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New remains of *Sinomastodon yangziensis* (Proboscidea, Gomphotheriidae) from Sanhe karst Cave, with discussion on the evolution of Pleistocene *Sinomastodon* in South China

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ABSTRACT

As a valid genus belonging to the family Gomphotheriidae, *Sinomastodon* is the unique brevirostrine trilophodont gomphotheriid known from the Old World and was primarily indigenous to China from the Early Pliocene to the Pleistocene. The new bunodont molars from the Sanhe karst Cave in Chongzuo, Guangxi Zhuang Autonomous Region (ZAR), South China have been described as *Sinomastodon yanziensis* of the middle Early Pleistocene, with associated reliable paleomagnetic dating of 1.2–1.6 Ma. This represents the southernmost distribution of *Sinomastodon* remains found in China. The diagnosis of *S. yanziensis* is revised here, the evolution of Pleistocene *Sinomastodon* in China is divided into three temporal stages, and the evolutionary trends on Early Pleistocene *Sinomastodon* molars are also summarized. *Sinomastodon* was once prevalent during the Early Pleistocene in South China and possibly became extinct at the end of the Early Pleistocene. Consequently, the Early Pleistocene fauna from South China is suggested to be named the *Gigantopithecus-Sinomastodon* fauna, to distinguish it from the typical Middle Pleistocene *Ailuropoda-Stegodon* fauna (s. s.).

1. Introduction and terminology

Gomphotheriidae is considered to be one of the most successful groups of Proboscidea. The progressive short-jawed gomphotheres that occur in the New World are represented by subfamily Cuvieroniinae, including four known genera: *Cuvieronius*, *Stegomastodon*, *Notiomastodon*, and *Haplomastodon* (Shoshani and Tassy, 2005). Correspondingly, Sinomastodontinae, including the single genus *Sinomastodon* with an elephant-like cranium and bunodont molars, is the unique brevirostrine trilophodont gomphotheriid known from the Old World (Wang et al., 2012).

Sinomastodon was erected by Tobien et al. (1986) on the basis of the Early Pliocene species *Mastodon intermedius*, discovered by Teilhard de Chardin and Trassaert (1937) in the Yushe Basin, Shanxi Province, China. To date, *Sinomastodon* was primarily restricted to China from the Early Pliocene to the Pleistocene (Chen, 1999). The Pliocene *Sinomastodon* remains (e.g., *Sinomastodon intermedius* [type species] and *Sinomastodon hanjiangensis*) have been found in the Shanxi and Shaanxi Province, North China (Tobien et al., 1986; Zong et al., 1989), in addition to sporadic occurrence in the Hengduan Mountains, Southwest China (Zong et al., 1996). Recently, a new *Sinomastodon* skull and molars from the early Early Pleistocene (2.14 Ma) Renzidong Cave in Anhui Province, East China have been described as *S. jiangnanensis* (Wang et al., 2012). Additionally, other isolated *Sinomastodon* teeth discovered in Pleistocene karst cave and fissure deposits in South China have been identified as *Sinomastodon yangziensis* (Chen, 1999), coexisting with the large hominoid, *Gigantopithecus blacki*.

In 2008, a research team co-organized by Chinese Academy of Sciences and Peking University carried out paleontological investigations in Chongzuo, Guangxi ZAR, South China and discovered the new strata with *G. blacki* in Sanhe karst Cave on Wuming Mountain (Fig. 1A). After systematic excavation, more than 30 large mammalian species were recovered, including *G. blacki*, *Pongo* sp., *Procynocephalus* sp., *Ailuropoda wulingshanensis*, *Dicoryphochoerus ultimus*, *Cervavitus fenqii*, and *Stegodon preorientalias* (Jin et al., 2009a). In addition, more than 50 small mammalian species were collected by screen-washing, including *Nesolagus sinensis*, *Hystrix magna*, *Typhlomys cinereus*, *Niviventer preconfucianus*, *Leopoldamys*

