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Revision to *Kowalskia* from the Houhecun Fauna and a New Discovery of *Tscherskia* (Cricetidae, Rodentia) from the Youhe Fauna of Weinan, Shaanxi Province, China

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Abstract: The fossil hamster (an isolated m1) from the early Early Pleistocene Houhecun fauna found in Dali, Weinan, Shaanxi, China, originally identified as *Kowalskia dalinica*, is reexamined. Its unique characters, including a high crown, very small degree of division of the anteroconid and relatively large size, is taken as evidence of its attribution to the genus *Sinocricetus*, instead of *Kowalskia* (junior synonym of *Neocricetodon*) suggested by the original author. Therefore, the specific name of the species established based on this m1 should be changed to *S. dalinicus* (Wang, 1988). *S. dalinicus* probably has a relatively close affinity with *S. major Li, 2010*, but there are still some obvious differences of characters between them. The discovery of *S. dalinicus* in the Houhecun fauna confirms that the genus indeed survived into the Pleistocene. A broken hamster mandible, which was found in Weinan, Shaanxi, China and belongs to the late Pliocene Youhe fauna, is also described here and identified as *Tscherskia* sp.. This specimen represents the earliest *Tscherskia* in Asia so far, but fails to refute the hypothesis that the genus originated in Europe during the early Pliocene.

Key words: Houhecun fauna, Youhe fauna, *Sinocricetus*, *Tscherskia, Kowalskia*, *Neocricetodon*

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1 Introduction

Cricetids (*sensu stricto*, containing only the extant Cricetinae and their fossil relatives), have a relatively large number of species and a relatively high evolutionary rate, so are of general importance to the biostratigraphy of the late Cenozoic of Eurasia (Zheng, 1984a, b, 1993; Topatshevskiy and Skorika, 1992; Hír, 1996a; Qiu, 1996; Qiu et al., 2013; Qiu and Li, 2016; Sinitsa and Delinschi, 2016). Additionally, their common ability to adapt to dry and cold environments also has a certain value in reconstructing paleoenvironments. Although the cricetids found in the late Cenozoic of China have been preliminarily summarized by some researchers, such as Zheng (1984a, 1993), Qiu (1996), Qiu and Li (2016), Wu and Flynn (2017), Xie (2017), etc., there are still many issues to be resolved concerning the classification, distribution and phylogeny of this group.

Recently, during the process of sorting fossil hamster material housed in the Department of Geology of Northwest University, the present authors re-observed the hamster material (an isolated m1) from the early early Pleistocene Houhecun fauna and obtained some new information about it. Furthermore, an unpublished fragmentary hamster mandible from the late Pliocene Youhe fauna was also discovered during the course of this same sorting process. Although these materials are limited, they provide new information about zoogeography and systematics of certain late Cenozoic cricetids and deserve to be reported.

2 Geological Setting

The materials studied in this paper are from the Houhecun and Youhe faunas.

The Houhecun fauna was excavated from the exposed strata on the banks of the Luohe River near Houhecun Village (Fig. 1), which is situated in Dali County, Shaanxi Province. The fossil site is only about 1 km away from the famous Dali Man site (Wang, 1988). Wang (1988) divided the strata there into four layers, the fauna being collected from the second and third. The second layer is brown-grayish clayey siltstone and silty clay, the third yellow-brownish sandstone bearing calcareous concretions and argillaceous stripes. These two layers were deposited continuously, but they have an unconformable contact with the underlying first layer—a gray-greenish silty claystone (Wang (1988) thought that it could be correlated with the Youhe Formation) and the overlying fourth layer—the gravel bed and loess-paleosol sequences on it. More detailed geological background information can be found in Wang (1988). The age of the Houhecun fauna is generally considered to be the earliest part of the Early Pleistocene by analyzing the composition of the fauna and comparing strata in the vicinity (Wang, 1988; Xu, 1989; Ji, 1993; Deng and Xue, 1997).

