

A NEW SPECIES OF THE RHINOCEROS
ALICORNOPS FROM THE MIDDLE MIOCENE
OF THE LINXIA BASIN, GANSU, CHINA

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ABSTRACT. A new species of the genus *Alicornops*, *A. laougouense*, from Laogou in Hezheng County, Linxia Basin, Gansu, China, is described. It is mid-sized in the subfamily Aceratheriinae, but is the largest known species of *Alicornops*. It represents the first discovery of the genus in Asia. The Middle Miocene fauna bearing *A. laougouense* is contemporaneous with the Dingjiaergou fauna of Tongxin, Ningxia, China, and its age corresponds to MN 6 in Europe. The discovery of *A. laougouense* in the Linxia Basin implies that *Alicornops* dispersed from Europe to Asia. During MN 6 times it was relatively widespread throughout Eurasia. *Alicornops laougouense* lived in open woodland rich in lakes and rivers.

KEY WORDS: Linxia Basin, China, Middle Miocene, Rhinocerotidae, Aceratheriinae.

THE Late Cenozoic deposits in the Linxia Basin, Gansu, China, are thick and well exposed. Recently, a mammalian fauna consisting of abundant fossils was discovered in this basin in Middle Miocene deposits at Laogou in Hezheng County (Text-fig. 1). The deposits consist of greyish yellow, gravelly, generally unconsolidated sands and occasionally hard sandstones. The sands are mostly medium grained and contain many fine gravels. The thickness of the deposits is approximately 58 m. The overlying deposits are grey, locally rusty yellow sandstones and fine gravels. The underlying beds are alternating thin-bedded light brown and light orange clays.

Judging by the percentage of specimens recovered, proboscideans were dominant and rhinocerotids were secondary in this fauna. The known fossils include *Amphicyon tairumensis*, *Anchitherium gobiensis*, *Gomphotherium* sp., *Hemicyon teilhardi*, *Hispanotherium matritense*, *Kubanochoerus gigas*, *Listriodon mongoliensis*, *Palaeotragus tungurensis*, *Platybelodon grangeri*, *Pliopithecus* sp., *Zygodon* sp., and the rhinoceros described herein. On the basis of overall similarities, this fauna can be correlated with the Dingjiaergou fauna of Tongxin, Ningxia, China, which corresponds to MN 6 (Qiu *et al.* 1999).

The fossils studied are deposited in the Institute of Vertebrate Palaeontology and Palaeoanthropology (IVPP), Beijing (prefixed V), and the Hezheng Palaeontological Museum, Gansu (prefixed H MV). L, length; W, width; H, height. MN; Neogene Mammal Zone. Terminology and taxonomy follow Heissig (1972, 1999) and Guérin (1980) (Text-fig. 2). The measurements are according to Guérin (1980) and given in mm.