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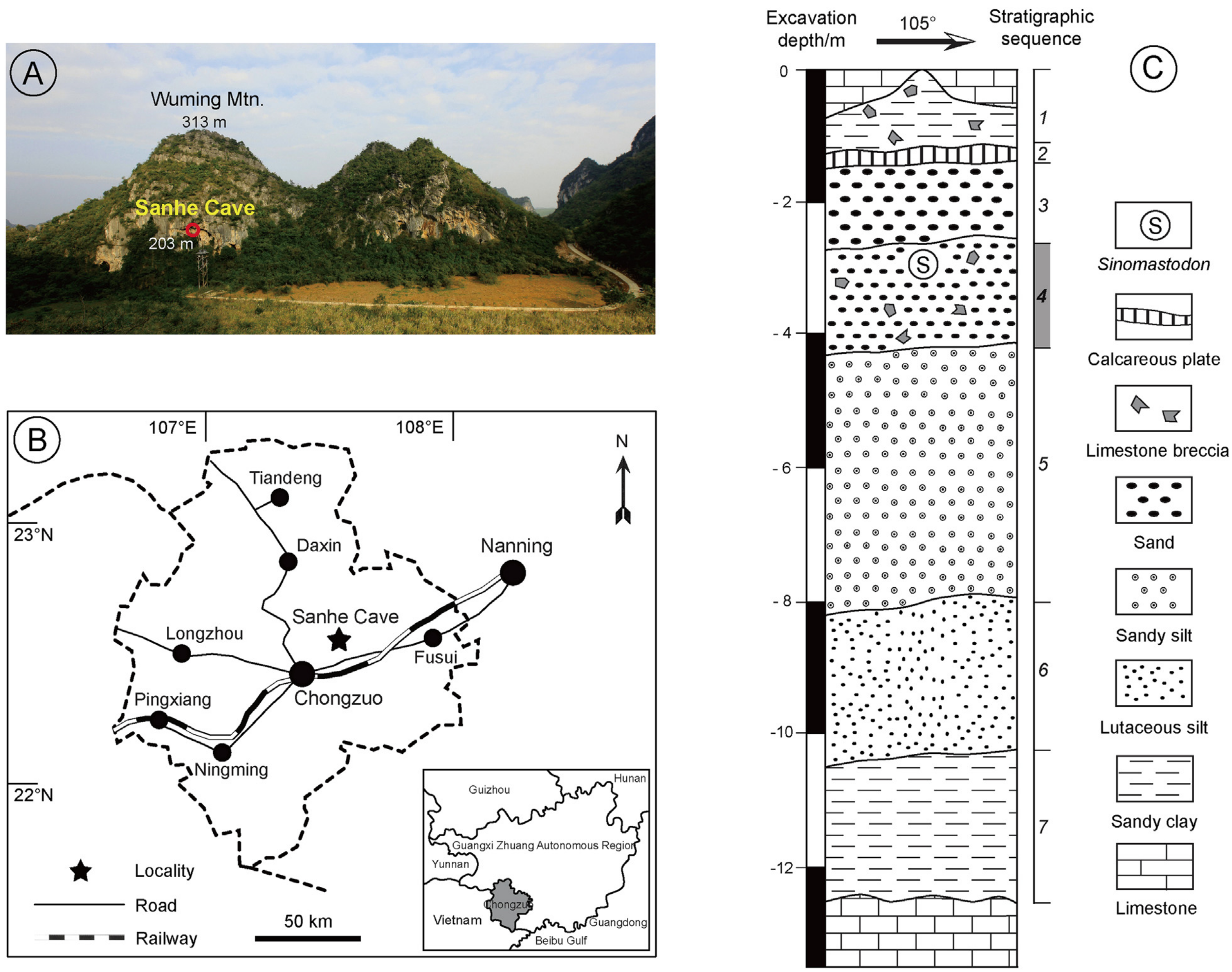

Fig. 1. Maps showing geomorphological landscape (A), geographical location (B) and stratigraphic sequence (C) of Sanhe karst Cave.

edwardsioides, and *Hapalomys gracilis* (Jin et al., 2008a, 2010; Wang et al., 2009). Two complete *Sinomastodon* molars were recovered in the limestone karst cave.

Sanhe Cave (22°16.493′N, 107°30.663′E) is located in Chongzuo Ecological Park, about 16 km northeast of Chongzuo urban district (Figs. 1B and 4, Locality 6). The landscape of Chongzuo Ecological Park and its adjacent areas are characterized by a spectacular morphology of karst peaks developed under a northern tropical climate. Sanhe Cave, which penetrates to the Permian limestone, is the largest tubular karst cave in this area. With the entrance 203 m asl, Sanhe Cave lies in the fifth horizon of the Chongzuo karst cave system, which corresponds with the *Gigantopithecus*-bearing Early Pleistocene sediments (Jin et al., 2009a, 2009b).

The deposits in Sanhe Cave can be divided into seven layers from the top to bottom with a thickness of approximately 12 m (Jin et al., 2009a). The *Sinomastodon* molars were recovered from the 4th layer composed of brown-yellow sand with tiny calcareous breccia (Fig. 1C).

