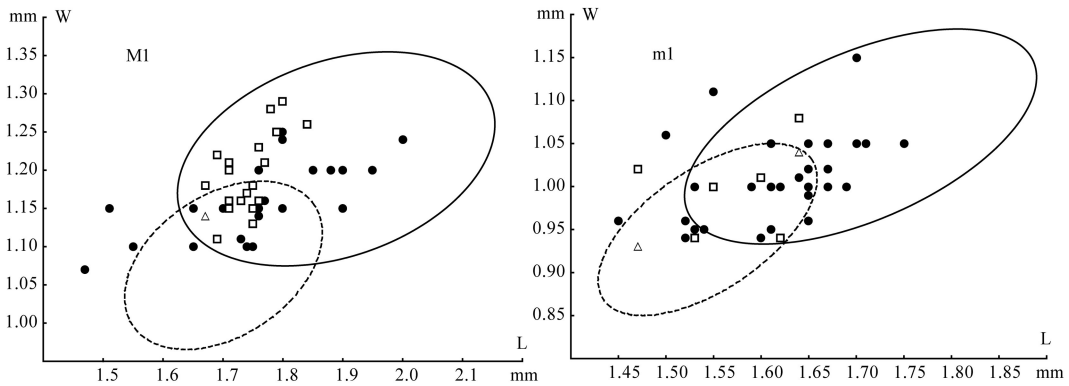

Fig. 5　Scatter diagram showing length and width of the molars of *Nannocricetus*
N. primitivus: square, Lantian; triangle, Shengou; *N. mongolicus*: solid line, Ertemte; broken line, Bilike; filled circles, Gaotege

Chronology *Sinocricetus progressus* and *Nannocricetus mongolicus* were recovered from both lower (DB02-1,2,3,4 and DB03-1) and upper (DB03-2) layers of Gaotege section, while *Sinocricetus major* was restricted in the lower part of the section. According to the paleomagnetical dating by Xu et al. (2007) and O'Connor et al. (2008), the lower part of Gaotege (including DB02-1,2,3,4 and DB03-1) should be about 4.2 Ma in age, while the upper part (DB03-2) is younger than 4.0 Ma and estimated at about 3.9 Ma (Fig. 6).

Disscussion In the early Late Miocene, *Sinocricetus* first occurred as *Sinocricetus* sp. at Shengou, Qaidam Basin (Qiu and Li, 2008). Later in middle to late Late Miocene, it appeared as cf. *Sinocricetus* sp. and *Sinocricetus* sp. at Shala and Baogeda Ula of central Nei

