

山东山旺新发现的中新世松鼠类化石¹⁾

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摘要: 我国新近纪的经典化石地点山东山旺, 硅藻土层巨厚, 动、植物化石保存精美, 迄今发现的哺乳动物化石已有 23 种 (Deng et al., 2003)。由于含化石层不适宜进行水筛选, 所采集到的小哺乳动物只有 6 种, 其中食虫目一种 (*Lusorex taishanensis* Storch et Qiu, 2004)、翼手目一种 (*Shanwangia unexpectula* Young, 1977)、啮齿目 4 种 (*Diatomys shantungensis* Li, 1974; *Ansomys shanwangensis* Qiu et Sun, 1988; *Plesiosciurus* aff. *P. sinensis* Qiu et Lin, 1986 和 *Meinia asiatica* Qiu, 1981)。根据哺乳动物群的研究和古地磁的测定, 山旺动物群的时代被确定为早—中中新世 (山旺期), 或与欧洲陆相哺乳动物分带的 MN4 ~ 5 相当 (Qiu and Qiu, 1995; Deng et al., 2003)。

本文描述近年在山旺硅藻土层中采集到的 3 种松鼠类化石, 同时检讨以前指定为飞松鼠 “*Meinia*”、*Parapetaurisata* 和 *Shuanggouia* 属的一些标本。所描述标本的骨骼严重破损, 但牙齿构造尚清楚。

亚洲花松鼠 *Tamiops asiaticus* (Qiu, 1981)

特征 (订正) 一种小个体花松鼠; 颊齿的尖、脊细弱; M1 和 M2 没有原小尖和后小尖; M3 和 m3 明显向后延展。

亚洲花松鼠是所记述 3 种松鼠中最小的一种, 个体与现代东洋区分布的花松鼠属 (*Tamiops*) 接近, 牙齿的形态特征基本一致: 齿尖相对齿脊壮硕; P4 ~ M2 的原脊和后脊近平行排列, 无原小尖和后小尖; p4 ~ m2 的下内尖显著, 下内尖角清楚, 唇侧谷窄且指向前舌侧。

Tamiops asiaticus 与云南禄丰和元谋晚中新世的 *T. atavus* 很相似, 只是牙齿的尺寸较小, 颊齿的尖、脊稍弱; 两者可能有较接近的祖裔关系 (Qiu and Ni, 待刊)。它以明显细弱的原脊和后脊、较长的上臼齿前边脊而容易区别于第四纪的 *T. swinhoei* (Zheng, 1993), 以及现生的 *Tamiops macclellandi* 和 *T. swinhoei*。此外, 其个体比 *T. macclellandi* 大, 比 *T. swinhoei* 小, 齿冠比后者略低, P4 ~ M2 的后脊在接近原尖处不甚收缩。但总的来说, 这一属的牙齿自中新世以来似乎变化不大, 比较明显的是齿尖和齿脊逐渐加强、后脊在舌侧渐趋收缩。

上述标本的形态, 与 “*Meinia*” *asiatica* Qiu, 1981 的特征完全一致。显然, 作者在记述山旺最早发现的那件松鼠标本时, 未注意到其形态与现生花松鼠的高度相似, 不仅建立了一个新的属, 而且还把它归入鼯鼠亚科。两件标本的比较表明, 无论是尺寸大小还是牙齿的形态特征, 都没有理由把它们看作是两个不同的属。因此, “*Meinia*” Qiu, 1981 是 *Tamiops* Allen, 1906 的同物异名, 应予以废弃。

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李氏松鼠(新种) *Sciurus lii* sp. nov.

特征 个体与现生北松鼠(*Sciurus vulgaris*)接近; P4 和 p4 大, 明显白齿化; 下颊齿的齿座和后边脊高; m3 具有齿座凹(trigonid basin)及明显的下中附尖。

该标本归入松鼠属(*Sciurus*)的理由是: 牙齿的大小与现生的北松鼠接近; 下门齿尖端高出颊齿齿列之冠面; 颊齿低冠, 尖、脊粗钝; 至少 P4 上的原脊和后脊近平行排列, 且其上无原小尖和后小尖; p4 ~ m3 具显著的下内尖。新种不同于全北区广布的现生松鼠属在于 P4 和 p4 更为白齿化, 下颊齿的齿座相对于跟座明显较高, 前边脊和后边脊也相对较高。

新近纪 *Sciurus* 类化石在旧大陆发现很少, 只有波兰 Weze 的 *S. warthae* 和内蒙古二登图的一个未定种(Sulimski, 1964; Black and Kowalski, 1974; Qiu, 1991)。新种牙齿的大小与两者的接近, 但 P4 和 p4 更为白齿化, M3 有清楚的后内缺, m3 具明显的齿座凹和下中附尖。此外, 它还以 P4 的前附尖较弱、下内尖小, 以及 p4 ~ m3 的齿座凹及后边脊较高而易于与二登图的 *Sciurus* sp. 区分。

在以前当作 *Shuanggouia lui* Qiu et Lin, 1986 和 *Parapetaurista tenurugosa* Qiu et Lin, 1986 副型标本描述的江苏泗洪下草湾的一些单个牙齿中, 其形态与正型标本的特征不甚一致, 而与山旺这一新种很相似, 差异仅是齿凹中的釉质层更为粗壮。这些牙齿的编号是 IVPP V 8154.4, 5, 6, 8, 9, 11, 13, 20 和 V 8152.8, 它们也可能系 *Sciurus* 属下的一个种。另外, *Shuanggouia* Qiu et Lin, 1986 被指定为 *Petauristinae* 亚科。经过以上剔除, 现在看来 *Shuanggouia* 属型种标本的特征是原脊和后脊汇聚于并不前后伸展的原尖, P4 ~ M2 有后小尖, m1 和 m2 前后压缩、下内尖不清楚, 釉质层在齿凹中并不十分褶皱。这些特征表明了 *Shuanggouia* 属适于松鼠亚科的定义, 而非鼯鼠亚科。

山旺的 *Sciurus lii* 是该属较早的化石记录, 它与北美中新世至早中新世 *Protosciurus* Black, 1963 的特征也很相似, 特别是与其中 *P. mengi* 的形态更接近, 两者的下颊齿都有高的齿座和后边脊。本文将新种归入松鼠属而非北美的原松鼠属, 这多少有点随意性, 也是由于其牙齿的形态与现生北松鼠的很相似, 以及我们对这两个属的了解还很不够。另外, *Sciurus* 与 *Protosciurus* 的相似, 也说明新旧大陆间中新世早期的松鼠可能有着密切的关系。

临朐东方松鼠(新属、新种) *Oriensciurus linqensis* gen. et sp. nov.