The Youhe fauna, a famous Pliocene fauna in China,

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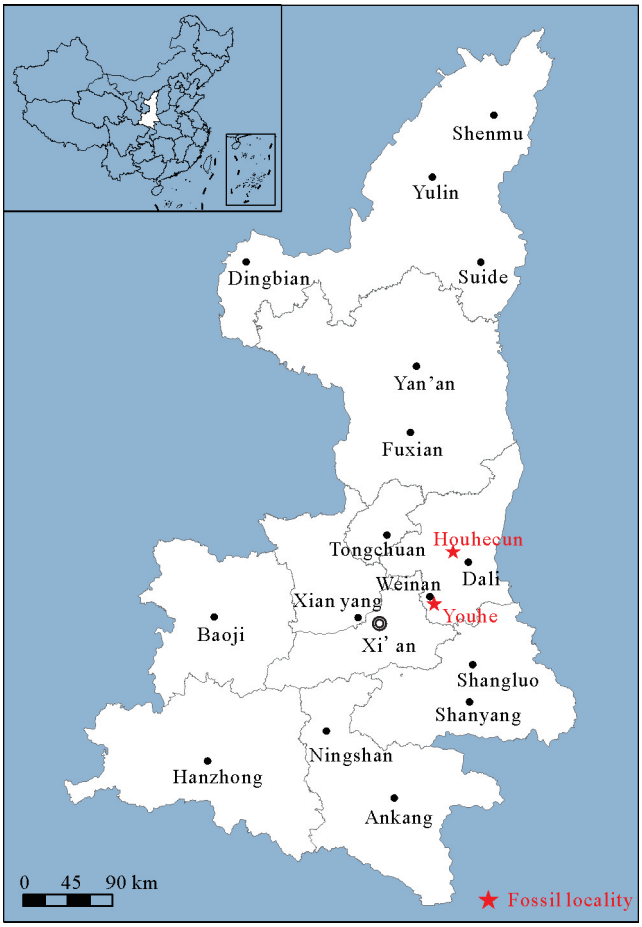

Fig. 1. Geographic location of Houhecun and Youhe (China basemap after China National Bureau of Surveying and Mapping Geographical Information).

was found in the gray-greenish lacustrine deposits of the Youhe Formation, exposed on the lower reaches of the Youhe River in Weinan City, Shaanxi Province (Xue, 1981) (Fig. 1). In terms of the age and nature of the fauna, this has been dealt with by previous researchers elsewhere (such as Xue, 1981; Li et al., 1984; Qiu et al., 1987; Ji, 1993; Deng and Hou, 2011; etc.).

3 Material, Method and Abbreviation

The holotype (NWUV 1491) of '*Kowalskia dalinica*' (=*Sinocricetus dalinicus* in this paper) and the specimen (NWUV 1490) of *Tscherskia* sp. are both housed in the Department of Geology, Northwest University (NWU), Xi'an, Shaanxi, China.

The terminology of molar morphology follows Qiu and Li (2016).

L = length, namely the maximum length of the crown of the molar; Wa = Anterior Width, namely the maximum width between the protoconid and the metaconid; Wp = Posterior Width, namely the maximum width between the hypoconid and the entoconid; CH = Crown Height. NWUV is the prefix of catalogue numbers of vertebrate fossil specimens housed in the Department of Geology, Northwest University.