Based on the faunal and paleomagnetic correlation, the geological age of Sanhe Cave is estimated to be middle Early Pleistocene, corresponding to approximately 1.2–1.6 Ma (Jin et al., 2008a, 2009a). In this paper, the Plio-Pleistocene boundary is determined at ca. 2.58 Ma (Gibbard et al., 2010). The discovery of the Sanhe Cave *Sinomastodon* is significant for understanding the systematic and evolutionary history of the genus in East Asia from the Quaternary because they represent the southernmost *Sinomastodon* remains with advanced molar features found so far in China. The terminology used here for occlusal structures of the *Sinomastodon* m3 is modified from Tassy (1996) (Fig. 2).

2. Institutional abbreviations

AMNH: American Museum of Natural History, New York;
CV: Chongqing Natural Museum, Chongqing;
F: Museum of Guangxi Zhuang Autonomous Region, Nanning;
HUM: Heritage Management Committee of Hubei Province, Wuhan;
IVPP, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing;
PUM, Paleontological Museum, Uppsala.

3. Systematic paleontology

Class Mammalia Linnaeus, 1758
Order Proboscidea Illiger, 1811
Family Gomphotheriidae Hay, 1922
Genus *Sinomastodon* Tobien et al., 1986
S. yangziensis (Chow, 1959)
Synonyms
1959. *Trilophodon yangziensis* Chow, p. 257, pl. 1
1959. *Trilophodon guangxiensis* Chow, p. 257, pl. 2
1965. *Trilophodon wufengensis* Pei, p. 213, pl. 1
1974. *Trilophodon serridenstoides* (Pei) – Xu et al., p. 301, pl. 2

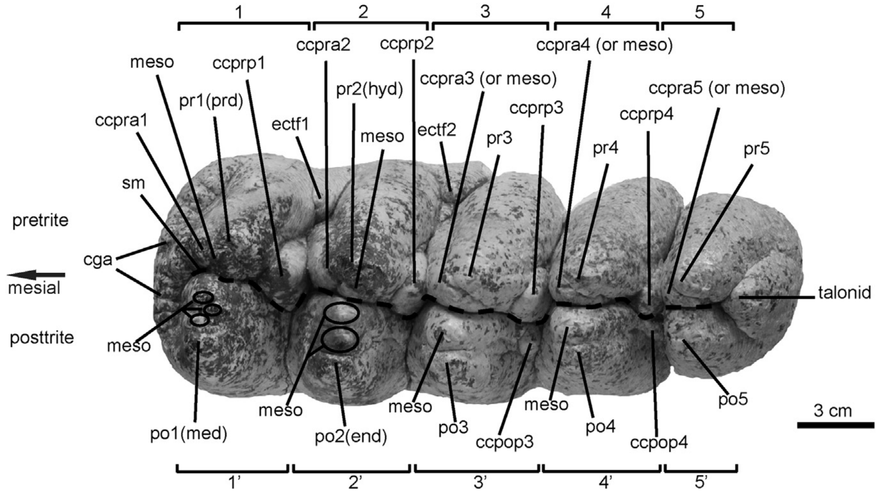

Fig. 2. The schematic representation of m3 occlusal morphology of *Sinomastodon* (*S. jiangnanensis*, IVPP 14011.03). Abbreviations: 1–5, pretrite halves of the 1st, 2nd, 3rd, 4th and 5th lophids; 1′-5′, posttrite halves of the 1st, 2nd, 3rd, 4th and 5th lophids; ccpoa, anterior posttrite central conule of each lophid; ccpop, posterior posttrite central conule of each lophid; ccpra, anterior pretrite central conule of each lophid; ccprp, posterior pretrite central conule of each lophid; cga, anterior cingulum; ectf, ectoflexus of each interlophids; meso, mesoconelet of each half-lophid; po, main cusp of posttrite of each lophid; po1 (med), metaconid; po2 (end), entoconid; pr, main cusp of pretrite of each lophis; pr1 (prd), protoconid; pr2 (hyd), hypoconid; sm, median sulcus.

1975. *Trilophodon serridenstoides* (Pei) – Han et al., p. 251, pl. 1
1980. *Tetralophodon wumingensis* Zhao, p. 299, pl. 1, Fig. 1
1982. *Trilophodon serridenstoides* (Pei) – Wang et al., p. 356, pl. 3
1987. *Trilophodon serridenstoides* Pei, pp. 69–73, pl. 7–9
1987. *Trilophodon liuchengensis* Pei, pp. 67–69, pl. 7
2004. *Sinomastodon* sp. – Zheng, p. 181, Fig. 5.39
2009. *Sinomastodon* sp. – Wang et al., p.232, Fig. 3

3.1. Holotype

One left M3 from Wushan, Chongqing, South China (IVPP 2399).

