Sciurid remains from the Late Cenozoic fssure-fllings of Fanchang, Anhui, China (Postprint)

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Date: 2017-08-11T00:00:00+00:00

Abstract

The sciurid materials discovered in the Late Cenozoic fissure fillings at Tangkou, Lailishan, Fanchang, Anhui are described. The fossils represent four tribes of the subfamily Sciurinae, comprising five genera and six species, including one new genus and two new species, namely Sciurus sp. from the tree squirrel tribe, Tamias sp. and Plesiosciurus zhengi sp. nov. from the chipmunk tribe, Sciurotamias wangi Qiu, 2002 and S. teilhardi Zheng, 1993 from the marmot tribe, and Pseudoratufa wanensis gen. et sp. nov. from the giant squirrel tribe. The studied materials represent a mixed collection from four different levels of the same fissure filling, and the fossil components may represent different time intervals ranging from the Early Miocene to the Pleistocene. This squirrel assemblage from Fanchang exhibits characteristics of the Late Cenozoic sciurine faunas from central and southern China, and contains the intriguing genus Pseudoratufa. The dental morphology of this new genus clearly demonstrates its arboreal squirrel characteristics, and it can be assigned to the very rare giant squirrel tribe. Its remains share similar fossilization and depositional processes with the hominoid, Diatomys, and beaver fossils discovered at this locality, seemingly indicating that these animals belong to contemporaneous or near-contemporaneous groups, and their co-occurrence also demonstrates that the Fanchang area had relatively humid forest habitats during the Miocene.

Full Text

Preamble

Vertebrata PalAsiatica, Vol. 54, No. 4, October 2016, pp. 286–301, figs. 1–8

Sciurid remains from the Late Cenozoic fissure-fillings of Fanchang, Anhui, China

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Abstract

Remains of sciurids from a late Cenozoic fissure in Anhui, China are described. Six taxa, including one new genus and two new species, representing five genera and four tribes in the subfamily Sciurinae are recognized. They are *Sciurus* sp., *Tamias* sp., *Plesiosciurus zhengi* sp. nov., *Sciurotamias wangi* Qiu, 2002, *S. teilhardi* Zheng, 1993, and *Pseudoratufa wanensis* gen. et sp. nov. The material described was collected from four levels of the fissure fillings. On the basis of the fossil content and coloration, the collection is considered to be a mixed sample with elements representing a rather long interval, probably ranging from the Early Miocene to the Pleistocene. The assemblage shows similar traits of the late Cenozoic sciurine faunas from central and southern China, and contains an intriguing genus *Pseudoratufa*. Characters of the latter' s dentition clearly demonstrate that the new-comer of ratufin is a tree squirrel; *Pseudoratufa* is probably coeval with the Fanchang hominoid, and with *Diatomys* and beavers found in this fissure. The joint occurrence of these taxa seems to be indicative of existence of forest biotopes once in this district during the earlier Miocene.

Key words: Fanchang, Anhui, China; late Cenozoic; fissure filling; Sciuridae

Citation: Qiu Z D, Jin C Z, 2016. Sciurid remains from the Late Cenozoic fissure-fillings of Fanchang, Anhui, China. *Vertebrata PalAsiatica*, 54(4): 286—301

1 Introduction

Fanchang is a county in southeastern Anhui Province, and lies about 20 km to the south of the Chang Jiang (the Yangtse River). Fissure-fillings are well developed in the Permian and Triassic limestones spread in this district (Yuan et al., 2009). Four mammal-bearing fissures—Tangkou, Renzidong, Xidong, and Ludong of different ages—were discovered by local people in the late 1980s and 1990s at Laili Hill, a limestone quarry 2 km northwest of Sun village and 10 km southwest of the county seat (Fig. 1 [Figure 1: see original paper]). A preliminary investigation of the mammalian remains from the four fissures reveals that the age of fossils contained in the deposits seems to be correlative with the topographical elevation of the fissures; that is, the higher the fissure, the older the age. The Tangkou sample includes elements indicative of Early or Middle Miocene age, whereas the Ludong sample indicates only Late Pleistocene age, and the Renzidong and Xidong fissures are intermediate. Remains of mammals from the Early Pleistocene Renzidong, including more than 70 species in 9 mammalian orders, have been studied in detail (Jin and Liu, 2009).