4 Systematic Palaeontology

4.1 Revision of the fossil hamster from the Houhecun fauna

Class Mammalia Linnaeus, 1758
Order Rodentia Bowdich, 1821
Family Cricetidae Rochebrune, 1883
Subfamily Cricetinae Fisher de Waldheim, 1817
Genus *Sinocricetus* Schaub, 1930

Type species: *Sinocricetus zdanskyi* Schaub, 1930

Referred species: *S. dalinicus* (Wang, 1988); *S. progressus* Qiu et Storch, 2000; *S. major* Li, 2010

Diagnosis: Cricetine with *Cricetulus*-like mandible. In comparison with *Nannocricetus* and *Kowalskia*, the molars have higher crowns and are more robust with deeper sinuses/sinusoids. Anterocone of M1 deeply and widely bifid posteriorly, with buccal cusp always connected to normally well-developed buccal spur of anterolophule or in some cases to the anterolophule. Mesoloph high and strong with variable length. Metaloph II still present in some M1 and M2. Anteroconid of m1 bifid posteriorly. In lower molars hypolophid connected with posterior arm of protoconid in a diagonal line, meeting mesolophid (when present) obliquely. Metalophid directed obliquely forward. Mesolophid frequently present on m1 and m2 (after Qiu and Li, 2016).

Distribution: the Late Miocene to the early Early Pleistocene in northern China.

Sinocricetus dalinicus (Wang, 1988)

1988 *Kowalskia dalinica* sp. nov., Wang, p. 62, pl. I, fig. 6

Holotype: NWUV 1491 (former catalogue number 83 DL 015), a left m1; Houhecun Village, Dali County, Shaanxi Province, China (Wang, 1988, pl. I, fig. 6).

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 (after Li, 2010).

Distribution: Houhecun Village, Dali County, Shaanxi Province, China, early Early Pleistocene.

Measurements: See Table 1. We remeasured the

Table 1 Measurements (mm) of m1 of *Sinocricetus dalinicus* from Houhecun and Gaotege

Locality	Specimen no.	L	W	CH	Data sources
Houhecun	NWUV 1491	2.84	1.38(Wa),1.47(Wp)	>2.02[a]	Present paper
		2.50	1.30	1.76	Wang, 1988
Gaotege	V 17023. 3	2.80	1.60		Li, 2010
	V 17025. 2	2.60	1.55	1.35[b]	

Note: a. The crown height is at least 2.02 mm, because the base of the crown of the specimen is missing; b. kindly provided by the reviewer.

specimen since the measurements given by the original author (Wang, 1988) were inaccurate.

Description: Among the fossils from Houhecun Village, only one left m1 (NWUV 1491, former catalogue number 83 DL 015) belongs to the cricetids (Wang, 1988), which represents a very young individual, judging from the degree of abrasion of the molar. Save for the specific measurements used, Wang (1988) has already made an accurate and detailed description of the specimen. To facilitate a better discussion, a much clearer picture of the specimen than the original is provided here (Fig. 2).

Comparison and discussion: Wang (1988) erected the new species '*Kowalskia dalinica*' based on this left m1. According to the description and plate of this specimen offered by Wang (1988), Qiu and Li (2016) considered that the main characters of the species—"m1 of high crown; the anteroconid of m1 clearly deeply divided anteriorly"—did not conform to the diagnosis of the genus *Kowalskia* (note: considered as a junior synonym of *Neocricetodon* in the present paper). As such, they recommended that it should be excluded from *Kowalskia*, although they did not make recommendations for reclassification of the species. After observing the tooth, we agree with Qiu and Li's opinion and consider that this specimen indeed should not be referred to *Kowalskia*, but for slightly different reasons to theirs. On this specimen, "m1 of high crown" is obviously real and, according to the diagnosis of *Kowalskia* summed up by Qiu and Li (2016), the species within *Kowalskia* do not have this character. However, perhaps due to the wrong impression caused by the original unclear plate, the description of "the anteroconid of m1 clearly deeply divided anteriorly" is inaccurate. The degree of separation of the anteroconid on this m1 is actually very small (Fig. 2c), but due to the presence of an obvious groove in front of it, the phenomenon that the anteroconid splits into two little cusps is still clear. In fact, another powerful proof that proves this tooth does not belong to *Kowalskia* is its size (Table 1). The tooth measurements offered by the original author were 2.50 mm long, 1.30 mm wide, and 1.76 mm high. After remeasurement, the length, anterior width and posterior width of the tooth are 2.84 mm, 1.38 mm and 1.47 mm respectively; the height of the crown is at least 2.02 mm, because the base of the crown is missing. Thus the length of this m1 is much longer than that of all species (nearly 20) in *Kowalskia* (cf. Qiu and Li, 2016, fig. 183, p. 343). At present, the largest species of *Kowalskia* is *K.* sp. from the Renzidong site, Fanchang County, Anhui Province, China (Jin et al., 2009), of which only two m1s have been found, with theirs sizes being 2.4 × 1.5 mm and 2.5 × 1.5 mm, respectively. Although the m1 from Houhecun is slightly shorter than the two teeth from Renzidong in width, it is significantly longer than them in length.