3.2. New fossil materials

Two well-preserved right m3 (IVPP, 18220.01, 02, Fig. 3, Table 1) and four molar fragments (IVPP, 18220.03-06).

Table 1
Measurements of m3 of *S. yangziensis* from Sanhe Cave (in mm).

No.		L[a]	W[b]	H[c]	W1[d]	W2	W3	W4	W5	W6
IVPP 18220.01	m3	185	65.6	50.4	58.1	65.6	63.8	61.3	54.5	45.3
IVPP 18220.02	m3	189	62.3	57.2	61.8	62.3	61.5	58.8	54.7	41.1

[a] L, length of the crown.
[b] W, width of the crown.
[c] H, height of the crown.
[d] W1, width of the 1st lophid.

3.3. Locality

Sanhe karst Cave from Chongzuo, Guangxi ZAR, South China.

3.4. Geological age

Middle Early Pleistocene (1.2–1.6 Ma).

3.5. Descriptions

IVPP 18220.01 is a bunodont m3 with a brachydont crown composed of six lophids and a talonid. The narrow crown tapers gradually from anterior to posterior. The median sulcus, running along the entire length of the crown, is well defined and slightly curved to the labial side. The enamel rings of the pretrite and posttrite of the first and second lophids connect with each other due to heavy wear by mastication. A trace of the anterior cingulum is observed on the anterior wall of the first pretrite half-lophid. The dentine–enamel junction on the worn surfaces is smooth. The pretrite half-lophids are slightly more posteriorly placed than the posttrite ones. The pretrite and posttrite are nearly parallel and intersect almost orthogonally with the median sulcus. The trefoil pattern is developed on the first five pretrite half-lophids while the secondary trefoil is present on the first three posttrite half-lophids. On the first three lophids, the mesoconelet of the pretrite is well developed and almost the same size as the main cusp. Both of the anterior/posterior pretrite central conules become isolated cusps and develop into the trefoil pattern together with the main cusp and mesoconelet after wear. Additionally, the posterior pretrite central conule of the anterior lophid and the anterior pretrite central conule of the posterior lophid are connected in transverse valleys. The mesoconelet of the posttrite is nearly equal in size to the main cusp. Both of the anterior/posterior posttrite central conules are ridge-shaped. The secondary trefoil is formed after wear. On the fourth and fifth lophids, the mesoconelets of the pretrite/posttrite become reduced compared to those of the first three lophids. Both of the anterior/posterior pretrite central conules are still well developed while the anterior/posterior posttrite central conules are very weak. The narrower sixth lophid has a simple structure composed of the large main cusps on both pretrite and posttrite side and the small anterior/posterior pretrite central conules. There is a small cone attached to the posterior wall of the sixth posttrite half-lophid. The talonid is composed of a single cusp and is inclined to the labial side. Some cement appears in the transverse valleys, while the posterior and lateral cingula are absent. The ectoflexi are present among the interlophids. No roots are preserved.

IVPP 18220.02 is a complete m3 whose basic characteristics are consistent with those of IVPP 18220.01 while the unique differences are as follows. The crown is slightly worn and the median sulcus curves strongly to the labial side instead of a slight curve. The serrated anterior cingulum extends through the anterior wall of the

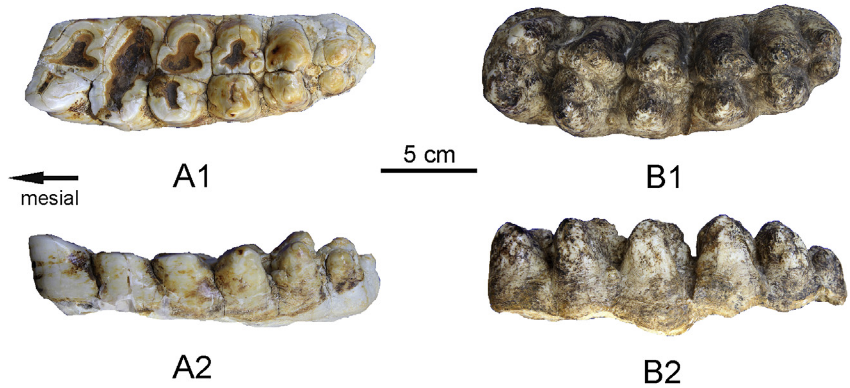

Fig. 3. The m3s of *Sinomastodon yangziensis* of the Sanhe Cave (A, IVPP, 18220.01; B, IVPP, 18220.02). A1-B1, occlusal view, A2-B2, lingual view.

first lophid. The mesoconelet of posttrite is separated into several small cones on the first three lophids. The talonid is relatively weaker than that of V18220.01 and attaches the posterior wall of the sixth lophid.