特征(属、种) 咬肌窝终止于 m1 之下; 下门齿尖端高出颊齿齿列冠面; 虚位短; 颊齿低冠, 具有相对较高的齿尖和低的齿脊; 原尖前后扩张; M1 和 M2 的原小脊和后小脊完整、近平行排列, 其上无小尖; M3 略向后扩张, 具后脊; 下颊齿的下内尖不清楚, 下内尖角圆, 下中尖小, 齿凹在唇侧开放。

新属或以其个体大小, 或以其颊齿低冠, 上白齿原尖前后扩展、原脊和后脊低而完整, 以及无小尖而易于与地松鼠(如 *Palaeosciurus*、*Atlantoxerus*、*Heteroxerus*、*Prospermophilus*、*Plesiosciurus* 和 *Sciurotamias* 等属)、花栗鼠及树松鼠的一些属(如 *Tamiops* 和 *Ratufa* 等)区别开来。其大小与 *Sciurus*、*Shuanggouia*、*Callosciurus*、*Dremomys* 和 *Spermophilinus* 接近, 形态也多少相似, 但却无法归入其中的任一属。它与 *Sciurus* 属的不同在于 M3 有后脊, 下白齿的下内尖融汇于后边脊、齿座凹在唇侧开放; 以 M1 ~ 2 的原尖前后扩展、原脊和后脊近平行排列、无小尖而区别于 *Shuanggouia* 属; 以弱得多的 M1 ~ 2 原脊和后脊, M3 有后脊, 下颊齿具下中尖和开放的齿座凹而区别于 *Callosciurus* 属; 以 M1 ~ 2 没有次尖状原尖一后脊“结”, 下白齿没有明显的下内尖而易于从 *Dremomys* 属中分离出来。新属以下白齿的齿座凹开放、下内尖角圆而与欧洲地松鼠

Spermophilinus 属的特征相似,但在 M1~2 的原脊和后脊的排列、小尖的有无, M3 后脊的存在与否,以及下前边尖的发育程度上两者都有很大的不同。

Oriensciurus linguensis 下颌骨的形态和上颊齿的构造都表明了其明显的树松鼠型的形态特征。但另一方面,其下颊齿的一些特征又与多数地松鼠相似,如下内尖部分融汇于后边脊、下内尖角浑圆。然而即使如此,也不妨碍把它归入树松鼠,因为某些树松鼠,如 *Collosciurus*, 其下颊齿也具有类似的形态。

结论 山旺的松鼠化石共发现了 4 种,即 *Tamiops asiaticus* (Qiu, 1981), *Sciurus lii* sp. nov., *Oriensciurus linguensis* gen. et sp. nov., *Plesiosciurus* aff. *P. sinensis* Qiu et Lin, 1986。相对只发现 8 种小哺乳动物的山旺动物群来说,松鼠类显得较为常见,这种情况与欧洲中新世动物群中松鼠相对多样的情形十分相似。山旺的松鼠又以树松鼠占有优势,似乎表明这一地区在中新世时有过以森林为主的生态环境。现生的 *Tamiops* 属和 *Sciurus* 属各自主要分布于东洋区和古北区,两者的共生又指示了山旺动物群具有现代东洋界与古北界过渡区的特色,同时也可能说明了山旺地区在中新世时的气候要比现在温暖、湿润。

关键词: 山东山旺, 中新世, 山旺组, 松鼠科

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NEW SCIURIDS FROM THE MIOCENE SHANWANG FORMATION, LINQU, SHANDONG

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Abstract Three forms of Sciuridae, *Tamiops asiaticus* (Qiu, 1981), *Sciurus lii* sp. nov., and *Oriensciurus linguensis* gen. et sp. nov. are described from the early-middle Miocene Shanwang Formation at Linqu, Shandong Province. Comparisons of *Tamiops asiaticus* with *Meinia asiatica* Qiu, 1981 suggest that neither the size nor the morphology of the bodies and dentition allows the two genera to be distinguished. The genus name *Meinia* Qiu, 1981 is therefore considered a junior synonym of *Tamiops* Allen, 1906. *S. lii* is one of the earliest records for the genus *Sciurus*. Some isolated teeth from the early Miocene locality Sihong, previously referred to *Shuanggouia lui* show similarities to *S. lii* and are assigned to the genus *Sciurus* in this paper. Redetermination of *Shuanggouia* argues convincingly for its assignment to Sciurinae rather than Petauristinae. *Oriensciurus linguensis* exhibits some characters similar to *Sciurus* in the upper cheek teeth, and to *Spermophilinus* in the lower ones. The overall dental features, however, group the new genus with tree squirrels. The Shanwang fossil sciurid association highly suggests the Shanwang area was a forest biotope during the Miocene, and indicates an obviously "Transitional Zone" between the modern Oriental Region and the Palearctic Region.

Key words Shanwang, Shandong, Miocene, Shanwang Formation, Sciuridae

1 Introduction

Shanwang is one of the classical Neogene localities in China and produces well-preserved remains of plants and animals in the diatomites. Twenty three forms of large and medium-sized mammals have been recovered from this locality (Deng et al. 2003). Unfortunately these deposits have proven unsuitable for screen washing, resulting in only six species of small mammals from a handful of specimens recovered until now. The small mammals previously recognized include one insectivore (*Lusorex taishanensis* Storch and Qiu, 2004), one chiroptere (*Shanwangia unexpectula* Young, 1977), and four species of rodents (*Diatomys shantungensis* Li, 1974; *Ansomys shanwangensis* Qiu

et Sun, 1988; *Plesiosciurus* aff. *P. sinensis* Qiu et Lin, 1986 and *Meinia asiatica* Qiu, 1981). The Shanwang fauna is biochronologically assigned to the late Shanwangian Chinese Land Mammal age or early-middle Miocene, which can be correlated with the European Land Mammal Zones MN4 ~ 5 (Qiu and Qiu, 1995; Deng et al., 2003).