The Tangkou site, discovered in the late 1980s, is at the top of Laili Hill (31º5 23”

N, 118°5 46" E), at an elevation of about 143 m above sea level. The visible deposits in this fissure reach a thickness of more than 20 m, which can be divided into four levels (in ascending order) as follows (Fig. 2 [Figure 2: see original paper]).

The fissure-fillings from this site can be divided into two units. Deposits from Layers 1–3 consist of alternating beds of fine-grained and coarse sandstones and conglomerates, while those from Layer 4 are made up of clays and brecciated limestones and shales fallen locally from the surrounding rocks. Remains from Layers 1–3 are usually worn by water transportation and colored gray or grayish brown and black, in contrast to those from Layer 4 that are colored reddish yellow and show no sign of abrasion.

The four levels are characterized as follows. Layer 1 consists of grayish yellow sandstones. Lithologically, this sandstone is well-cemented, comprising fine-grained sandstones at the base that grade upward into pebbly medium to coarse-grained sandstones, with lenticular bodies of sands and gravels occurring throughout. Layer 2 comprises brownish gray coarse sandstones, forming a layer of well-indurated, pebbly rocks interbedded with siliceous bands locally. The gravels are better sorted and usually 1–3 cm in diameter. This layer contains a small number of mammalian remains and measures 0.8 m in thickness. Layer 3 comprises brownish gray sandstones and conglomerates. Sediments in this layer are cemented and rather hard, with contained gravels being well-rounded and generally 1–5 cm in diameter. This layer contains remains of hominoids, *Platybelodon*, *Hipparion*, *Kubanochoerus*, and other mammals, with a thickness of 4.8 m. Layer 4 consists of reddish brown sandy clays with brecciated limestones and occasionally yellowish shales. The gravels, broken locally, are poorly rounded and sorted, and highly diverse in size (generally 8–30 cm and attaining a maximum size of 50 cm). Fossil remains are sparse, and the layer has a thickness of 5.6 m.

Zheng (1993) first reported fragmentary materials of *Kubanochoerus* and *Platybelodon* at this site. Subsequently, during the field seasons of 1999–2001, abundant remains of mammals were collected by a team led by one of us (Jin Changzhu) and funded by the project "the State Key Scientific Research," a program of "Research of the Early Hominid Ancestors of 2–4 Ma in China and Their Environmental Background"(Jin and Wei, 1999). The sample was assembled throughout the fissure-fillings of the above section (Fig. 2). This assemblage of mammals is quite varied and apparently consists of taxa from different time intervals. The occurrence of *Democricetodon*, *Megacricetodon*, *Diatomys*, *Platybelodon*, and *Kubanochoerus* in this sample obviously indicates an Early or Middle Miocene age, while *Leopoldamys*, a large-sized murine, suggests an age younger than the Early Pliocene. This clearly demonstrates that the Tangkou assemblage, as featured in literature citations, consists of different mammal associations of mixed ages, ranging from Early Miocene to Pleistocene.

In this paper, we describe sciurid material collected from the fissure-fillings at the Tangkou site. Although the sciurids described are a mixed sample with

elements representing different periods, they improve our knowledge of the taxonomy of the sciurid family and contribute to a better understanding of their spatial distribution in the late Cenozoic of China. The other mammal material will be described elsewhere.

Funding: This research was supported by the National Natural Science Foundation of China (Grant No. 41430102).

Received: 2015-10-15

2 Systematic Description

Sciuridae Gray, 1821

Sciurinae Fischer von Waldheim, 1817

Sciurini Fischer von Waldheim, 1817

***Sciurus* Linnaeus, 1758**

***Sciurus* sp. (Fig. 3A [Figure 3: see original paper]-E) Material:** Five cheek teeth (1 DP4, 1 P4, 1 M1/2, 1 M3, 1 m3), IVPP V 20847.1–5.

Measurements (length × width, in mm): DP4, 2.00 × 2.05; P4, 2.15 × 2.65; M1/2, 2.35 × 2.95; M3, 2.90 × 3.00; m3, 3.05 × 2.95.

Description: These teeth are rather heavily built with low and blunt cusps and crests. The DP4 is subtriangular due to the prominent and expanded parastyle. The protocone is relatively high and slightly constricted. The protoloph and the metaloph are complete, with the lingual portion being slightly convergent to join the protocone. A protoconule and a metaconule are absent, but the middle part of the metaloph bulges slightly. There is a low buccal connection between the paracone and the metacone. The posteroloph is complete and pronounced, gradually elevated to join the apex of the protocone.