To sum up, this m1 can certainly be excluded from *Kowalskia* (=*Neocricetodon*), but what should its true taxonomic position be? Our comparison showed that the m1 from Houhecun is clearly similar to *Sinocricetus major* Li, 2010 in many respects. First, in terms of size, in Cricetinae only *S. major* is comparable to this m1 in size (Fig. 3), all other species in Cricetinae (except the species of *Cricetus*) being distinctly smaller than this m1 in size, while the species of *Cricetus* (e.g., lengths of m1 of *Cricetus cricetus*: 2.96–3.50, after Pradel, 1981a, p. 298, tab. I A; or 2.73–3.25, after Hír, 1997, p. 70, tab. VI) are generally clearly larger than it in size. Second, in terms of molar morphology, some characters of this m1, such as comparatively high crown, mesolophid anterolingually directed, anteroconid bifid slightly anteriorly, are also in line with those of *Sinocricetus major* (Li, 2010). So it is very likely that this tooth should be referred to *Sinocricetus* (so its Latin name should be changed to *S. dalinicus*), probably with a relatively close affinity to *S. major*. Meanwhile, this m1 also has some obvious differences in certain aspects with m1s of *S. major* previously reported. Only two isolated m1s of *S. major* have been reported, which are from the early Pliocene (about 4.2 Ma) Gaotege site in central Inner Mongolia, China (Li, 2010). Compared with them, the Houhecun material clearly has a much higher crown (Table 1); the

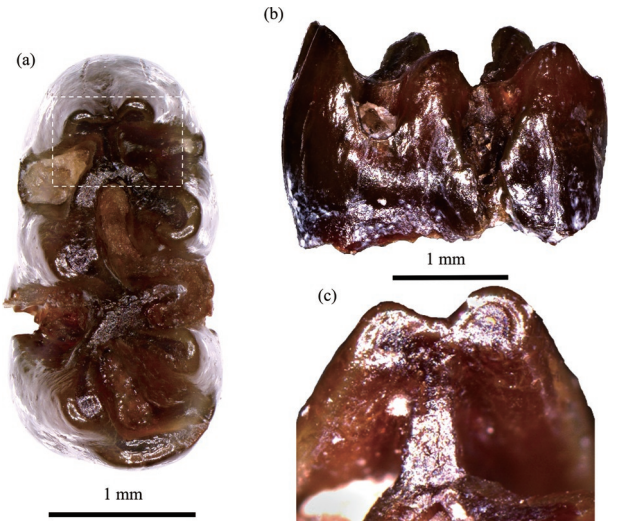

Fig. 2. m1 (NWUV 1491, holotype) of *Sinocricetus dalinicus* from Houhecun Village, Dali County.
(a) Occlusal view (The dashed box indicates the range of (c)); (b) buccal view; (c) a close-up of anteroconids and anterolophid (The scale is not shown).