SYSTEMATIC PALEONTOLOGY

Order PERISSODACTYLA Owen, 1848

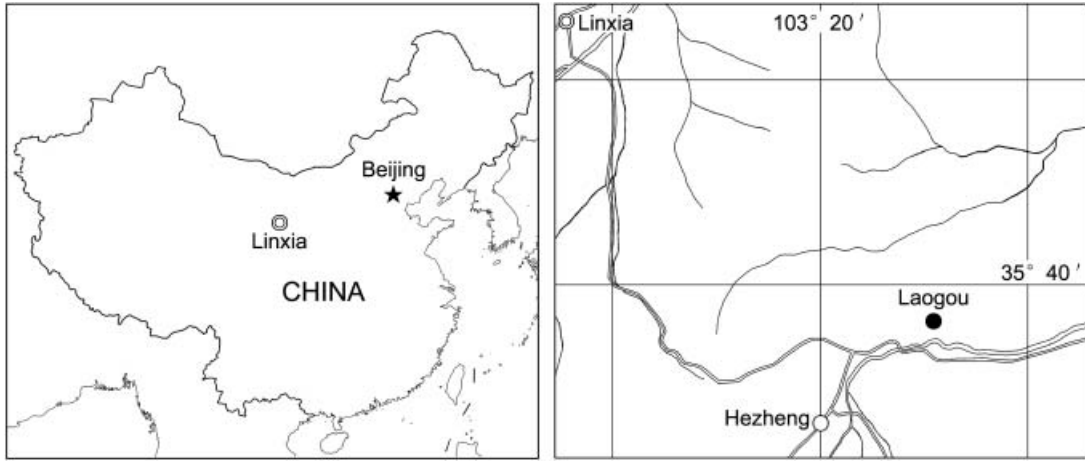
Family RHINOCEROTIDAE Owen, 1845

Subfamily ACERATHERIINAE Dollo, 1885

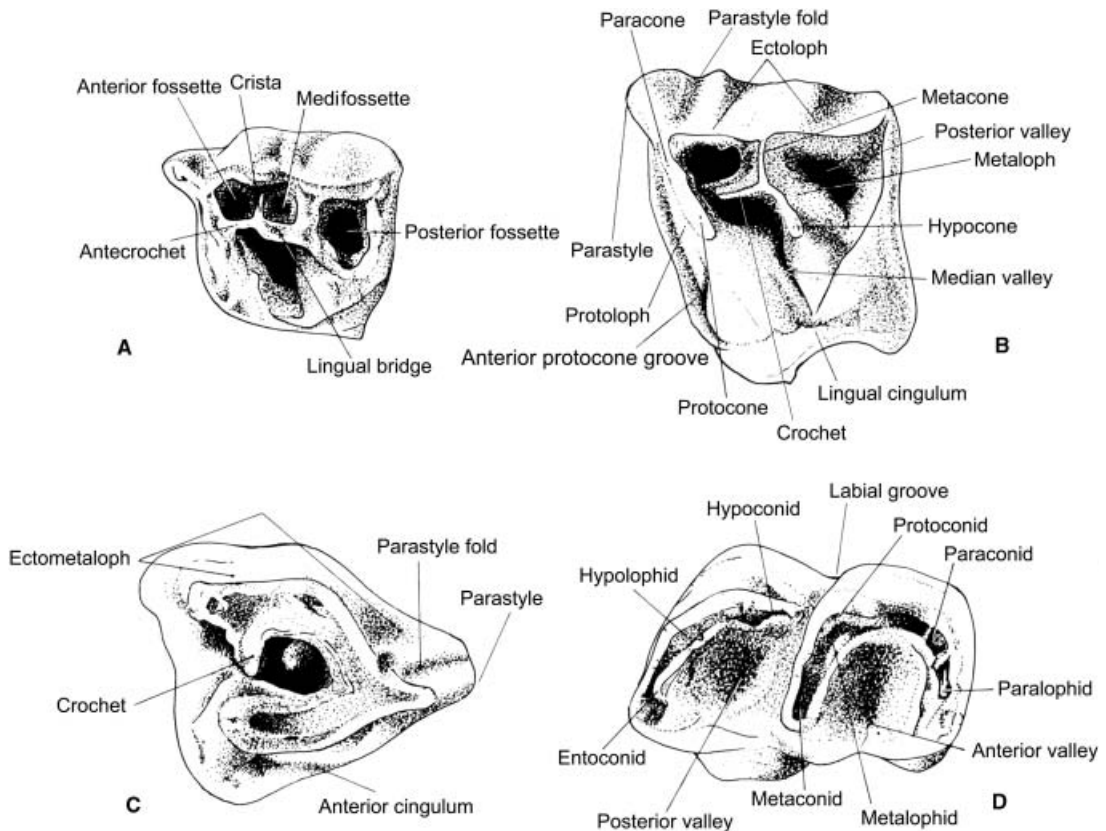
Tribe ACERATHERINI Dollo, 1885

Genus ALICORNOPS Ginsburg and Guérin, 1979

Type species. *Alicornops simorreense* (Lartet, 1851), from Simorre, France.



TEXT-FIG. 1. Map of the Linxia Basin (Gansu, China) showing the locality referred to in this paper.



TEXT-FIG. 2. Terminology of rhinocerotid cheek teeth (after Guérin, 1980). A, left P2. B, left P4. C, right M3. D, left m3.

Alicornops laogouense sp. nov.

Plate 1; Text-figures 3–6

Derivation of name. From *Laogou*, the name of the locality from which the material was collected.

Holotype. HMV 0982, an adult skull without the occipital surface.

Referred material. HMV 0983, a broken right mandible belonging to a very old individual. IVPP V 12672.1, left P2; V 12672.2, right P2; V 12672.3, left P3; V 12672.4, left i2; V 12672.5, right p3; V 12672.6, right p4; V 12672.7, right m1; V 12672.8, right m3; V 12672.9, left p2; V 12672.10, left p3; V 12672.11, left p4; V 12672.12, left p4; V 12672.13, left m2; V 12672.14, left m3; V 12672.15, left m3. These fifteen isolated teeth correspond to a minimum of two individuals.

Type horizon and locality. Middle Miocene (corresponding to MN 6 in Europe) at Laogou, Hezheng, Gansu, China.