The P4 is similar to the DP4, except for its subrectangular outline due to the less expanded parastyle, larger size, and stronger cusps and lophs. The M1/2 is subquadrate in occlusal outline. The protocone is prominent and expanded anteroposteriorly. The transverse protoloph and somewhat oblique metaloph are low but complete, with the latter slightly constricted just buccal of the protocone. No protoconule or distinct metaconule are present. The mesostyle is indistinct. Both anteroloph and posteroloph are complete and strong but lower than the protoloph and the metaloph. The M3 and m3 are moderately expanded posteriorly. Enamel of the basins is smooth.

Remarks: These teeth show relatively light color and no sign of wear by transportation and probably come from the upper level. They cannot be referred to any described taxon and represent a generalized sciurid with relatively large size in this assemblage. Judging from the heavily built cheek teeth, the low and strong principle cusps and crests, the anteroposteriorly expanded protocone, and the nearly parallel arrangement of protoloph and metaloph on M1/2, this

sciurid demonstrates characters of a tree squirrel, comparable to the genus *Sciurus* both in size and morphology. Compared with the extant *Sciurus vulgaris*, the Fanchang sciurid is slightly larger in size, with stronger cusps and crests and less posteriorly expanded M3 and m3. It is close to *S. lii* from Shanwang in size but differs in having stronger cusps and crests and less posteriorly expanded M3 and m3 (see Qiu and Yan, 2005). Thus, these specimens are assigned to an indeterminate species of *Sciurus* because of the inadequate material.

Tamiini Weber, 1928

***Tamias* Illger, 1811**

***Tamias* sp. (Fig. 3F [Figure 3: see original paper])** One M3 (IVPP V 20848) represents a small squirrel found in this assemblage. The tooth measures 1.70 mm long and 1.75 mm wide, which is too small to match any described squirrels. It is moderately expanded posteriorly. The protocone and the paracone are pronounced and high. The protoloph is conspicuous but bears no protoconule. A metaloph is absent. The anteroloph is marked and elevated. The posteroloph is distinct and connects the protocone to the paracone. Enamel of the basin is nearly smooth.

The M3 is similar to that of *Tamias* or *Tamiops* in size and in having a distinctly elevated anteroloph but differs from the latter in being less expanded posteriorly and lacking rugged enamel on the basin. It resembles that of *Tamias* more closely than it does the corresponding tooth of *Tamiops*. Nevertheless, it is distinguishable from that of *Tamias sibiricus*, the living chipmunk widely distributed in the Palearctic Region of Asia, by its somewhat smaller size and from that of *T. ertemteensis*, a common chipmunk in the Neogene faunas of central Nei Mongol, by its less posterior expansion (Qiu, 1991). Thus, it is assigned to an indeterminate species of *Tamias*.

***Plesiosciurus* Qiu & Lin, 1986**

***Plesiosciurus zhengi* sp. nov. (Figs. 4, 5; Table 1)** *Plesiosciurus* aff. *P. sinensis*: Qiu & Sun, 1988, p. 54.

Etymology: Named in honor of Mr. Zheng Longting from the Anhui Museum, who first reported the discoveries of the Tangkou fissure and organized and helped in many aspects of the Fanchang field work.

Holotype: Left M1/2 (IVPP V 20849).

Paratypes: Twenty-eight cheek teeth (6 M1/2, 5 M3, 2 dp4, 1 p4, 8 m1/2, 6 m3), V 20850.1–25.

Measurements: See Table 1.

Diagnosis: Larger-sized *Plesiosciurus* with more heavily built cheek teeth. Metaconule absent, but the connection between paracone and metacone strengthened in M1 and M2; no sign of metaconule and metaloph in M3; and

m1 and m2 less anteroposteriorly compressed with anterolingual-posterobuccally arranged ectolophid.

Description: The outline of M1/2 is subquadrate and wider than long. The cusps are more striking and higher than the lophs. The protocone is large and slightly expanded anteroposteriorly. The complete protoloph and the metaloph are low and nearly convergent to join the protocone, with the transverse protoloph bulging somewhat and the oblique metaloph distinctly constricted just buccal of the protocone. A protoconule and a metaconule are absent, but a bulge at the middle part of the metaloph is usually present. The anteroloph and the posteroloph are both complete and pronounced but lower than the protoloph and the metaloph. A mesostyle is absent, and a steep connection between the paracone and the metacone is present.