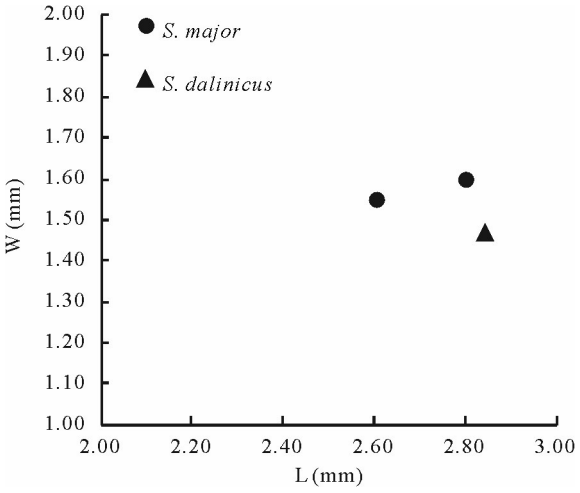

Fig. 3. Scatter diagram of length and width of m1s of *S. dalinicus* and *S. major*.

length-width ratio of the Houhecun material is larger than that of the two m1s from Gaotege, the former being more slender (Fig. 3); on Houhecun material the position of lophids (especially anterolophid) relative to sinusids is also obviously higher than that of the m1s from Gaotege. These differences seem to imply that the material from Houhecun possesses more derived characters in comparison with *S. major* from Gaotege.

The confirmation of *S. dalinicus* presence in the Houhecun fauna provides more reliable evidence for *Sinocricetus* survival into the Quaternary, the previous evidence being considered uncertain (Qiu and Li, 2016). However, due to the scarcity of the material of *S. dalinicus*, the aforementioned views need to be verified by more material found in the future.

4.2 The new discovery of the fossil hamster from the Youhe fauna

The specimen to be described below was collected by the second author of the present paper and Mr. Wang Hong in 1982 from the same stratum as the Youhe fauna (even if not at the same locality) and was previously unpublished.

Genus *Tscherskia* Ognev, 1914

1928 *Cricetinus* gen. nov., Zdansky, p. 54, taf. V, figs. 4–11

Type species: *Tscherskia triton* (de Winton, 1899)

Referred species: *T. europaeus* (=*Cricetinus europaeus* Kretzoi, 1959); *T. rusa* (Storch, 1974); *T. gritzai* (=*C. gritzai* Topachevski et Skorik, 1992); *T. beremendensis* (=*C. beremendensis* Hír, 1994); *T. janossyi* (=*C. janossyi* Hír, 1996); *T. koufosi* (=*C. koufosi* Koliadimou, 1996).

Diagnosis: medium-sized cricetids with a size usually between *Cricetulus* and *Cricetus*; brachyodont molars; mesolophes of M1-3 usually present, either free or connected to the metacone, but rarely reach the buccal tooth edge; protolophule II (axioloph) of M3 usually has a sagittal rather than an anterior-inward extension direction; anteroconid of m1 divided or undivided; mesolophid of m3 almost always well-developed; the mesolophid may be also present on m1 and m2, but rarely reaches the lingual tooth edge (modified from Xie, 2017) .