3.6. Comparisons

With six lophids, the trefoil pattern on the pretrite side and the secondary trefoil on the posttrite side, and the missing lateral and posterior cingula, the Sanhe Cave bunodont m3s are clearly more progressive than the typical Chinese Neogene gomphotheres, such as *Gomphotherium* (PMU 3054), *Platybelodon* (IVPP 5573) and *Choerolophodon* (IVPP 17658). *Anancus* (IVPP 5836) is distinguishable from the Sanhe Cave m3s by bearing more lophids and the opposite lophid structures (i.e., chevroning). The m3s of the North American short-jawed Cuvieroniinae, such as *Stegomastodon platensis* (AMNH 11190), *Cuvieronius hyodon* (AMNH 29780), and *Haplomastodon chimborazi* (AMNH 45976) are distinct from the Sanhe Cave m3s by having distinct plicate enamel (i.e., ptychodonty) and more complicated structure on the posttrite half-lophids, and the especially obvious secondary trefoil. Thus, the Sanhe Cave bunodont m3s should be assigned to the genus *Sinomastodon*.

The m3s of the Pliocene species *S. intermedius* (type species, IVPP 2878) and *S. hanjiangensis* (IVPP 4687) are evidently more primitive than those of the Sanhe Cave because of their relatively smaller size, broader crown (Fig. 6 in Wang et al., 2012), 5 lophids, ridge-shaped posterior pretrite central conule, smaller mesoconelets of the posttrite, the absence of the posterior posttrite central conule and cement in the transverse valleys, and developed posterior and lateral cingula.

The early Early Pleistocene *S. jiangnanensis* (IVPP 14011.03) from Renzidong Cave (Figs. 4 and 5, Table 3, Locality 1) differs from the Sanhe Cave remains by the following characteristics on m3 (Wang et al., 2012): noticeably larger size, broader crowns (Fig. 6 in Wang et al., 2012), 5 lophids, no secondary trefoil on the posttrite, the

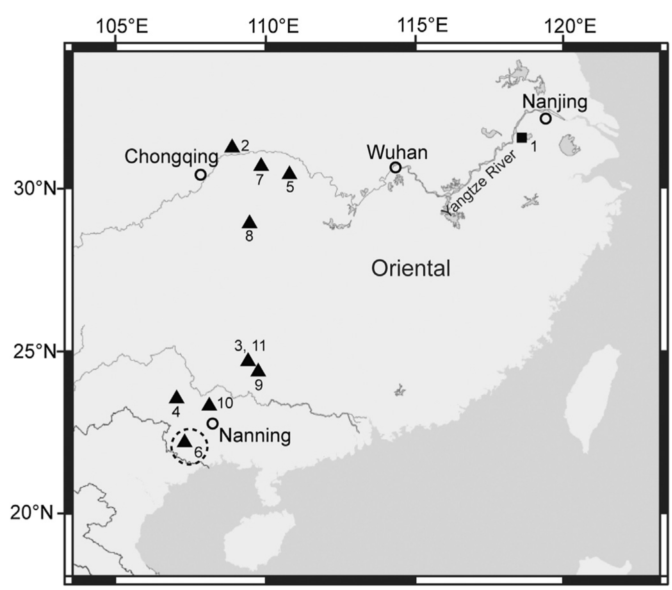

Fig. 4. Map showing the Pleistocene *Sinomastodon* localities in South China. The earliest Pleistocene ■ (*S. jiangnanensis*); Early Pleistocene ▲ (*S. yangziensis*); Locality numbers correspond to those in Table 3.