The M3 has the same pattern as the anterior portion of the M1/2 and has moderate expansion of the posterior part. It has no metaloph and shows no notch between the posterior arm of the protocone and the posteroexternal lobe. Basin enamel is as smooth as in M1/2.

The p4 is distinctly narrower anteriorly than posteriorly, with the protoconid and the metaconid situated very close to one another and the former located posterior to the latter. There is no anteroconid. The entoconid is completely incorporated in the posterolophid, and the entoconid corner is curved. A mesoconid and a mesostylid are absent. The ectolophid is straight and orientated anterolingual-posterobuccally. The dp4 is similar to the p4 except for its smaller size, larger length relative to width, weaker cusps and crests, and diverged roots.

The m1/2 is subrhomboidal and slightly compressed anteroposteriorly. The entoconid is completely incorporated in the posterolingual crest. The entoconid corner is curved. A mesoconid and a mesostylid are lacking. The anterolophid is low and joins the base of the protoconid. The posterolophid is much more elevated than the anterolophid. The metalophid is complete, connecting the protoconid and metaconid to close the trigonid basin posteriorly. The buccal valley is moderately wide, and the talonid basin is dammed by a straight and anterolingually arranged ectolophid.

The m3 is moderately expanded posteriorly. The entoconid is incorporated in the posterolingual crest linking the metaconid and hypoconid. The ectolophid is distinct, without mesoconid. The metalophid fails to close the trigonid basin posteriorly. Enamel on the talonid basin of p4-m3 is smooth.

Discussion: The described specimens fit the diagnosis of *Plesiosciurus* by their small size; relatively heavily built cheek teeth; more striking cusps than crests; M1 and M2 having moderately expanded protocone, complete and converging protoloph and metaloph, but lacking protoconule and mesostyle; lower cheek teeth having entoconid completely incorporated in posterolophid, straight ectolophid, but lacking mesoconid and mesostylid; subrhomboidal m1 and m2 having long metalophid; and m3 moderately expanded posteriorly (see Qiu, 2015).

Plesiosciurus, considered to be a chipmunk or ground squirrel, was defined by Qiu and Lin (1986) based on material from the Early Miocene Xiacaowan Formation of Sihong. These teeth from Fanchang are similar to the type specimens of *P. sinensis* in morphology but differ in larger size (Fig. 5), having more heavily built dentition, absence of metaconule and presence of stronger connection between the paracone and metacone in M1/2, lack of metaconule and metaloph in M3, and in less anteroposteriorly compressed m1/2 with anterolingual-posterobuccally arranged ectolophid. These differences are indicative of different specific status for the squirrel, which is here proposed as *P. zhengi* sp. nov.

In addition to type specimens, a partial body imprint and fragmentary skeleton with three damaged teeth was collected from the Early/Middle Miocene Shanwang Formation, Linqu, Shandong Province, and published under the name *Plesiosciurus* aff. *P. sinensis* by Qiu and Sun (1988). The Linqu cheek teeth fall within the range exhibited by the new species both in size and pattern, thus they are here referred to the new species *P. zhengi*.

The similarities of *Plesiosciurus zhengi* to *P. sinensis* indicate that the two species were probably closely allied, but their affinities remain uncertain. However, the larger size with more heavily built cheek teeth, the absence of metaconule and the presence of stronger connection between paracone and metacone in M1 and M2, and the less anteroposteriorly compressed m1 and m2 are interpreted as derived states for *P. zhengi*.

Tribe Marmotini Pocock, 1923

***Sciurotamias* Miller, 1901**

***Sciurotamias wangi* Qiu, 2002 (Fig. 6 [Figure 6: see original paper])**
Referred specimens: Nine cheek teeth (1 P4, 4 M1/2, 2 m1/2, 2 m3), IVPP V 20851.1-9.

Measurements (length × width, in mm): P4, 1.75 × 2.25; M1/2, 2.05 × 2.60, 2.15 × 2.65, 2.30 × 2.75, 2.15 × 2.75; m1/2, 2.40 × 2.45; m3, 2.70 × 2.60.

Description: The P4 is worn by water transportation. It is U-shaped in outline of the occlusal surface with undeveloped parastyle but long anteroloph. The protocone is prominent. The protoloph and the metaloph are strong and complete, with the metaloph slightly constricted at the contact with the protocone. A protoconule and a metaconule are absent. A pronounced connection between the paracone and the metacone is present. The anteroloph and posteroloph are complete but lower and weaker than the protoloph and the metaloph.