Remarks: The genus *Cricetinus* and its type species *C. varians* were erected by Zdansky (1928) based on the large-sized fossil hamster materials from middle Pleistocene Locality 1 of Zhoukoudian (Chou-K'ou-Tien), Beijing, but their authenticity has long been in dispute. Zheng (1984) proposed several different characters of the skull between *C. varians* from Zhoukoudian and recent *T. triton*, e.g., the length of the incisive foramen of the former (6.8–8.5 mm) is slightly larger than that of the later (5.4–8.0 mm), but the measurements of these characters of the two species given by Zheng (1984) all largely overlap, although the former is always slightly larger than the latter. These differences are so subtle that we cannot rule out that these differences may be caused by intraspecies variation, such as individual age variation. In fact, the last two differences, i.e. *C. varians* having relatively well-developed temporal ridges and a particularly straight and not convex cross-section of the dorsal profile (which was considered by Zheng as the most important difference between them), are exactly the characteristics of the old-aged individual of the recent *T. triton*. Moreover, we also suspect that most of the above differences are probably caused by fossil deformation. Circumstantial evidence is that the sum of the mean lengths of three single upper molars (LM1 + LM2 + LM3 = 2.32 mm + 1.80 mm + 1.44 mm = 5.56 mm) of *C. varians* from Zhoukoudian is even smaller than the mean toothrow length (LM1-3 = 5.60 mm) (Zheng, 1984, p. 187, tab. 4). However, "as far as hamsters are concerned, the sum of the lengths of particular teeth is always greater than the length of the tooth-row made up of these teeth. This is due to the overlap of successive teeth." (Pradel, 1981b, p. 287). In living *T. triton*, *Cricetulus longicaudatus* (long-tailed dwarf hamster) and *Cricetulus barabensis* (striped dwarf hamster), for instance, the means of the above two measurements are 5.57 mm vs. 5.36 mm (N > 41), 3.93 mm vs. 3.73 mm (N > 25), 3.80 mm vs. 3.59 mm (N = 10) respectively (Xie, 2017, pp. 26–27, tab. 2–2; p. 41, tab. 2–9; p. 45, tab. 2–11), the sums of the lengths of particular teeth are all obviously greater than the lengths of the toothrows in three species. The most likely explanation for this unusual phenomenon of *C. varians* from Zhoukoudian is that the skulls (at least the toothrows) of the species had undergone deformation, which caused the distance between adjacent molars to increase. Indeed, since the thickness of the skulls of small rodents is generally very thin, their skulls are easily deformed after burial. For example, we observed all 21 skulls of *T. triton* collected from the late middle Pleistocene Locality 2 of Shanyangzhai in Hebei Province, China, which is also a cave or fissure deposit like the fossil localities in Zhoukoudian, finding that all of them had undergone a relatively large degree of deformation caused by extrusion, which generally make the measurements of the skulls slightly larger. So the differences in the skull between *C. varians* and *T. triton* proposed by Zheng (1984) are very dubious and need further verification. Xie (2017) considered that *Cricetinus* and *C. varians* are junior synonyms of *Tscherskia* and *T. triton* respectively, by comparing characters of their molars, suggesting that all the species referred to *Cricetinus* previously should theoretically be placed in *Tscherskia*.

Tscherskia sp.

Material: A fragmentary right mandible with m2–3 (NWUV 1490); lower reaches of the Youhe River, Weinan City, Shaanxi Province, China.

Distribution: Youhe Formation, Weinan City, Shaanxi Province, China, late Pliocene.

Measurements: See Table 2.

Description: The body of the mandible is too broken to show any special features.

The molar crown is low (Fig. 4). The occlusal outline of m2 is basically rectangular, with the lingual anterolophid very weak (possibly partly due to abrasion) and the buccal one relatively well-developed. The mesolophid is quite high, anterior-inwardly connecting to the metaconid. The

Table 2 Measurements (mm) of molars of *Tscherskia* sp. from Youhe Formation

	L	Wa	Wp	CH
m2	1.89	1.46	1.40	0.99
m3	1.90	1.43	1.25	0.90
m2–m3	3.80			

Fig. 4. Molars (NWUV 1490) of *Tscherskia* sp. from the Youhe river, Weinan.

posterolophid encloses the posterosinusid. The tooth has two roots.

The occlusal outline of m3 roughly approximates a triangle. The m3 is almost as long as m2. The anterolophid is similar to that of m2. The mesolophid does not bifurcate at the end and laterally connects to the lingual tooth edge. In the sinusid there is a short and low ridge (not the ectomesolophid) extending from the anterior wall of the hypoconid to the buccal tooth edge. In the same position of m2, the trace of a similar ridge is also present. The entoconid is somewhat vestigial, but the degree of contraction of the posterior part of the crown is very small. The posterosinusid is enclosed by the well-developed posterolophid. The tooth has two roots.