Diagnosis. Mid-sized skull, about 30 per cent smaller than that of extant *Rhinoceros unicornis*, but larger than other known species of the genus *Alicornops* (*A. simorreense* and *A. alfambrense*). There is no horn on the nasals or the frontal. It differs from *A. simorreense* in the following ways: (1) the nasals are 1.7 times as long as wide, but the width of the nasal base is narrower; (2) the skull is much higher; (3) the skull roof is lozenge-shaped, with a narrower maximal frontal width; (4) the frontal bone narrows posteriorly, but less strongly; (5) the surface between the parietal crests is slightly wider with a minimum width of 25 mm; (6) the nasal notch is situated at the level of the middle of P3, shallower than that of *A. simorreense* at the level of P4; (7) the postorbital process is much weaker; (8) the anterior margin of the orbit is situated at the level of the anterior part of M1, more anterior than that of *A. simorreense* at the level of the M1/M2 boundary or anterior part of M2.

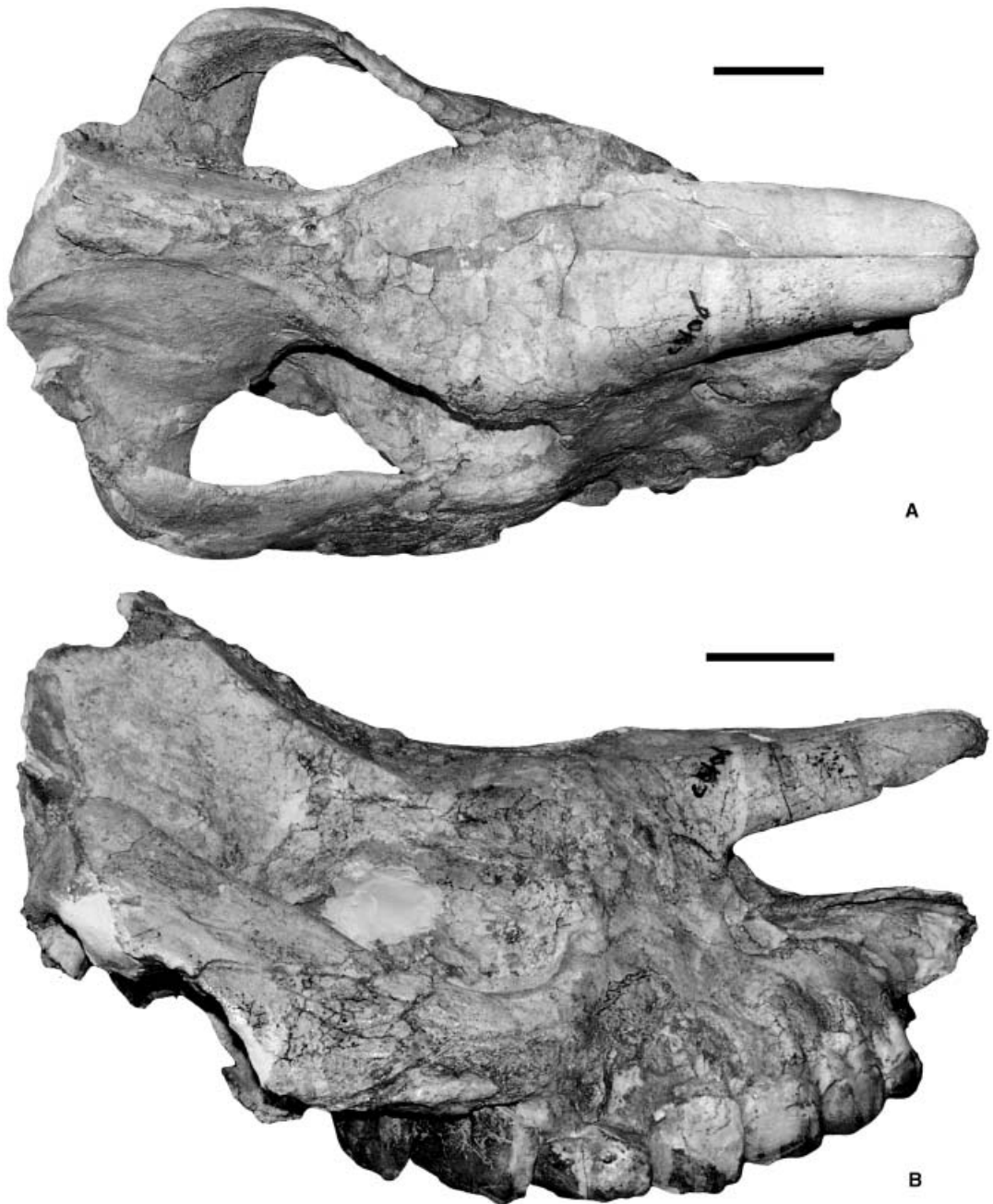
Description

Skull. The occipital part of the skull (HMV 0982) is lost. The skull is slightly distorted along the midline, and its roof is shifted towards the left. Both premaxillae are broken. This individual was apparently an adult (Text-figs 3–4; Pl. 1, fig. 1). The skull is mid-sized in the subfamily Aceratheriinae (Table 1), about 7 per cent smaller than *Hoploacetherium tetradactylum* (Guérin, 1980) and *Acerorhinus fuguensis* (Deng, 2000), about 30 per cent smaller than that of the extant *Rhinoceros unicornis*. There is no indication of any horn on the nasals and the frontal, though the anterior surface of the nasal tip is rather rough. In lateral view, the profile of the skull is flat and the occipital elevation high. In dorsal view, the roof of the skull is lozenge-shaped. The parietal crests become gradually closer posteriorly to produce a high, narrow surface between them with a minimum width of 25 mm. The braincase is narrow, with a minimum width of 68.5 mm, so that its lateral walls are steep.