This paper deals with two new sciurids and revises a squirrel previously assigned to the genus "*Meinia*" by one of the present authors. Material of these taxa, collected from the diatomaceous mining quarry of Shanwang in the last few years, includes three extruded skeletons and complete or incomplete dentitions. The poor preservation of the skeletons, mainly due to extrusion during the burial process and damage in collection, renders difficulty for obtaining detailed information of the skulls and postcranial skeletons, but the well-preserved teeth provide very good dental characters for these taxa.

2 Systematics

Sciuridae Gray, 1821
Sciurinae Baird, 1857
***Tamiops* Allen, 1906**
***Tamiops asiaticus* (Qiu, 1981)**
 (Fig. 1)

Meinia asiatica gen. et sp. nov., Qiu, 1981, figs. 2 ~ 4, pls. I ~ II, p. 228.

Meinia asiatica, Qiu and Sun, 1988, p. 50.

Meinia asiatica, Qiu and Qiu, 1995, p. 41.

Material An incomplete skeleton with partly preserved soft body outline, teeth including left P3 ~ M3 and right P3 ~ M1, and a damaged left lower jaw with p4 and broken m1 and m2, V 14407; a right M1 and M2 from another individual, V 14408.

Diagnosis (emended) Small-sized *Tamiops* with thinner crests and weakly developed cusps on cheek teeth; M1 and M2 lacking conule; M3 and m3 greatly expanded posteriorly.

Measurements (Table 1).

Table 1 Measurements of the teeth of *Tamiops asiaticus* (mm)

	Length		Width	
	Left	Right	Left	Right
P3	0.60	0.60	0.65	0.70
P4	1.50	1.50	1.45	1.50
M1	1.45	1.45, 1.35	1.75	1.80, 1.65
M2	1.50	---, 1.40	1.75	---, 1.70
M3	1.75	---	1.60	---
p4	1.70	---	1.40	---
m1	1.70	---	---	---

Description The skull is crushed and seriously damaged. The zygomatic notch is opposite the anterior end of P4. The mandible, measured 23 mm long from the anterior tip to the condyle and 4.5 mm deep beneath the position of m1, is heavy with a short and relatively arcuate diastema. The superior border of the mandible drops steeply anterior to p4. Tip of the incisor ends above the level of the occlusal surface of the cheek teeth. The masseteric fossa terminates with a prominent process below the anterior end of p4. The mental foramen is large and lies below the diastemal surface and midway along its length. The coronoid process is sharply pointed and curves backward. The condyle

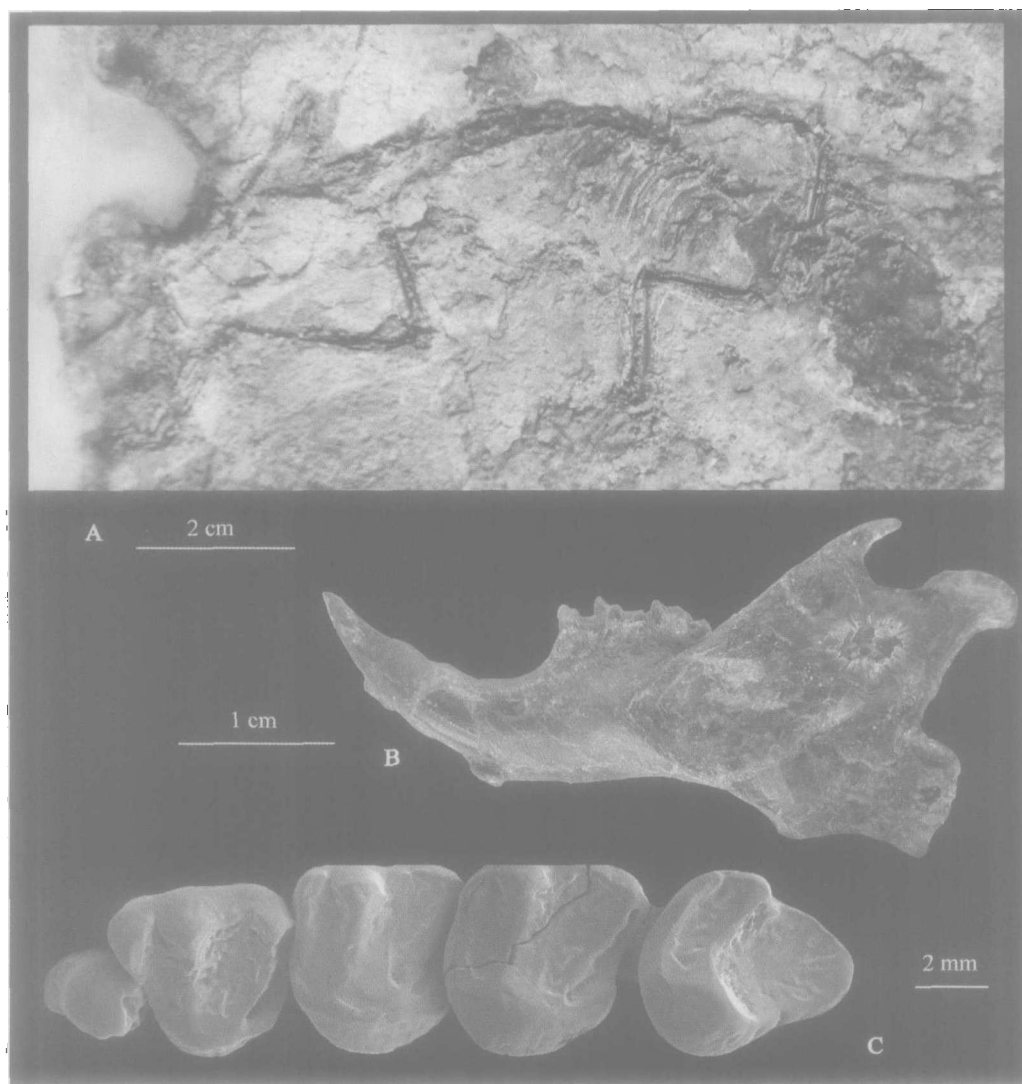


Fig. 1 *Tamiops asiaticus* (Qiu, 1981), V 14407
A. Extruded skeleton; B. left lower jaw, labial view; C. left P3 ~ M3, occlusal view

is large, lying in a level plane with the alveolar border.