Comparison and discussion: The overall characters of the specimen, such as the lack of mesoconid, ectomesolophid and stylid, as well as its comparatively late geological age, show that it should clearly be referred to Cricetinae. To date, as many as 13 valid genera within Cricetinae have been found in China, spanning from the late Miocene to the present. They are *Neocricetodon* (=*Kowalskia*), *Amblycricetus*, *Nannocricetus*, *Aepyocricetus*, *Allocricetus*, *Bahomys*, *Sinocricetus*, *Colloides*, *Tscherskia*, *Cricetulus*, *Allocricetulus*, *Cricetus* and *Phodopus* (Qiu and Li, 2016; Xie, 2017; Li et al., 2017). Unlike *Neocricetodon* and *Amblycricetus*, whose mesolophid of lower molars usually extends to the tooth edge, the mesolophid of the m2 of the specimen from Youhe does not reach the tooth edge. It is also different from *Allocricetus*, which often lacks the mesolophid on m1 and m2. The tooth crown of the fossil is low, unlike *Bahomys*, *Sinocricetus*, *Colloides* and *Aepyocricetus* which have a comparatively higher crown. The sizes of the molars of the Youhe specimen are obviously smaller than those of *Cricetus*, but significantly larger than those of the small-sized *Nannocricetus*, *Cricetulus*, *Allocricetulus* and *Phodopus*. Yet the characters described above for the specimen precisely coincide with the diagnosis of the genus *Tscherskia* proposed by Xie (2017), so this material should be referred to this genus.

However, due to the lack of the key m1 and M1 on the specimen from Youhe, as well as the m2 and m3 of the species in Cricetinae being evolutionarily conservative, it is very difficult to further identify the specimen from Youhe to species level and determine its relationship to other species in *Tscherskia*, based on what is currently very limited material, so it is necessary to temporarily identify it as *Tscherskia* sp.. Even so, because of its discovery in the upper Pliocene of China, the specimen is still of special significance. Xie (2017) considered that there were 7 species in *Tscherskia*, namely *T. europaea*, *T. gritzai*, *T. beremendensis*, *T. janossyi*, *T. koufosi*, *T. mesolophidos* (=*T. mesolophidus*) and *T. triton*. The former 5 species were mainly found in the Pliocene of southeastern Europe and the later 2 species in the Pliocene (*T. mesolophidos*) and the Pleistocene (*T. triton*) of China. In addition, Storch (1974) described a species *T. rusa* from the Holocene (dated between 2200–700 B.C.) of northern Iran, which has a confusing geographic location and geological age. Xie (2017) also stated that this was an interim opinion, because the *Cricetinus mesolophidos* was not formally published at that point. *C. mesolophidos* was formally published in 2017, based on the material collected from the Yushe Basin, Shanxi Province, China, with a stratigraphic range in the Yushe Basin of about 4.7–3.3 Ma (Wu and Flynn, 2017). But this specific name has been quoted years prior to its formally publication (such as Zheng and Zhang, 2000, 2001, the specific name quoted then was *C. mesolophidus*, which was a *nomen nudum*). Xie (2017) considered that *Cricetinus* was the junior synonym of *Tscherskia* and suggested all the species in *Cricetinus*, including *C. mesolophidus* (*nomen nudum*), should be theoretically transferred to *Tscherskia*. Based on the detailed description of *C. mesolophidos* given by Wu and Flynn (2017), we can now further discuss the taxonomic position of the species. Although the species has some characters of *Tscherskia* (=*Cricetinus*), such as M1 rarely developing the spur of the anterolophule, the mesolophs on M1–3 connecting to the metacone, its most important and obvious character—all m1–3 possessing a mesolophid which reaches the tooth margin—precisely coincides with the diagnosis of *Neocricetodon* (=*Kowalskia*) summarized by Qiu and Li (2016) and is very different from all other species in *Tscherskia*. The characters of *C. mesolophidos* seem to indicate that it has a transitional morphology between *Neocricetodon* and *Tscherskia*, but the primitive characters are in a more dominant position. Therefore, we consider that it may be more reasonable to place *C. mesolophidos* in *Neocricetodon*, namely as *N. mesolophidos*, whose survival time (4.7–3.3 Ma) directly follows the survival time (6.3–4.7 Ma) of the type species *N. grangeri* of the genus in the Yushe Basin (Wu and Flynn, 2017).