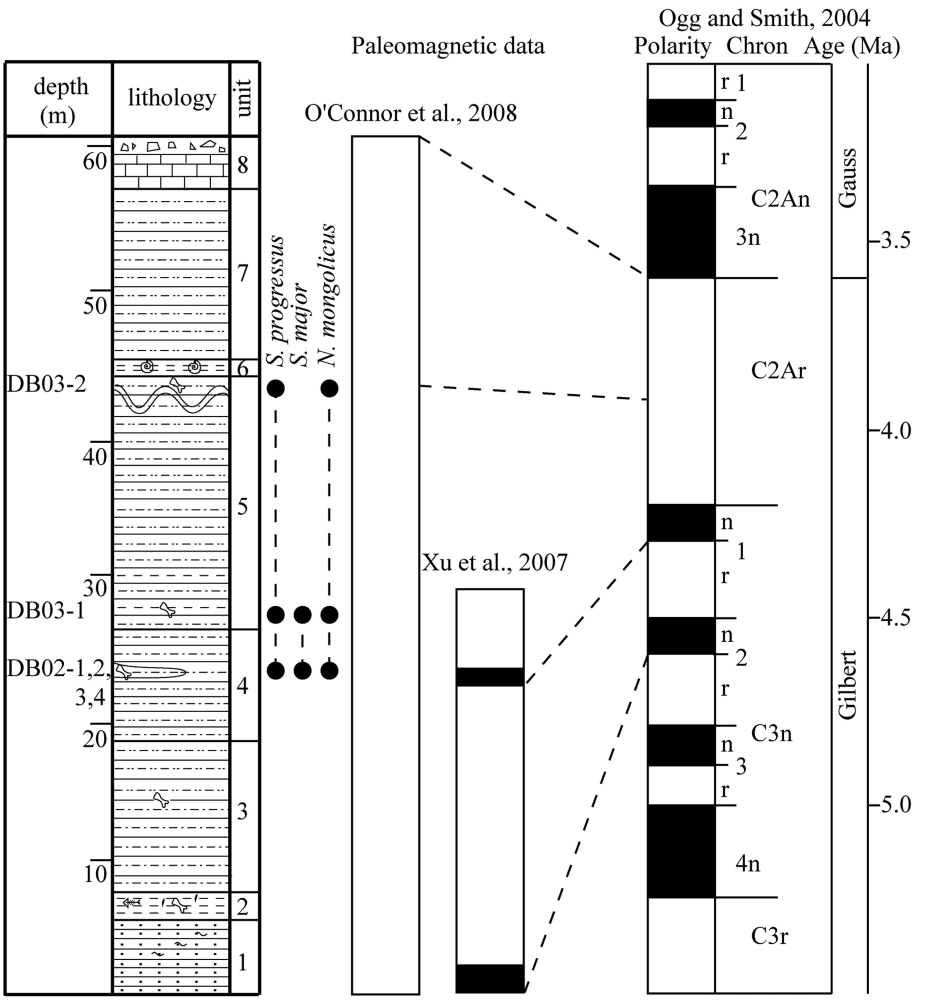

Fig. 6 Distribution of the cricetids of the Gaotege paleomagnetic sections given by Xu et al. (2007) and O'Connor et al. (2008)

Mongol (Qiu et al., 2006). In the latest Late Miocene Ertemte and Harr Obo, it was represented by more derived *S. zdanskyi* (Wu, 1991), which was also found from the Late Miocene strata of Lingtai, Gansu (Zheng and Zhang, 2001). *S. zdanskyi* was replaced by *S. progressus* in Early Pliocene Bilike (Qiu and Storch, 2000). *S. progressus* was also found in Early Pliocene strata of Gaotege, Nei Mongol, upper strata of Lingtai, Gansu, and Late Pliocene strata in Nihewan Basin, Hebei, respectively (Zheng and Zhang, 2001; Li et al., 2008).

Compared with *S. zdanskyi* from Ertemte and Harr Obo, *S. progressus* from Bilike and Gaotege has some derived characters on cheek teeth, which are represented as increasing of development of protoloph I and connection between mesoloph and anterior wall of metacone on M1–2, increasing frequency of single and labially seated anterolophulid on m1, and increasing frequency of connection between pseudomesolophid and posterior wall of metaconid on m2 (Table 5).

Table 5　Evolutionary trends in tooth characters of some species of *Sinocricetus*

Characters		*S. zdanskyi*		*S. progressus*	
		Ertemte	Harr Obo	Bilike	Gaotege
Presence of protoloph I	M1	19%	25.93%	56.25%	33.3%
		21/111	7/27	18/32	1/3
	M2	82.06%	61.90%	100%	100%
		96/117	13/21	37/37	4/4
Connection between mesoloph and anterior wall of metacone	M1	24.32%	22.22%	83.87%	100%
		27/111	6/27	26/31	2/2
	M2	81.20%	61.90%	94.59%	100%
		95/117	13/21	35/37	3/3
Anterolophulid on m1	Double	51.11%	81.82%	18.79%	0
		46/90	9/11	3/19	
	Single, labially seated	41.11%	18.18%	78.95%	100%
		37/90	2/11	15/19	3/3
Connection between pseudomesolophid and posterior wall of metaconid on m2		8.91%	10.53%	47.73%	40%
		9/101	2/19	21/44	2/5

Table 6　Evolutionary trends in tooth characters of *Nannocricetus*

Characters			*N. primitivus*		*N. mongolicus*			
			Lantian	Shengou	Ertemte	Harr Obo	Bilike	Gaotege
Frequency of metaloph II	M1		53.33%	0	11.11%	20%	14.29%	18.18%
			8/15	0/2	10/90	2/10	4/28	4/22
	M2		69.23%	100%	9.52%	14.29%	7.69%	17.86%
			9/13	2/2	8/84	1/7	1/13	5/28
Lingual anteroloph	M2	weak	18.75%	0	15.56%	12.50%	29.41%	21.43%
			3/16		14/90	1/8	5/17	6/28
		strong	81.25%	100%	84.44%	87.50%	70.89%	78.57%
			13/16	3/3	76/90	7/8	12/17	22/28
	M3	weak	11.11%	0	28.85%	33.33%	80%	53.85%
			1/9		15/52	2/6	8/10	7/13
		strong	88.89%	100%	71.15%	66.67%	20%	46.15%
			8/9	1/1	37/52	4/6	2/10	6/13
Absence of lingual anterolophid	m2		33.33%	0	31.91%	25%	91.67%	67.65%
			6/18		30/94	3/12	22/24	23/34
	m3		16.67%	–	9.09%	0	33.33%	36.36%
			2/12		5/55		3/9	8/22
Presence of mesolophid on m3			16.67%	–	17.02%	9.09%	18.18%	34.62%
			2/12		8/47	1/11	2/11	9/26