The postcranial skeletons are poorly preserved. Length of the humeri and radius are about 21 mm and 28 mm long, respectively. The femur and the tibia, respectively, measure about 27 and 33 mm.

The P3 has a prominent main cusp and a low ridge encircling the posterolingual margin of the tooth. The occlusal outline of the P4 is subtriangular due to the expansion of the parastyle. The protocone and paracone are prominent. The protoloph and the metaloph are moderately developed, lacking a distinct protoconule and metaconule. They are higher than the anteroloph and posteroloph, and converge slightly toward the protocone. A mesostyle is absent. M1 and M2 are subquadrate with protocone moderately expanded anteroposteriorly and high paracone. The protoloph and metaloph are

narrow and low, but complete. They are directed slightly anteriorly and lack a distinct conule. A trace of a protolophule or an accessory loph extends from the protocone into the central basin. Union of the protocone-posteroloph is thick. A distinct mesostyle is absent, but a low and thin labial crest joining the paracone and metacone is present. M3 is greatly expanded posterointernally and does not show a notch between the posterior arm of the protocone and the posteroloph. The protocone and protoloph are prominent. The metacone and metaloph are absent. The posteroloph is thin and low, joining the paracone and the protocone. Enamel on the central basin is distinctly crenulated on P4 ~ M3.

The p4 is transversely narrower anteriorly than posteriorly due to the relatively appressed protoconid and metaconid. The metaconid is the highest cusp. The entoconid is distinct and forms an angular entoconid corner with the low posterolophid. There is a low crest, joining the metaconid posteriorly and separated from the small metastylid by a narrow notch. The anterolophid and trigonid basin are poorly developed and open. The buccal valley is narrow and the ectolophid is straight and low, lacking a distinct mesoconid. The enamel surface of the basin is rugose. Both the m1 and m2 are damaged, but a distinct entoconid and an angular entoconid corner can be seen in m2. The metaconid is the highest cusp on m1 ~ m2. The two molars have a well developed anterolophid which closes a small and high trigonid basin with the complete metalophid. The buccal valley is narrow and directed slightly anteriorly. The ectolophid is low and oriented anterolingually, lacking a mesoconid. There is a small and low metastylid.

Comparison and discussion This squirrel is assigned to the extant genus *Tamiops* based on small size of its cheek teeth, relatively blunt cusps and low crests, thin and nearly parallel arrangement of protoloph and metaloph lacking distinct conules on P4 ~ M2, presence of a prominent entoconid and angular entoconid corner, narrow and anterolingually directed buccal valley, and absence of a mesoconid on p4 ~ m2 (Qiu and Ni, in press).

Tamiops asiaticus resembles *T. atavus* from the late Miocene of Lufeng and Yuanmou, Yunnan, but differs from the latter in smaller size of cheek teeth with thinner crests and slightly less blunt cusps (Qiu and Ni, in press). *T. asiaticus* is closely related to *T. atavus* and very probably gave rise to it. With an increase in size of teeth and strengthening of cusps and crests, it could readily be transformed into *T. atavus*.

Tamiops asiaticus can be distinguished from the Pleistocene *T. swinhoi* (Zheng, 1993) and the extant species *Tamiops maclellandi* and *T. swinhoi* by its thinner protoloph and metaloph and relatively longer anteroloph on upper molars. It is slightly larger than *T. maclellandi* and smaller than *T. swinhoi* in size. In addition, *T. swinhoi* is higher crowned and has a relatively thicker metaloph that is constricted labial to the protoconid on P4 ~ M2, and has a less posteriorly-expanded M3. It seems that the genus underwent little change in dental morphology since late Miocene, except for strengthening of cusps and lophs, and labial constriction of the metaloph on P4 ~ M2.

Qiu (1981) assigned a partial skeleton and dentition from the same locality Shanwang to a flying squirrel *Meinia asiatica*. "*Meinia asiatica*" is identical with the squirrel described above in dental morphology. The author did not note the strong similarities of "*Meinia*" to the extant tree squirrel *Tamiops*, when he described that taxon. Comparison of the two specimens indicates that neither the size of the bodies and teeth, nor the dental morphology, distinguishes these two genera. It is proposed, therefore, to combine these genera, assigning the name "*Meinia*" Qiu, 1981 under *Tamiops* Allen, 1906, because that name has priority.

Sciurus Linnaeus, 1758

Sciurus lii sp. nov.

(Fig. 2)

Shuanggouia lui gen. et sp. nov. [partim], Qiu and Lin, 1986, pl. II, figs. 2,3,6,8, pp. 195 ~ 204.

Parapetaurista tenrugosa gen. et sp. nov. [partim], Qiu and Lin, 1986, pp. 195 ~ 204.

Etymology Named in honour of our friend Mr. Li Junde from the Shanwang Administration Office for Key National Nature Conservation, who made a great contribution to protecting the fossil locality of Shanwang.

Holotype An incomplete skeleton with left P3, P4 and M3, left p4 ~ m3 and right p4 and m1. Shanwang Administration Office for Key National Nature Conservation number: SWB 980002.

Diagnosis Close to *Sciurus vulgaris* in size. P4 and p4 large and distinctly molariform; m3 with clear trigonid basin and distinct mesoconid; trigonid and posterolophid of lower cheek teeth high.

Measurements (Table 2).