M1/2 is subquadrate in outline, with a conspicuous and slightly anteroposteriorly expanded protocone. The paracone and the metacone are also strong and more or less the same size. The protoloph and the metaloph are pronounced, with the latter being oblique and constricted buccal of the protocone. The anteroloph and the posteroloph are complete, with the posteroloph buccally bulging to join the protocone. A protoconule and a metaconule are absent, but

a bulge at the middle part of the metaloph can be observed. There is a tiny mesostyle connected to the paracone. The anterior valley is slightly larger than the posterior one.

The m1/2 is subrhomboidal. As in the upper cheek teeth, it has heavily built cusps and crests. The entoconid, separated from the metaconid by a wide and deep notch, is weakly developed and incorporated in the strong and elevated posterolingual crest. The entoconid corner is curved. There is no mesoconid, but a very tiny mesostylid connected with the entoconid can be seen. The metalophid is low and complete to close the small trigonid basin posteriorly. The anterolophid is prominent and joins the protoconid at the base. The buccal valley is narrow, and the talonid basin is dammed by a low and short ectolophid. The m3 is moderately expanded posteriorly. The entoconid is completely incorporated in the strong posterolingual crest. A low mesostylid, connected to the posterolingual crest and separated from the metaconid by a notch, is distinguishable. There is no distinct mesoconid.

Discussion: The described specimens are colored grayish black and show traces of water transportation. They are probably older, coming from a lower level.

Characters of the specimens correspond to the diagnosis of *Sciurotamias*: prominent cusps and crests; complete and converging protoloph and metaloph; lingually constricted metaloph; absence of protoconule on M1/2; merged entoconid with the posterolophid; curved entoconid corner; and presence of a distinct notch between the metaconid and the posterolingual crest on m1 and m2. *Sciurotamias* is a group of ground squirrels endemic to China. Two extant species, *S. davidianus* and *S. forresti*, and five fossil species—*S. pusillus*, *S. wangi* and *S. leilaoensis* from the Late Miocene, *S. praecox* and *S. teilhardi* from the Pleistocene—are included in the genus (Teilhard, 1940; Zheng, 1993; Qiu, 2002; Wang, 2003; Qiu and Ni, 2006; Qiu et al., 2008).

The Fanchang *Sciurotamias* can be easily distinguished from *S. davidianus* by its relatively wider cheek teeth with relatively weaker cusps and lophs, less lingually constricted metaloph, absence of metaconule on M1 and M2, presence of a complete metalophid, and a small mesoconid on m1/2. It shows some resemblance to *S. forresti* in relatively wide cheek teeth with less strong cusps and lophs, less constricted metaloph bearing no metaconule on M1 and M2, but differs in larger size, having a tiny mesostyle on M1 and M2, a small mesostylid, and a complete metalophid on m1/2. The taxon is larger than *S. pusillus* and *S. praecox* in size. In addition, it differs from the former in having less constricted metaloph bearing no metaconule on M1 and M2, having complete metalophid and lacking mesoconid on m1/2, and differs from the latter in having stronger cusps and lophs, distinct connection between the paracone and the metacone on M1/2, and lacking mesoconid on m1/2. The main differences between the Fanchang taxon and *S. leilaoensis* are the relatively wider cheek teeth with stronger cusps and lophs, the less constricted metaloph bearing no metaconule on M1 and M2, and the presence of a tiny mesostylid on m1/2 in the former. Compared with *S. teilhardi*, it is slightly larger in size with

heavier cusps and lophs, less lingually constricted metaloph on M1 and M2, and indistinct mesoconid on m1/2.

The described specimens are mostly similar to the type specimens of *S. wangi* in size, in the absence of protoconule and metaconule, the presence of small mesostyle on M1 and M2, and in having more complete metalophid on m1/2. Minor differences are the stronger cusps and crests, the less lingually constricted metaloph on M1 and M2, and the presence of a tiny mesostylid on m1/2 in the Fanchang specimens. While it is unlikely that these specimens are completely identical to those of *S. wangi*, it is considered inadvisable to create a new species based on the inadequate material and the minor differentiated morphology. Thus, they are referred to *S. wangi* known from the Late Miocene of Yunnan (Qiu, 2002; Qiu and Ni, 2006).