The nasals are flat, with a rounded tip and a narrow central groove along the suture between them. They are about 1.7 times as long as wide (Table 1), and gradually become slightly narrower from the base to the tip, without an abrupt constriction. Both lateral margins of the nasals are convex transversally, and the ventral surface is also convex anteroposteriorly. In lateral view, the nasal notch is narrowly and shallowly U-shaped, with a posterior border situated at the level of the middle of P3. There is a single large infraorbital foramen near the lower corner of the nasal notch, at the level of the middle of P3. The surface anterior to the orbit is smooth, and the facial crest is weak. In ventral view, the zygomatic arches are narrow and abruptly expanded laterally from the middle to the rear. In lateral view, they are wide, with narrow anterior and posterior ends. There is a weak postorbital process on the upper margin of the zygomatic arches and a prominent angle at the middle of the lower margin. The anterior ends of the zygomatic arches are situated at the level of the boundary between P4 and M1.

The frontal is flat and narrows posteriorly. It is broadest at the supraorbital tubercles. The suture between the nasals and the frontal is slightly concave anteriorly. The postorbital processes on the frontal as well as the lacrimal and supraorbital tubercles are weak. The orbits are in a high position, just below the frontal. The anterior margin of the orbit is situated at the level of the anterior part of M1.

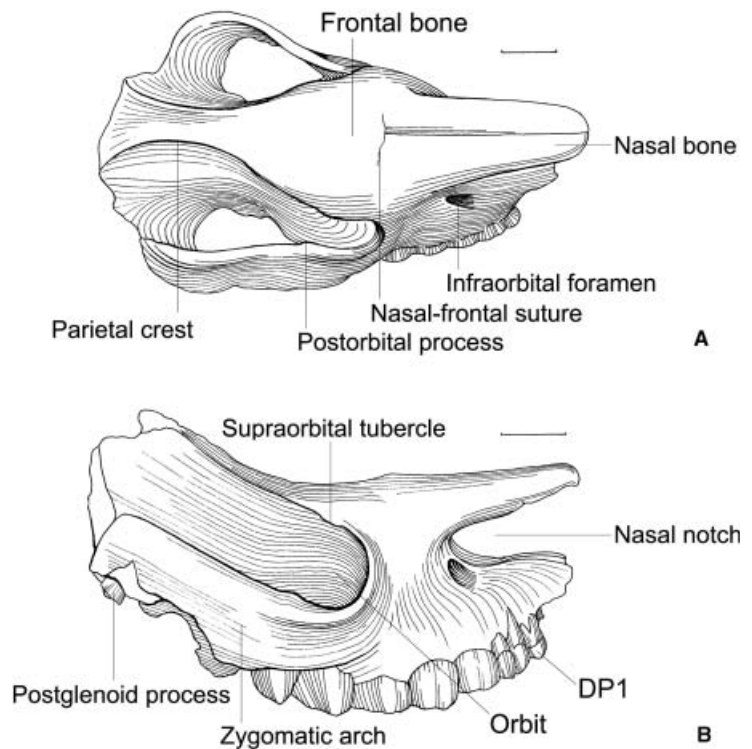
The postglenoid processes are robust, with a rounded depression on the upper part of their posterior surfaces. The articular surfaces behind the glenoid fossa are broad. There is a longitudinal median crest on the ventral surface of the occipital. The palate is wide and flat, with a width of 66 mm in front of M1. The posterior margin of the palate is deeply V-shaped and situated at the level of the posterior part of M2.



TEXT-FIG. 3. *Alicornops laogouense* sp. nov., holotype, skull, HMV 0982; Middle Miocene, Laogou, Hezheng, Gansu, China. A, dorsal view. B, lateral view. Scale bars represent 50 mm.