Table 2 Measurements of the teeth of *Sciurus lii* sp. nov. (mm)

	Length		Width	
	Left	Right	Left	Right
P3	1.00	---	1.10	---
P4	2.60	---	2.85	---
M3	2.90	---	2.85	---
p4	2.55	2.50	2.50	2.50
m1	2.50	2.55	2.65	2.60
m2	2.70	---	2.80	---
m3	3.05	---	2.80	---

Description The skeleton is incomplete. Judging from the preservation of dispersed parts i.e. the shift of skull and the dispersed manus, the soft body had been partially destroyed and the skeleton had begun to dismember before the burial process. Most of the caudal vertebrae and all the bones of pes are also missing.

The skull is crushed, which is estimated about 60 mm long, and 31 mm wide between the two zygomatic arches. The lower jaws are better preserved, with a small and slightly ventrally-recurved coronoid process, and a posteriorly-directed condyle. The angle is expanded, large and flat, with thick lower border and somewhat straight posterior margin. There is a distinct semilunar notch between the angle and condyle. The mandible is about 39 mm long from the tip of the incisor to the posterior edge of the angle, and depth of the ramus measures 9 mm beneath the position of m1. Tip of the incisor ends above the level of the occlusal surface of the cheek teeth.

The vertebral column is poorly preserved. Length from the atlas to the last sacral vertebrae is about 198 mm.

The scapula is asymmetrically fan-shaped with the weak spine almost equally dividing the supraspinous fossa and infraspinous fossa. It is about 28 mm from the proximal end to the distal end, and the width measures 25 mm. Both ends of the humeri are damaged. The shaft of the humerus, about 40 mm long, diminishes from the proximal to the distal end. The ulna and the radius are nearly equal in dimension, with the former 43 mm long and the latter 36 mm. The ossa coxae, estimated 55 mm long, are destroyed. The obturator foramen is oval, enclosed by the ramus of the pubis and ischium, 16 mm long and 8 mm wide. The femur, about 60 mm long, is relatively robust with a strong head and prominent trochanters. The proximal end of the tibia is about 10 mm wide with distinct medial and lateral condyles, separated by the intercondyloid fossa. Length of the tibia exceeds 50 mm.

The cheek teeth are low crowned with heavily built cusps. The P3 is single-rooted with a prominent cusp surrounded by a strong anterolingual ridge. The P4 is trapezoid shape, and molariform with a large parastyle. The protocone is prominent, located anterior to the midline. The protoloph

and the metaloph are moderately developed and sub-parallel in orientation. The protoloph is thinner than the metaloph, and the metaloph is complete; both lophs lack a distinct conule. The anteroloph and posteroloph are low and well developed. There is a distinct and isolated mesostyle. The enamel of the basins and valleys is rugose. M3 is moderately expanded posteriorly with a broad basin. The protocone is strong and expanded anteroposteriorly. The protoloph is low and lacks a distinct protoconule. The metacone, metaloph and mesostyle are absent, but a strong posteroloph is present that joins a low labial ridge from the paracone. There is a small notch between the posterior arm of the protocone and the posteroloph.

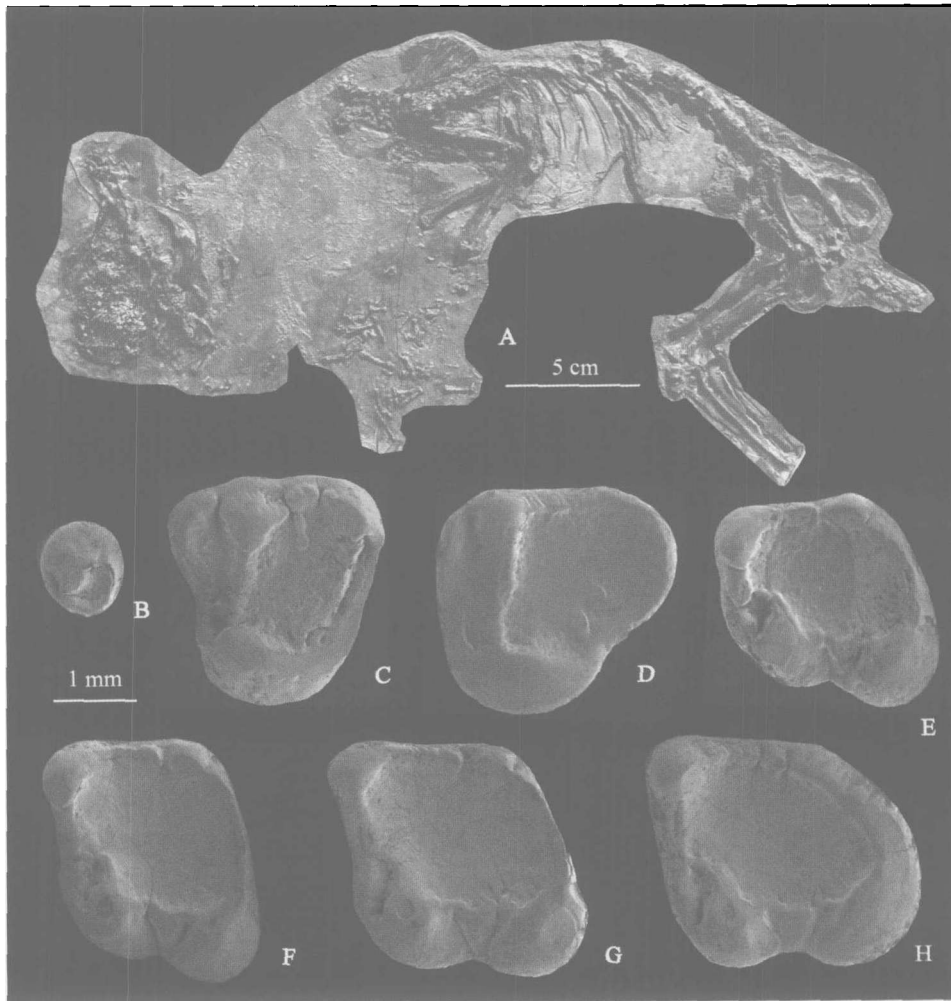


Fig. 2 *Sciurus lii* sp. nov., SWB 980002, holotype
 A. Incomplete crushed skeleton; B. left P3; C. left P4; D. left M3; E. left p4; F. left m1;
 G. left m2; H. left m3; cheek teeth occlusal view