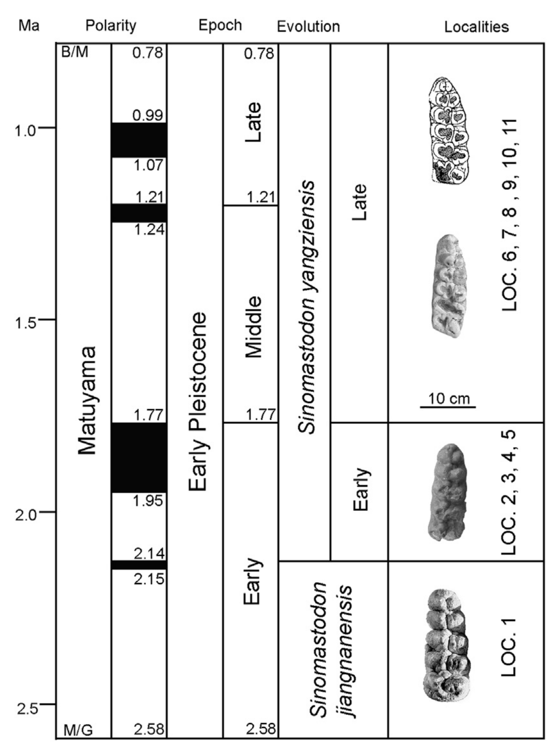

Fig. 5. The temporal evolutionary stages of Early Pleistocene *Sinomastodon* in South China. Locality numbers correspond to those in Table 3.

posterior pretrite central conule clearly inflating to the posttrite side, no cement in the transverse valleys, and weak lateral cingula (Table 2).

Table 2
Distinctions among Quaternary *Sinomastodon* remains in South China based on m3 morphology.

Characters	Taxa		
	S. jiangnanensis	*S. yangziensis*	
		Early	Late
Number of lophid	5 lophids with a talonid	5 lophids with a talonid of 2 pillars	6 lophids with a talonid
Size	Relatively large	Relatively small	Relatively small
Shape of crown (L/W)[a]	Relatively broad (2.52)[b]	Relatively slender (2.65)[c]	Relatively slender (2.88)[d]
Cement in valleys	Absent	Present	Present
Secondary trefoil	Absent	Present	Present
Anterior cingulum	Developed	Weak	Weak
Lateral cingulum	Weak	Absent	Absent
Posterior cingulum	Weak	Absent	Absent

[a] L/W, length/width.
[b] Average of calculation based on the data from Wang et al. (2012).
[c] Average of calculation based on the data from Huang and Fang (1991) and Pei (1987).
[d] Average of calculation based on the data from Zhao (1980) and this paper.

Table 3
Pleistocene *Sinomastodon* localities in South China and their geological age.

No.	Locality	Region	Geological age
1	Renzidong Cave	Fanchang County Anhui Province	Earliest Pleistocene (2.14 Ma)
2	Longgupo Cave	Wushan County Chongqing City	Early Early Pleistocene
3	Juyuandong Cave	Liucheng County Guangxi ZAR	Early Early Pleistocene
4	Chuifeng Cave	Tiandong County Guangxi ZAR	Early Early Pleistocene
5	Inexplicit site	Wufeng County Hubei Province	Early Early Pleistocene (?)
6	Sanhe Cave	Chongzuo City Guangxi ZAR	Middle Early Pleistocene (1.2–1.6 Ma)
7	Longgudong Cave	Jianshi County Hubei Province	Middle Early Pleistocene
8	Dongpaoshan Cave	Baojing County Hunan Province	Late Early Pleistocene
9	Bijiashan Cave	Liuzhou City Guangxi ZAR	Middle Early Pleistocene
10	Jiaoshan Cave	Wuming County Guangxi ZAR	Late Early Pleistocene
11	Fengmenshan Cave	Liucheng County Guangxi ZAR	Late Early Pleistocene (?)

Based on the above comparison, the *Sinomastodon* m3s from Sanhe Cave are evidently more progressive in molar morphology than the earlier species of *Sinomastodon*, and should be assigned into the early Pleistocene *S. yangziensis*. Compared with the Sanhe Cave remains, the m3s of *S. yangziensis* from the Longgupo Cave (CV 760), Liucheng Juyuandong Cave (originally *Trilophodon serridenstoides*, IVPP 1723), and Wufeng site (originally *Trilophodon wufengensis*, HUM 587) share a majority of basic crown characters, except for the following differences: 5 lophids, relatively smaller mesoconelet of the pretrite, the nearly straight median sulcus and occasional presence of lateral cingula. Considering the more derived specimens of *S. yangziensis*, the Sanhe Cave m3s are most similar to those of *S. yangziensis* from Jiaoshan (originally *Tetralophodon wumingensis*, F 0132) and Bijiashan (originally *Trilophodon serridenstoides*, IVPP 5184.01) in its relatively smaller size, elongated crown, 6 lophids, relatively larger mesoconelet and posterior central conule of the pretrite, the mesoconelet of posttrite separating into several small cones, the presence of the posterior posttrite central conule on the first three lophids, no lateral and posterior cingula, a little cement in the transverse valleys, and the median sulcus occasionally strongly curving to the labial side instead of a slight curve. Additionally, the faunal analysis indicates that the geological ages of Jiaoshan and Bijiashan are middle/late Early Pleistocene (Jin et al., 2008b), which corresponds with the paleomagnetic correlation for Sanhe Cave of 1.2–1.6 Ma (Jin et al., 2009a).