***Sciurotamias teilhardi* Zheng, 1993 (Fig. 7 [Figure 7: see original paper]) Referred specimens:** Ten cheek teeth (1 P4, 2 M1/2, 1 dp4, 2 p4, 3 m1/2, 1 m3), IVPP V 20852.1-10.

Measurements (length × width, in mm): P4, 1.90 × 2.30; M1/2, 2.10 × 2.50, 2.25 × 2.75; dp4, 1.65 × 1.45; p4, 1.70 × 1.65, 1.85 × 1.80; m1/2, 2.10 × 2.20, 2.25 × 2.55; m3, 2.75 × .

Description: The P4 is subrectangular in outline of the occlusal surface with a slightly expanded parastyle and short anteroloph. The protocone is high and prominent. The protoloph and the metaloph are complete, and the metaloph is constricted at the contact with the protocone. A protoconule is absent, but a metaconule-like bulge is present. A distinct mesostyle is lacking, but a pronounced connection exists between the paracone and the metacone.

The outline of M1/2 is subquadrate. The protocone is conspicuous, high, and slightly expanded anteroposteriorly. The metacone is larger than the paracone. The protoloph and the metaloph are strong, with the latter being oblique and lingually constricted. The anteroloph and the posteroloph are complete, lower than the protoloph and the metaloph. A protoconule is absent, but a small metaconule is present. A tiny mesostyle connected to the paracone can be observed. The central valley is larger than the anterior and the posterior valleys.

The dp4 is distinctly narrower anteriorly than posteriorly, with the more posteriorly situated protoconid separated from the metaconid by a narrow fissure. The entoconid is completely incorporated in the prominent and elevated posterolophid. A mesoconid and a mesostylid are absent. The p4 is similar to the dp4 in shape and structure but larger in size with stronger cusps and crests. A small mesoconid is present in one specimen.

The m1/2 is subrhomboidal, with the entoconid incorporated in the posterolingual crest. The entoconid corner is curved. A mesoconid and a mesostylid are missing. The metalophid is long and closes the small trigonid basin posteriorly. The anterolophid is complete and joins the protoconid at the base. The pos-

terolingual crest is elevated, joining the hypoconid at its apex and separated from the metaconid by a notch. The buccal valley is narrow and shallow. The smooth talonid basin is dammed by a low and anterolingual-posterobuccally arranged ectolophid. The m3 is moderately expanded posteriorly. The entoconid is incorporated in the strong posterolingual crest, which is connected to the hypoconid and separated from the metaconid by a notch. The metalophid fails to join the metaconid. Enamel on the talonid basin is not rugged.

Discussion: The specimens described are colored yellowish red and show no sign of wear by water, differing from those of *Sciurotamias wangi*. They are probably from an upper level.

These specimens exhibit a suite of characters that are highly diagnostic for the genus *Sciurotamias*. They cannot be referred to *S. wangi* from the same fissure, not only because of their slightly smaller size with less heavy cusps and crests and the distinctly lingually constricted metaloph on M1 and M2, but also due to the different color of the specimens.

Rather, they fit the diagnosis of *S. teilhardi* Zheng, 1993 in size, by the presence of distinctly lingually constricted metaloph and small mesostyle, the lack of protoconule and developed metaconule on M1 and M2, and the complete incorporation of the entoconid in an elevated posterolophid and the curved entoconid corner on m1 and m2. Minor differences of these teeth from the original specimens (see Zheng, 1993) are the more complete metalophid, the indistinct mesoconid, and less deep notch between the metaconid and the posterolingual crest on m1 and m2. The differences mentioned, however, are of variable characters in the type material. Thus, these specimens are temporarily referred to *S. teilhardi*.

Ratufini Moore, 1959

***Pseudoratufa* gen. nov.**

Type species: *Pseudoratufa wanensis* sp. nov.

Etymology: From Greek *pseud*, "false," alluding to the difference of the new genus from *Ratufa*, a living ratufin genus.

Diagnosis: Relatively large-sized squirrels with heavily built and unilaterally hypsodont cheek teeth. P4-M2 with perfectly rounded corners; P4 relatively small, without anterostyle; M1/2 with distinctly anteroposteriorly elongated protocone, strong, lingually constricted and approximately parallel arrangement of protoloph and metaloph bearing no protoconule and metaconule, pronounced protolophule, and anteroloph and posteroloph incorporated in the protocone lingually and joining the paracone and metacone buccally to circle the occlusal surface. The p4 is small, without anteroconid, with entoconid incorporated in the posterolingual crest to circle the talonid basin together with the protoconid, hypoconid, metaconid, and the ectolophid. Short and thick secondary crests

from the protoloph and metaloph are well developed on the central valley in M1 and M2.