The p4, although somewhat smaller than m1 ~ m2, is completely molariform. It is transversely

narrower anteriorly than posteriorly due to the relatively close position of the protoconid and metaconid; it resembles m1 ~ m2 in all details. The hypoconid is the most prominent cusp in this tooth. The entoconid is distinct and forms an angular entoconid corner with the strong posterolophid. There is a small metastylid, connected with the metaconid and separated from the entoconid by a notch. The anterolophid is thick and short, bearing a tiny anteroconid, that weakly joins the protoconid to close a small trigonid basin with the low metalophid. The buccal valley is wide and the ectolophid is weak and low that joins a small mesoconid. The p4, m1 and m2 are similar in morphology, but increase in size from p4 to m2; they are transversely relatively wider with stronger cusps and lophs posteriorly, and the anteroconid blends progressively into the anterolophid. The m3 is distinctly expanded posteriorly with distinct trigonid basin and small mesoconid. The tooth resembles to the other cheek teeth in morphology of the trigonid, while the entoconid and hypoconid are submerged in a strong and curved posterointernal crest.

Comparison and discussion This specimen is referred to *Sciurus* because it possesses the following characters: size of cheek teeth similar to the extant *Sciurus vulgaris*; tip of incisor ending above the level of occlusal surface of cheek teeth; low-crowned, heavy dentition with strong cusps and low lophs; P4 protoloph and metaloph less convergent lingually, lacking protoconule and metaconule; p4 ~ m2 with distinct entoconids. The new species differs from *Sciurus vulgaris*, the widespread tree squirrel in the Palearctic Region, in its more molariform P4 and p4, higher trigonid relative to the talonid and higher anterolophid and posterolophid on lower cheek teeth.

Fossil record of *Sciurus* in the Neogene of the Old World is poorly known. Only *S. warthae* from Weze, Poland and an indeterminate species from Ertemte, China are described in the literature (Sulimski, 1964; Black and Kowalski, 1974; Qiu, 1991). The new species is close to these two forms in size of molars, but differs in having a larger and more molariform P4 and p4, a lingual notch between the protocone and posteroloph on M3, and a distinct trigonid basin and a mesoconid on m3. In addition, it is distinguished from the Ertemte *Sciurus* sp. by a smaller parastyle on P4, smaller entoconids, and higher trigonid basins and posterolophids on p4 ~ m3. In China, "*Sciurus* sp." was also reported by Teilhard (1936, 1938) from Loc. 9 and 12 of Zhoukoudian (Choukoutien), and by Bohlin (1946) from Tabenbuluk. The Zhoukoudian sciurid has been assigned to *Eutamias* by Qiu (1991) based on its small size, incorporation of entoconid into posterolophid and with rounded posterointernal corner on m1 and m2. The Tabenbuluk one, represented by an M3 and an m2 can also be excluded from the genus *Sciurus* because of the same reasons (Bohlin, 1946).

Some isolated cheek teeth of sciurids from Sihong (Xiacaoan), Jiangsu, were formerly referred to *Shuanggouia lui* and *Parapetaurista tenurugosa*. These teeth are essentially identical with the corresponding teeth of the Shanwang squirrel and differ from the type specimens in morphology. All of these teeth, catalogued as IVPP V 8154.4, 5, 6, 8, 9, 11, 13, 20 and V 8152.8 (Qiu and Lin, 1986), correspond in most details to the diagnosis of the new species, except for having more robust wrinkled enamel on the basins. We believe these specimens should be excluded from *Shuanggouia*, but referred to a species of *Sciurus*. Additionally, *Shuanggouia*, previously assigned to Petauristinae, is characterized by convergence of its protoloph and metaloph labially toward the unexpanded protocone, having a metaconule on P4 ~ M2, plus anteroposteriorly compressed m1 and m2 with an indistinct entoconid. These characters argue convincingly for assignment of *Shuanggouia* to Sciurinae rather than Petauristinae.

In morphology, the new *Sciurus* shows similarities to *Protosciurus* known from the middle Oligocene to early Miocene of North America. Especially, it is similar to *P. mengi* in having a high trigonid and posterolophid on the lower cheek teeth (Black, 1963). It is possible that the Chinese tree squirrel may be grouped with the American genus. However, we place the new species to the genus *Sciurus* rather than *Protosciurus* primarily as a matter of convenience pending better knowledge of *Protosciurus*, and owing to its great similarities of dentition to the living squirrel. The similarity of *Sciurus* to *Protosciurus* suggests that they were closely allied.

The new species from Shanwang is an early record for *Sciurus*. It seems that the genus has a low evolutionary rate in dental morphology since the early or middle Miocene. Distinct changes of the dentition probably include a tendency toward a reduction of the first and last cheek teeth, decrease in height of trigonid and posterolophid in lower cheek teeth.

***Oriensciurus* gen. nov.**

Etymology Orien- (Lat.) = oriental, a prefix denoting place where the squirrel was found.

Type species *Oriensciurus linqensis* sp. nov.

Diagnosis Masseteric fossa terminating below m1; tip of lower incisor ending above the level of occlusal surface of cheek teeth; diastema short; cheek teeth low crowned with relatively high cusps and low lophs; protocone expanded anteroposteriorly; protoloph and metaloph on M1 and M2 complete, sub-parallel and lacking conules; M3 slightly expanded posteriorly with thin and posterolabially-directed metaloph; on lower cheek teeth entoconid indistinct relative to prominent posterolophid, entoconid corner curved, mesoconid small and trigonid basin open labially with anterolophid separated from protoconid.

Differential diagnosis The dental pattern of *Oriensciurus* agrees with that of a generalized sciurid and therefore fits the definition of the subfamily Sciurinae. The new genus is readily distinguished from the ground squirrels (such as *Palaeosciurus*, *Atlantoxerus*, *Heteroxerus*, *Prospermophilus*, *Plesiosciurus*, *Sciurotamias*, etc.), chipmunks and some of the tree squirrels (*Tamiops* and *Ratufa* for example) by different size, by either low crowned cheek teeth with anteroposteriorly expanded protocone and low lophs on upper molars, or the relatively complete protoloph and metaloph lacking conules.