Upper dentition. On all upper cheek teeth the labial cingula are present but low; the parastyles are sharp; the labial walls of the ectolophs are flat, with a marked parastyle fold on their front; and the hypocones are not constricted. Most of the teeth are covered with thin, irregular cement on their labial walls (Pl. 1, fig. 1; Text-fig. 5A-C). Upper cheek

TEXT-FIG. 4. Interpretive diagram of the skull of *Alicornops laougouense* sp. nov. based on Text-figure 3. A, dorsal view. B, lateral view. Scale bars represent 50 mm.



tooth measurements (L×W×H in mm) are: DP1, 22.5×19×22; P2, 32.5×39×36, 31.5×37.5×40, 33×39×24.5; P3, 39×49×39.5; 38.5×48×49; P4, 42×57×45; M1, 52.5×57.5×41; M2, 52×57×48; M3, 50×49×48.

Upper premolars. The anterior, lingual and posterior cingula are well developed, and form a continuous shelf-like wall from P2 to P4, high above the base of the teeth. The protocone is not constricted. The protoloph and metaloph are of different widths, and their lingual surfaces are rounded. DP1 is small, about half the width of P2. It is single-rooted, with a triangular occlusal surface. Its protoloph is absent, the hypocone well developed, the posterior fossette rounded, and the lingual cingulum relatively well developed. P2 has a narrow lingual bridge between the protoloph and metaloph, which is higher than the lingual cingulum. Its hypocone is larger than the protocone; its crochet and crista are delicate and connect with each other to form a medifossette (Pl. 1, fig. 1; Text-fig. 2A); its posterior valley is triangular and wide; its parastyle is narrow and projecting. P3 has a larger protocone than hypocone; the entrance of its median valley is closed towards the base; its crochet is well developed, but the crista and antecrochet are absent (Pl. 1, fig. 1), or the crista is weak (Text-fig. 5B); its posterior valley is wide. P4 has an open entrance to the median valley with a well-developed crochet but without a crista (Pl. 1, fig. 1).

Upper molars. The holotype (HMV 0982) retains complete upper molars (Pl. 1, fig. 1). The lingual surface of the protocone is flattened and the lateral surfaces are rounded. The protocone is wide. The crista is absent. The labial wall of the ectoloph on M1 and M2 forms a wide fold at the metacone. The entrance to the median valley is open. M1 has a long and large crochet and antecrochet. Its anterior and posterior cingula are well developed, but the lingual cingulum is present only on the entrance to the median valley; its protocone is markedly constricted. M2 is similar to M1, but the constriction of the protocone and antecrochet is weaker, and its lingual cingulum is absent. M3 is triangular. The labial wall of its ectometaloph is convex; its protocone is not constricted, and is expanded gradually towards to the base; its crochet is narrow and long, but the antecrochet is absent; its median valley is wide; its anterior cingulum is well developed and forms a shelf-like wall, but the posterior one is weak and low; its lingual cingulum is absent.

Mandible. The mandible (HMV 0983) retains the right horizontal ramus and the lower part of the right ascending ramus (Pl. 1, figs 2–3). All teeth except m3 are worn deeply to reach the root. The horizontal ramus is thick. The lower

TABLE 1. Skull measurements of *Alicornops laogouense* sp. nov. in mm.

4 Distance between the nasal tip and notch, 134	22 Width of the nasal base, c. 78
5 Minimum width of the braincase, 68.5	25 Height of skull in front of P2, 124
9 Distance between the nasal notch and the orbit, 75	26 Height of skull in front of M1, 143
14 Distance between the nasal tip and the orbit, 211	27 Height of skull in front of M3, 131
17 Minimum width between the parietal crests, 25	28 Width of the palate in front of P2, 63
18 Width between the postorbital processes, 141	29 Width of the palate in front of M1, 66
21 Maximum width between the zygomatic arches, 269	30 Width of the palate in front of M3, 53

margin is flat and curves slightly upwards in the anterior part. The vasorum notch is wide and shallow. The mental foramen is long, and situated near the lower margin and at the level of p3. The heights of the horizontal ramus respectively in front of p3, m1, m2, m3, and posterior to m3 are 79, 88, 86.5, 82, and 90 mm.

Lower dentition. Most of the lower teeth are covered with thin and irregular cement on their labial walls, especially in the labial grooves. The lingual cingulum is present on the entrance to the anterior valley. The paralophid is short. The labial groove is widely and shallowly V-shaped. The metalophid and hypolophid are oblique (Pl. 1, fig. 2; Text-figs 5E–J, 6). Lower cheek tooth measurements (L × W × H in mm) are: p2, 30 × 20.5 × 20.5; p3, 38 × 29.5 × 32.5, 38 × 30 × 16; p4, 41.5 × 30 × 26, 41.5 × 31 × 23, 42 × 32.5 × 42; m1, 44.5 × 29 × 30; m2, 46.5 × 29.5 × 31; m3, 49 × 29.5 × 18, 42 × 27 × 36.5, 45.5 × 29 × 34.5, 46 × 30 × 24.