In early Late Miocene, *Nannocricetus* first occurred as *N. primitivus* in the Bahe Formation, Shaanxi and Shengou (upper Youshashan Formation), Qaidam Basin (Zhang et al., 2008; Qiu and Li, 2008). In late Late Miocene, this genus first appeared as *Nannocricetus* sp. at Baogeda Ula in central Nei Mongol area (Qiu et al., 2006). In the latest Late Miocene, a derived species *N. mongolicus* is known at Ertemte and Harr Obo, Nei Mongol. This last species was also found from the Late Miocene–Late Pliocene strata of Lingtai, Gansu, Early Pliocene strata of Gaotege, and Late Pliocene strata of Nihewan Basin, Hebei (Wu, 1991; Zheng and Zhang, 2001; Li et al., 2003, 2008). In dental morphology, some evolutionary trends can

be observed on *Nannocricetus*, i. e. the increasing number of roots from 3 to 4 on M1–2, reduction of the metaloph II on M1–2, narrowing and separation of the anteroconid on m1, reduction of the lingual anteroloph(id) on M2–3 and m2–3, and increasing frequency of mesolophid on m3 (Table 6).

Sinocricetus and *Nannocricetus* were geographically mainly restricted in northern China. In this respect, they can be regarded as endemic genera. The two genera were usually found in many Neogene localities in northern China and coexisted with the widely distributed Eurasian genus *Kowalskia*. In the latest Miocene, *Sinocricetus* and *Kowalskia* dominated in number of specimens among bunodont Cricetini from Ertemte. In Early Pliocene, however, the number of specimens of *Sinocricetus* and *Kowalskia* were distinctly reduced. In Early Pliocene Gaotege fauna, *Kowalskia* was absent, and *Sinocricetus* was further reduced in specimen number, while *Nannocricetus* began dominating the Cricetini. It seems that the primordial Cricetinae retaining mesoloph(id) were gradually replaced by the modern *Cricetulus*-like cricetids without mesoloph (id).

Conclusions 1) Two genera and three species including one new species, i. e. *Sinocricetus major* sp. nov., *S. progressus* and *Nannocricetus mongolicus* were recovered from the Pliocene Gaotege locality, Nei Mongol.

2) The new species *S. major* is characterized by its remarkably large size and connection between pseudomesolophid and posterior wall of metaconid on m2.

3) *S. major* sp. nov. was found from the lower part of Gaotege section with paleomagnetic dating ~4.2 Ma, while *S. progressus* and *N. mongolicus* were dated 4.2–~3.9 Ma.

4) *Sinocricetus* and *Nannocricetus* are possible endemic genera in northern China throughout the early Late Miocene to the latest Pliocene times.

5) In dental morphology, *Sinocricetus* demonstrates the evolutionary trend of increasing frequencies of development of protoloph I on M1–2, labially seated anterolophulid on m1, and connections between mesoloph and anterior wall of metacone on M1–2 and between pseudomesolophid and posterior wall of metaconid on m2. In *Nannocricetus*, dental morphological changes include the increasing number of roots from 3 to 4 on M1–2, reduction of the metaloph II on M1–2, narrowing and separating of the anteroconid on m1, reduction of lingual anteroloph(id) on M2–3 and m2–3, and increasing frequency of development of mesolophid on m3.

Acknowledgements The author thanks his colleagues who participated in the fieldworks of Gaotege area, especially to Prof. Qiu Zhuding from IVPP, Dr. Wang Xiaoming, Ms. Jingmai O'Connor from NHMLAC, Mr. Deliger and Mr. Wang Hongjiang from Administration Station of Cultural Relics of Xilingol League, Nei Mongol, Mr. Feng Wenqing, Zhou Wei, Gao Wei from IVPP. The author would like to express his gratitude to Prof. Qiu Zhuding for his valuable discussion of the subject, and to him and Mr. Zhijie Jack Tseng for their critique of the manuscript. Many thanks are also given to Profs. Feng Zuojian and Ma Yong from Institute of Zoology, Chinese Academy of Sciences for their help on observing the specimens of extant hamsters and Mr. Zhang Wending for the photographs.

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