Oriensciurus resembles *Sciurus*, *Shuanggouia*, *Callosciurus*, *Dremomys*, and *Spermophilinus* in size, and in having either complete protoloph and metaloph lacking conules on upper molars, or rounded entoconid corner and trigonid basin open labially on lower cheek teeth. However, it differs from *Sciurus* in the presence of a metaloph on M3, the prominent posterolophid that incorporates the entoconid, and the trigonid basins open labially on lower cheek teeth. Conspicuous differences between *Oriensciurus* and *Shuanggouia* are M1 and M2 with protoloph and metaloph lacking conules and sub-parallel to the expanded protocone in *Oriensciurus*, whereas in *Shuanggouia* M1 and M2 the protoloph and metaloph bearing a metaconule converge toward the narrow protocone (Qiu and Lin, 1986). *Oriensciurus* is distinguishable from *Callosciurus* by having a much weaker protoloph and metaloph on M1 ~ 2, the presence of a metaloph on M3, plus a mesoconid and open trigonid basins on lower cheek teeth. *Oriensciurus* is readily distinguished from *Dremomys* (Qiu, 2002) by the absence of a hypoconid-like union of protocone-posteroloph on M1 ~ 2 and a distinct entoconid on lower molars. *Oriensciurus* is similar to the European ground squirrel *Spermophilinus* in having a trigonid basin open labially and a rounded entoconid corner on lower molars (De Bruijn and Mein, 1968; De Bruijn et al., 1970; Daxner-Höck and Mein, 1975; Ziegler and Fahlbusch, 1986); it differs from *Spermophilinus* in lacking a metaconule on M1 ~ 2, plus having a metaloph on M3, and the anteroconid is indistinct on lower cheek teeth. In addition, the protoloph and metaloph converge toward the protocone less in *Oriensciurus* than in *Spermophilinus*.

***Oriensciurus linqensis* sp. nov.**

(Fig. 3)

Etymology Named for the area of its discovery at Linq, a county in Shandong province.

Holotype An extruded skeleton with left P4 ~ M3 (P4 damaged), right M1 ~ 3, and a damaged right mandible with p4 ~ m3. V 14409.

Diagnosis As for the genus.

Measurements (Table 3).

Table 3 Measurements of the teeth of *Oriensciurus linquensis* gen. et sp. nov. (mm)

	Length		Width	
	Left	Right	Left	Right
P4	---	---	2.25	---
M1	2.40	2.35	2.85	2.85
M2	2.45	2.45	2.90	2.90
M3	2.65	2.60	2.80	2.85
p4	---	2.50	---	1.80
m1	---	3.00	---	2.60
m2	---	3.15	---	2.65
m3	---	3.30	---	2.55

Description The skeleton is incomplete and crushed. The skull is about 67 mm long, and the length of the mandible is estimated 39 mm. The diastema is 6.7 mm long. The mental foramen is large, located 1.7 mm below the diastemal surface and 0.6 mm anterior to p4. The masseteric fossa terminates below the anterior roots of m1. The angle is large and flat. Tip of the incisor ends above the level of the occlusal surface of the cheek teeth.

The vertebral column is poorly preserved. Length from the atlas to the last sacral vertebrae is about 160 mm.

The shaft of the humerus, about 35 mm long, diminishes from the proximal to the distal end. The ulna and the radius are nearly equal in dimension, with the former being 37 mm long and the latter 30 mm. The ossa coxae, estimated 40 mm long, are destroyed. The femur is about 60 mm long. The tibia is about 50 mm long with its proximal end about 8 mm wide. The phalanges of the feet are longer, stronger and straighter than those of the hands.

The cheek teeth are low crowned with relatively high cusps and low lophs. The anterior portion of P4 is not preserved. The P4 metaloph is complete and strong, but narrows precipitously before reaching the protocone. The protoloph is thick and subangular on the posterointernal corner of tooth, continuing anteriorly to join the protocone. A low and incomplete mesoloph crosses most of the central basin. The M1 is subquadrate in occlusal outline, wider than long. The protocone is relatively low, expanded anteroposteriorly. The paracone and metacone are high, markedly precipitous lingually due to abrupt drop of the protoloph and the metaloph. The protoloph and metaloph are very low, and sub-parallel in orientation. The metaloph is complete and also thins markedly before joining the protocone. There is no a protoconule nor a metaconule. The anteroloph and posteroloph are lower than the protoloph and metaloph with the posteroloph very thick lingually and angular at the posterointernal corner of tooth. A distinct and small mesostyle is present and a remnant of the mesoloph extends lingually into the central basin. The M2 is similar to M1, but slightly larger. The mesoloph is indistinct in this tooth, but a narrow crest extends lingually in the minute notch between the mesostyle and metacone. M3 is slightly expanded posteriorly. The protocone is less prominent than in M2, the paracone is still a pronounced cusp, and the metacone is indistinct on the rounded posteroloph. The protoloph of M3 is well developed and narrow, the metaloph is low and complete, joining the protocone lingually and the posteroloph posteriorly. The posteroloph is thin, not expanded posterointernally. A small and distinct mesostyle is present.

The p4 is distinctly narrower anteriorly than posteriorly. The lophate metaconid is elongated transversely, continuing labially as the anterolophid, situated distinctly anterior to the protoconid. The entoconid is completely incorporated into the posterolophid which joins the large hypoconid; the posterolophid is separated from the metaconid by a notch. The entoconid corner is curved. The anterolophid is thick, bearing no anteroconid, and fails to join the protoconid to close the trigonid ba-