Lower incisor. The i2 (V 12672.4) is large and strong, with an oval transversal section. Its worn surface is short, and the labial surface is devoid of enamel (Text-fig. 5D).

Lower premolars. The labial cingulum is well developed and high above the base of the teeth. The anterior valley is V-shaped, but the posterior valley is U-shaped. The p2 is triangular in outline and long, with double roots. Its labial cingulum is discontinuous at the level of the protoconid. The p4 has a serrated labial cingulum.

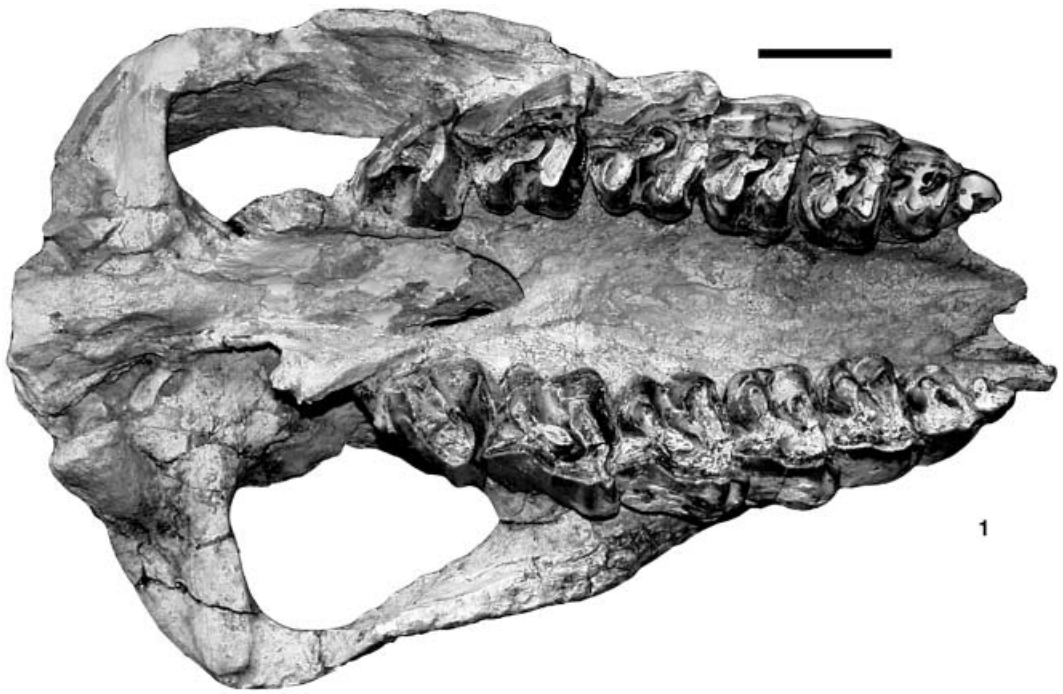
Lower molars. The anterior and posterior valleys are V-shaped. The labial cingulum is serrated on m1 and m2. The well-developed labial cingulum of m3 is continuous with the posterior one to form a shelf-like wall, and the posterior valley is wide and deep.

COMPARISON AND DISCUSSION

The cranial and dental characters of the rhinocerotid material from Laogou described here are easily recognizable as typical of *Aceratheriini* (Heissig 1989, 1999). Lartet (1851) established a new species, *Rhinoceros simorreense*, based on a fragment of skull from Simorre in France with upper cheek tooth rows from P2 to M3, and lower cheek tooth rows from p2 to m3. Hooijer (1966) referred this species to the genus *Aceratherium*, but its generic position has changed several times since then. Ginsburg (1974) considered that the species should be placed in the genus *Dromoceratherium*, but Heissig (1976) placed it in the genus *Mesaceratherium*. Subsequently, Ginsburg and Guérin (1979) created a new subgenus, *Alicornops*, and assigned *Aceratherium (Alicornops) simorreense* as the type species. Yan and Heissig (1986) elevated *Alicornops* from subgenus to genus. Later, Heissig (1989), Prothero *et al.* (1989), and Cerdeño (1992) accepted *Alicornops* as a genus. Cerdeño (1995) performed a cladistic analysis that showed *Alicornops* to have a more crownward evolutionary position than *Aceratherium*.