Differential diagnosis: The dental pattern of *Pseudoratufa* is similar to that of *Ratufa* in large size, in P4-M2 having relatively low cusps and crests, crest-like protocone, approximately parallel arrangement of protoloph and metaloph, in M1 and M2 having perfectly rounded corners, conspicuous protolophule, well-developed secondary crests on the central valley, and strong crest formed by the anteroloph, posteroloph, protocone, paracone, and metacone encircling the occlusal surface. The main differences between *Pseudoratufa* and *Ratufa* are: (1) the cheek teeth are distinctly unilaterally hypsodont in *Pseudoratufa*; (2) the cusps and crests are relatively higher in *Pseudoratufa* than in *Ratufa*; (3) the P4 and p4 are markedly smaller relative to M1 in *Pseudoratufa* than in *Ratufa*; (4) the P4 lacks parastyle in *Pseudoratufa*, but an anteriorly expanded parastyle exists in *Ratufa*; (5) the protoloph and metaloph are complete in *Pseudoratufa* but strongly constricted lingually or unconnected with the protocone in *Ratufa*; (6) the anteroloph and posteroloph in M1/2 are distinctly weaker and lower than the protoloph and metaloph in *Pseudoratufa*, but they are almost equal to the protoloph and metaloph in both thickness and height in *Ratufa*.

***Pseudoratufa wanensis* sp. nov. (Fig. 8 [Figure 8: see original paper])**
Etymology: *Wan*, the abbreviation for Anhui Province in Chinese. Named after Anhui, where this new species was found.

Holotype: Left M1/2 (IVPP V 20853).

Paratypes: Five cheek teeth (1 P4, 3 M1/2s, 1 p4), V 20854.1–5.

Measurements (length × width, in mm): P4, 1.70 × 2.20; M1/2, 2.40 × 3.25, 2.45 × 3.15, 3.10 × 3.75, 2.45 × ; p4, 2.05 × 1.80.

Diagnosis: Same as for the genus.

Description: The cheek teeth are heavily built and unilaterally hypsodont, with the lingual crown height distinctly higher than that of the buccal side on the P4 and M1/2. Their occlusal surfaces are subrounded in outline. The P4 is rather small relative to the molars. A parastyle is absent. The protocone is high and pronounced. The paracone is distinctly larger than the metacone. The protoloph and the metaloph are strong and high, nearly parallel in arrangement but slightly converged toward the protocone lingually. The anteroloph and the posteroloph are complete but distinctly lower and weaker than the protoloph and the metaloph. There is no sign of protoconule and metaconule. A distinct mesostyle is also absent. The secondary crests in the central valley are undeveloped, except for a spur from the middle part of the metaloph.

The M1/2 has conspicuous cusps, relatively low crests, and perfectly rounded corners. The protocone is crest-like and anteroposteriorly elongated. The paracone is distinctly larger and higher than the metacone. The protoloph and

metaloph are strong but constricted just buccal of the protocone, with the protoloph interrupted at the middle part. They are approximately parallel and connect with the protocone. There is no protoconule and metaconule. A distinct mesostyle is also absent. The protolophule is pronounced, extending buccally to one third of the central valley. There is a low connection between the paracone and the metacone. The anteroloph and the posteroloph are complete but lower and weaker than the protoloph and metaloph. Both are incorporated in the elongated protocone lingually and connected with the paracone and metacone buccally to circle the occlusal surface. Enamel on the central valley is crenulated; several short and thick secondary crests from the protocone and metacone are developed as well as the protolophule and the mesostyle crest.

The p4 is subquadrate and narrower anteriorly than posteriorly. The protoconid and the metaconid are nearly equal in size. They are situated closely and separated by a very narrow and shallow valley. An anteroconid is absent. The hypoconid is prominent and extends posterobuccally. The entoconid is incorporated in the posterolingual crest connected with the metaconid and the hypoconid. The entoconid corner is curved. A mesoconid and a mesostylid are lacking. The ectolophid is thick, connecting the protoconid and the hypoconid. It joins the posterolingual crest via the protoconid and the hypoconid to circle the talonid basin. The buccal valley is wide and shallow.