3.7. Amended diagnosis of *S. yangziensis* (Chow, 1959)

As the advanced species of *Sinomastodon, S. yangziensis* is smaller in size than the earlier species: *S. intermedius*, *S. hanjiangensis*, and *S. jiangnanensis*. Compared with the above-mentioned species, M3/m3 exhibit narrow crowns, 5 or 6 lophs/lophids and a talon/talonid, and relatively more complicated crown structure, viz. the relatively larger mesoconelet and posterior central conule of the pretrite, and the development of the secondary trefoil on the first three lophs/lophids of posttrite due to the presence of the posterior posttrite central conule. The lateral and posterior cingula are basically absent while the anterior cingulum is highly reduced. Cement is present in the transverse valleys. The median sulcus of m3 tends to be curved to the labial side on the derived specimen.

4. Discussion

Chow (1959) erected *T. yangziensis* based on a bunodont M3 from the Pleistocene of Wushan, Chongqing City, South China (IVPP 2399). Tobien et al. (1986) created the new genus *Sinomastodon* and included *T. yangziensis* in *S. intermedius*. Huang and Fang (1991) considered that it was inappropriate to place all the brevirostrine trilophodont proboscideans from the Plio-Pleistocene of North and South China into a single species *S. intermedius*, and therefore restored *S. yangziensis*. Chen (1999) agreed that *S. yangziensis* is a valid species.

To date, the found Pliocene *Sinomastodon* remains are distributed across North China and sporadically in the Hengduan Mountains. Quaternary remains of *Sinomastodon* in China include two species, *S. jiangnanensis* (Wang et al., 2012) and *S. yangziensis*, which are found only south of the Yangtze River.

The early Early Pleistocene *S. jiangnanensis* from Renzidong Cave (Figs. 4 and 5, Table 3, Locality 1), situated in the transitional zone between the Palaearctic and Oriental zoogeographical regions of eastern China, reflects the morphological transition of the genus from Neogene to Quaternary (Wang et al., 2012). Based on the faunal analysis, Renzidong fauna, with many typical northern forms, indicates a warm semi-arid and semi-humid forest-grassland environment (Jin and Liu, 2009) and implies a cooling event at the beginning of the Quaternary (2.58–2.14 Ma) (Wang et al., 2010a), resulting in a southward migration of *Sinomastodon* and the speciation of *S. jiangnanensis*.

There have been ten *S. yangziensis* localities (Pei, 1965; Xu et al., 1974; Han et al., 1975; Zhao, 1980; Wang et al., 1982; Pei, 1987; Huang and Fang, 1991; Zheng, 2004; Wang, 2009; Jin et al., 2009a) reported from the Pleistocene karst cave and fissure deposits of South China (Figs. 4 and 5, Locality 2–11). Mainly based on the biostratigraphical analysis of associated mammalian fauna, their geological ages are estimated as Early Pleistocene.

The present fossil records indicate that *S. yangziensis* was distributed widely during the Early Pleistocene, not only in the Guangxi ZAR of South China (such as Juyuandong Cave and Fengmenshan Cave in Liucheng, Chuifeng Cave in Tiandong, Sanhe Cave in Chongzuo and Jiaoshan Cave in Wuming), but also north to the

Three Gorges Area of the Yangtze River (such as Longgupo Cave in Wushan and Longgudong Cave in Jianshi). Consequently, *S. yangziensis* is considered as the typical element of the Oriental zoogeographical realm (Fig. 4), which reveals the geographical separation with *S. jiangnanensis.* The faunal analyses of Sanhe Cave and Longgupo Cave (Huang and Fang, 1991; Jin et al., 2009a) demonstrate *S. yangziensis* lived in an environment with a lush tropical-subtropical forest and a warm and humid climate, which is distinct from that utilized by *S. jiangnanensis.* No reliable fossil record of Middle or Late Pleistocene *Sinomastodon* has been discovered in China.