This means that there is only one species of *Tscherskia* recorded in China (or even in Asia as a whole), namely *T. triton*, which was found in the Pleistocene of China and is now still living in the southeastern Palaearctic. However, the discovery of the *T.* sp. from Youhe proves that *Tscherskia* has indeed appeared in China in the Pliocene, representing the earliest member of *Tscherskia* in Asia up

to now. But its geological age is still younger than the *Tscherskia* found in Europe, which in Europe first appeared at about 4 Ma at the Csartòna 2 of Hungary (Hír, 1994). In terms of the diversity of the species of *Tscherskia*, Europe is also significantly higher than Asia. Thus the hypothesis proposed by Xie (2017) that *Tscherskia* originated in Europe during the Early Pliocene and then spread to Asia, is still valid. As for the true nature of the fossil hamster from Youhe, such as the systematic relationship between it and the five extinct species of *Tscherskia* in Europe and the recent *T. triton* in Asia, we can only wait for the discovery of more material.

Additionally, among the originally published fossils of the Youhe fauna, there is a maxillary (or skull) with M1–3, belonging to the cricetids (Xue, 1981, p. 35, 40, pl. II, fig. 7). Xue (1981) identified this specimen as "*Cricetulus* sp." in the faunal list, but in the ensuing text it was identified as "*Cricetinus* sp.". Except for its measurements, the original author did not offer a description of the specimen, the figure not being clear either. Zheng et al. (1985) referred this specimen to *Kowalskia yananica* Zheng, Yuan, Gao et Sun, 1985, which was established by them based on the fossil found in the upper part of the Wucheng loess, but they did not explain their reasons. Deng and Hou (2011) revised it to *Kowalskia* sp., but also did not explain their reasons. Regrettably, this specimen could not be located during this work. As things stand, we suggest that, without actually seeing the specimen, it is not appropriate to speculate too much about its species-level classification. But, according to its measurements (M1 2.5 × 1.6 mm, M2 1.7 × 1.6 mm, M2 1.5 × 1.4 mm), it is certain that the specimen should not be referred to the small-sized *Cricetulus*; it is more likely to be allocatable to either *Tscherskia* or *Neocricetodon*, which have similar sizes to this specimen.

5 Conclusions

(1) A re-study of a m1 from the Houhecun fauna, which was referred to *Kowalskia dalinica* by Wang (1988), showed that according to its special characters it should be referred to the genus *Sinocricetus* and the specific name should be changed to *S. dalinicus*. This species probably has a relatively close affinity with *S. major*, but there are still some obvious differences of characters between them. The discovery of *S. dalinicus* in the Houhecun fauna broadens the geographical distribution of the genus and confirms that the genus indeed survived into the Pleistocene.

(2) The *Tscherskia* sp. from the late Pliocene Youhe fauna described in this paper represents the earliest *Tscherskia* in Asia, but its geological age is still younger than the *Tscherskia* found in Europe, so the assumption that the genus originated in Europe during the early Pliocene and then spread to Asia is still valid. *Cricetinus* (=*Tscherskia*) *mesolophidos* from the Pliocene of the Yushe Basin should be placed within *Neocricetodon*, according to its characters.

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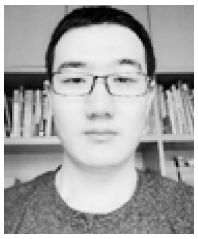

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