Discussion: The squirrel represented by the specimens is characterized by its large size with heavily built cheek teeth, relatively low cusps and crests, anteroposteriorly elongated protocone, and approximately parallel arrangement of the protoloph and the metaloph bearing no protoconule and metaconule on P4-M2. Characters of these teeth clearly demonstrate that it is a tree squirrel. By a combination of features, this squirrel is easily distinguished from known sciurines, such as *Sciurus*, *Oriensciurus*, *Tamiops*, *Shuanggouia*, *Atlantoxerus*, *Tamias*, *Plesiosciurus*, *Sinotamias*, *Prospermophilus*, and *Palaeosciurus*, etc. These features are the unilaterally hypsodont cheek teeth; the distinctly smaller P4 and p4 relative to the molars; the perfectly rounded corners of P4-M2; the crest-like protocone; the complete and nearly parallel arrangement of protoloph and metaloph; the absence of protoconule and metaconule; the presence of pronounced protolophule; the anteroloph and posteroloph incorporated in the protocone lingually and joining the paracone and metacone buccally to circle the occlusal surface in M1 and M2; the entoconid incorporated in the posterolingual crest; the prominent posterolingual crest and the ectolophid enclosing the talonid basin with the protoconid, metaconid, and hypoconid in p4; and the development of short and thick secondary crests from the protocone and the metacone on the central valley in M1 and M2. Therefore, the described specimens are designated to a new genus and species, despite the poor material available.

The similarities of the new genus to *Ratufa* in dental morphology appear to imply that the two genera have close affinities. It is rather unlikely that *Pseudoratufa* was a close descendant of *Ratufa*, or vice versa. There is a strong possibility, however, that the two genera can be included in the same tribe Ratufini.

Teeth of this taxon are colored grayish black or brown and show wear by water. They are probably from a lower level. Among the materials from the fissure, those of hominoids, *Diatomys*, and beavers also show similar color and wear characteristics. Judging by the relatively dark color of the teeth and traces of rolling, these remains are probably from similar deposits of an older stratigraphic interval that contains the same faunal association. If this assumption is correct, it would be indicative of existence of forest biotopes in this district during the earlier Miocene, because the hominoids reflect a forest habitat, which may also be true for *Diatomys* and *Pseudoratufa*. In addition, beavers often require open water.

3 Conclusion

The sciurids from the Tangkou fissure deposits are included in five genera and six species, belonging to four tribes in the subfamily Sciurinae: *Sciurus* sp. of Sciurini; *Tamias* sp. and *Plesiosciurus zhengi* of Tamiini; *Sciurotamias wangi* and *S. teilhardi* of Marmotini; and *Pseudoratufa wanensis* of Ratufini. The assemblage contains members commonly known in Chinese late Cenozoic faunas but also includes an intriguing element, *Pseudoratufa*, which may represent a newcomer to the tribe Ratufini.

The presence of these sciurids indicates a late Cenozoic age for the fissure fillings. Since the material described is from sampling throughout the four levels of the deposits, the sample is a mixed assemblage with elements representing a rather long interval probably spanning the Early Miocene to Pleistocene. For this small association of sciurids from this fissure, it is at present impossible to recognize contemporaries, and the age of these taxa is difficult to precisely assess because of the complex fissure stratigraphy, poor sampling control, and inadequate materials.

Nevertheless, judging from the morphology, traces of transportation, and coloration of fossils, *Plesiosciurus* and *Pseudoratufa* are relatively old, probably from the Early or Middle Miocene; *Sciurotamias teilhardi* is younger than *S. wangi*, which are roughly coeval with populations from Yunnan (Late Miocene) and Wushan (Early Pleistocene), respectively (Zheng, 1993; Qiu and Ni, 2006); *Sciurus* and *Tamias* may be younger than the Late Miocene.

The intriguing ratufin *Pseudoratufa* is probably in the same association as the hominoid, *Diatomys*, and beavers, inferred from the fossil color and roll traces in the materials. Their co-occurrence seems to indicate the existence of a forest biotope in the earlier Miocene.

Acknowledgements: The authors express their gratitude to Dr. X. M. Wang from the Natural History Museum of Los Angeles County, USA, and Dr. L. J. Flynn from Harvard University, USA for commenting on the manuscript and English content. Many thanks are also due to Miss H. W. Si and Mr. W. D. Zhang from IVPP for the photographs.

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