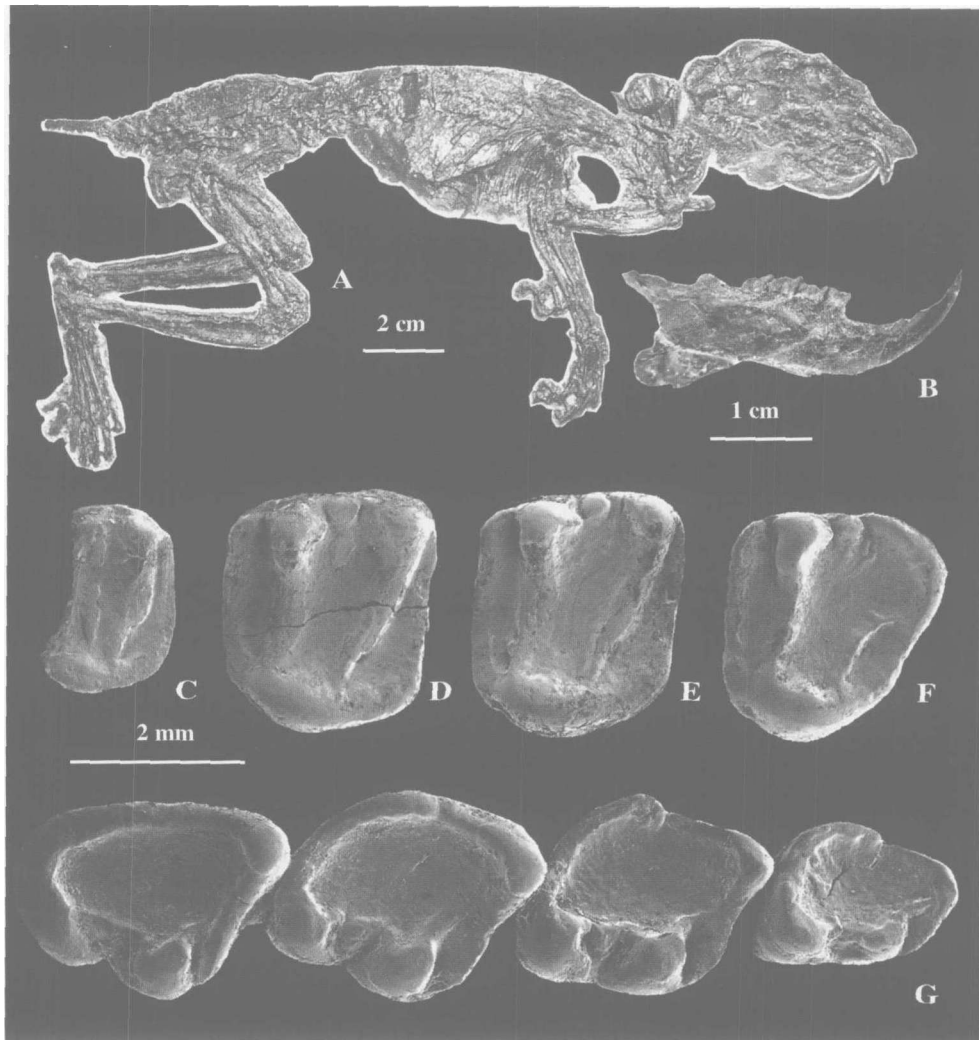


Fig. 3 *Oriensciurus linqensis* gen. et sp. nov., V 14409, holotype

A. Extruded skeleton; B. right lower jaw, labial view; C. damaged left P4; D. left M1; E. left M2; F. left M3; G. right p4 ~ m3; cheek teeth occlusal view

sin labially. The buccal valley is shallow and the mesoconid is indistinct. The m1 is rhomb shape in occlusal outline. The protoconid and hypoconid are located closely and weakly join the small mesostylid. The metaconid is situated anterior relative to the protoconid. The entoconid is indistinct incorporated into the lingual end of the posterolophid. A minute metastylid is present, separated by a small notch from the prominent posterolophid. The anterolophid is thick, directed labially and failing to close the narrow trigonid basin. The metalophid weakly joins the anterolophid near the midline. The m2 is similar to m1, but larger in size with more prominent metalophid, less distinct entoconid, more rounded entoconid corner and less distinct notch between the posterolophid and indistinct metastylid. The m3 is greatly expanded posteriorly and transversely wider anteriorly than posteriorly. The tooth resembles the m1 and m2 in the morphology of the trigonid, while the hypoconid

has merged into the prominent, rounded posterolophid. The buccal valley is relatively wide and a small mesoconid is present. Enamel of the basins in these cheek teeth is smooth.

Discussion *Oriensciurus linguensis* shows similarities to *Sciurus lii* in size and morphology, such as the low crowned teeth with low lophs, the absence of conules and the presence of small mesoconids. However, it is clearly different from the latter in its relatively less heavy dentition with higher cusps on upper cheek teeth, in having a low metaloph on M3, in the entoconid incorporated into the posterolophid and the anterolophid separate from the protoconid on p4 ~ m3.

The short diastema of mandible, the high termination of the lower incisor, the low-crowned cheek teeth, the anteroposteriorly expanded protocone, the low, complete and sub-parallel protoloph and metaloph lacking conules group *Oriensciurus linguensis* with the tree squirrels. In several characters such as the submerged entoconid and the rounded entoconid corner, it is similar to most of the ground squirrels. However, such features can also be seen in some tree squirrels, the extant *Callosciurus* for instance. Thus, we believe that *Oriensciurus* was mainly arboreal, similar to *Callosciurus* and *Sciurus*.

3 Conclusion

The sciurid association found at Shanwang is composed of four genera and species in subfamily Sciurinae, i.e. *Tamiops asiaticus* (Qiu, 1981), *Sciurus lii* sp. nov., *Oriensciurus linguensis* gen. et sp. nov., *Plesiosciurus* aff. *P. sinensis* Qiu et Lin, 1986. It appears that sciurids were rather common and diverse relative to the eight known taxa of small mammals in this Miocene locality. This situation is comparable to the larger diversity of squirrels in Europe during the Miocene (De Bruijn, 1999).

Among the four sciurids, at least three forms (except *Plesiosciurus* aff. *P. sinensis*) were arboreal. The dominance of tree squirrels strongly suggests a forest biotope, and implies that the Shanwang area had landscapes dominated by forest during the early/middle Miocene.

Two genera of the association, *Tamiops* and *Sciurus* are extant, of which the former are distributed today in South China (Oriental Region), while the latter in North China (Palearctic Region). This suggests that the Shanwang fauna is a Transitional Zone between the Oriental Region and the Palearctic Region. Furthermore, the Shanwang area might be warmer and moister during the early/middle Miocene than this area is during the present day.

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