The evolution and extinction of terrestrial mega-mammals (such as *Sinomastodon*) correlate to the changes of climate and environment. Analysis of Pleistocene sporopollen in China has shown that there was a significant transformation of vegetation between 1.6 and 0.8 Ma. The climate became cold and dry during this period (Tong et al., 1999). The severe climatic and environmental changes during the late Early Pleistocene (1.0–0.8 Ma) made the forest habitat fragmented and deteriorated, which might have a strong effect on the habitat of *Sinomastodon*, possibly causing extinction and complete replacement by *Stegodon orientalis* in South China. Besides the extinction of *Sinomastodon*, there have been other related paleontological events during the late Early Pleistocene in South China. *Ailuropod wulingshanensis* was replaced by *Ailuropoda baconi* (Jin et al., 2007), *Niviventer preconfucianus* was replaced by *N. confucianus*, *Hapalomys gracilis* was replaced by *H. delacouri*, and *Leopoldamys edwardsioides* was replaced by *L. edwardsi* (Wang et al., 2009, 2010b).

Based on the faunal and chronological succession (Jin et al., 2008b), the evolution of *Sinomastodon* of the Early Pleistocene in South China can be divided into three temporal stages (Fig. 5, Table 3). The *Sinomastodon jiangensis* stage (between the Gauss-Matuyama boundary and the Reunion normal subchron, 2.58–2.14 Ma), represented by remains from Renzidong Cave, is characterized by the relatively broad crowns, 5 lophs/lophids on M3/m3, no cement in the transverse valleys, and a weak lateral cingula. The fauna includes many Neogene relic species, such as *Villanyia fanchangensis* (Zhang et al., 2008) and *Beremendia jiangnanensis* (Jin et al., 2009c), and several most primitive species from the Quaternary, such as *Ailuropoda microta* (Jin et al., 2007), *Tapirus sanyuanensis* (Jin and Liu, 2009), and *Diplothrix yangziensis* (Wang et al., 2010a). It is a transitional stage from Pliocene to Pleistocene, based both on *Sinomastodon* morphology and faunal characteristics.

The early stage of *Sinomastodon yangziensis* (between the Reunion and Olduvai normal subchrons, 2.14–1.77 Ma), represented by the remains from the Longgupo, Juyuandong, and Chuifeng caves and Wufeng site, is characterized by the relatively narrow crowns, 5 lophs/lophids on M3/m3, secondary trefoil, some cement in the transverse valleys, and the absence of lateral cingula. These faunas contain the first appearance of primitive species in the Pleistocene, such as *G. blacki*, *Cuon dubius*, and *Stegodon preorientalis*.

The late stage of *S. yangziensis* (between the Olduvai subchron and the Matuyama-Brunhes boundary, 1.77–0.78 Ma), represented by remains from Sanhe, Longgudong, Bijiashan, Dongpaoshan, Jiaoshan, and Fengmenshan caves, is characterized by the relatively narrow crowns, 6 lophs/lophids on M3/m3, secondary trefoil, cement in the transverse valleys, absence of lateral cingula and sometimes the median sulcus strongly curving to the labial side instead of a slight curve. The faunas are distinguished by the increased dental size of *G. blacki* and the first appearance of *Ailuropoda wulingshanensis*, *Cuon antiquus*, *Tapirus sinensis*, and *Nesolagus sinensis* (Jin et al., 2010).

The Quaternary *Sinomastodon* groups from *S. jiangensis* to *S. yangziensis* exhibit the following evolutionary trends in their molars: size decreases; the number of M3/m3 lophs/lophids increases from five to six; the crown becomes narrower; the median sulcus gradually curves to the labial side on m3; the anterior, posterior and lateral cingula become gradually reduced or absent altogether; cement in the transverse valleys varies from absent to present; the crown structure becomes more complicated, especially the secondary trefoil on the posttrite which changes from absent to present.

5. Conclusions

The Pleistocene *Sinomastodon* remains are mainly found in South China, while the Pliocene *Sinomastodon* finds are distributed across North China and sporadically in the Hengduan Mountains. nAs the southernmost *Sinomastodon* remains found so far in China with advanced molar features, the discovery of *S. yangziensis* from Sanhe karst Cave provides new data to revise the diagnosis of this species, to divide the temporal evolution stages of Pleistocene *Sinomastodon* in South China, and to summarize the evolutionary trends on Early Pleistocene *Sinomastodon* molars.

S. yangziensis is one of the typical members of the *Gigantopithecus* fauna. Thus, the Early Pleistocene fauna from South China is suggested to be named the *Gigantopithecus-Sinomastodon* fauna, to distinguish it from the typical Middle Pleistocene *Ailuropoda-Stegodon* fauna (s. s.) and the Late Pleistocene Asian elephant fauna (Jin et al., 2009b).

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