EXPLANATION OF PLATE 1

Figs 1–3. *Alicornops laogouense* sp. nov.; Middle Miocene, Laogou, Hezheng, Gansu, China. 1, holotype, skull, HMV 0982; ventral view. 2–3, mandible, HMV 0983. 2, occlusal view. 3, lateral view. Scale bars represent 50 mm.



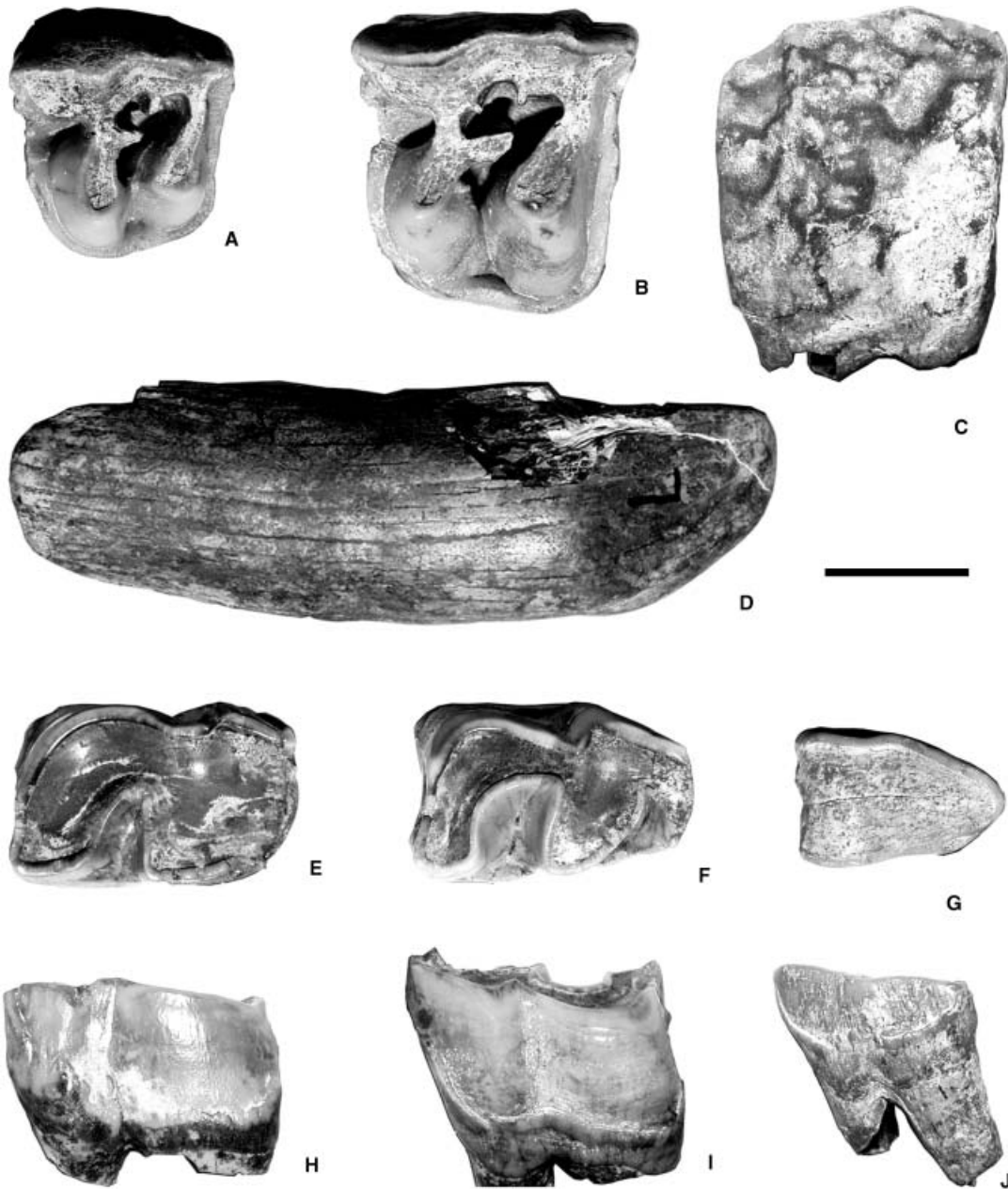
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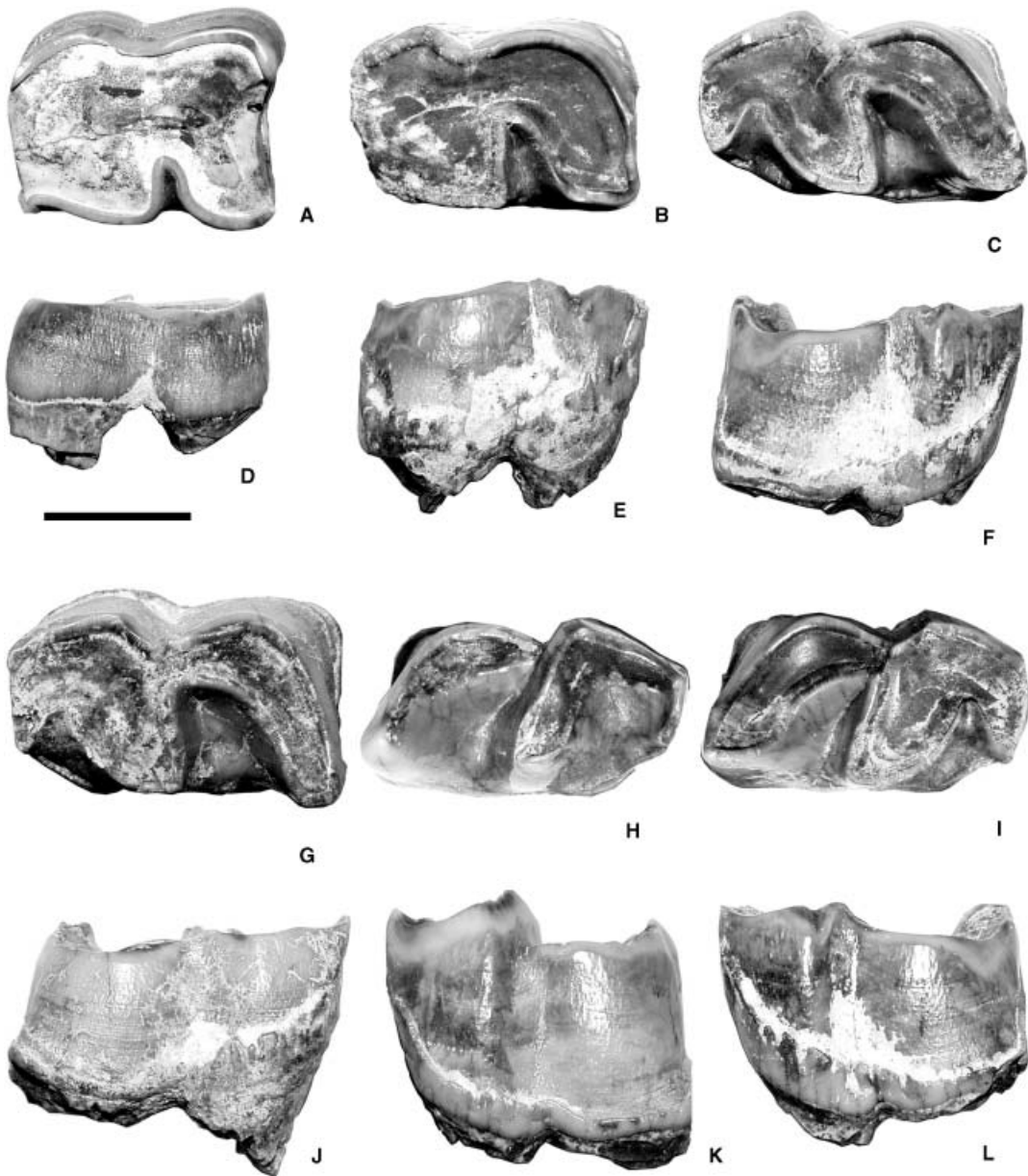


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TEXT-FIG. 5. *Alicornops laogouense* sp. nov., isolated teeth; Middle Miocene, Laogou, Hezheng, Gansu, China. A, V 12672.2, right P2. B–C, V 12672.3, left P3. D, V 12672.4, left i2. E, H, V 12672.12, left p4. F, I, V 12672.10, left p3. G, J, V 12672.9, left p2. A–B, D–G, occlusal view; C, H–J, labial view. Scale bar represents 20 mm.

The skull, and especially the teeth of *A. laogouense*, resemble those of *A. simorreense* from Simorre and Villefranche d'Astarac (Lartet 1851). Their common characters include a well-developed labial cingulum on the lower premolars, weak or absent crista on the upper molars, a molar protocone with a rounded lingual margin, a strong molar parastyle fold, and a slightly constricted protocone on the molars. The



TEXT-FIG. 6. *Alicornops laogouense* sp. nov., isolated teeth; Middle Miocene, Laogou, Hezheng, Gansu, China. A, D, V 12672.5, right p3. B, E, V 12672.6, right p4. C, F, V 12672.7, right m1. G, J, V 12672.8, right m3. H, K, V 12672.15, left m3. I, L, V 12672.13, left m2. A–C, G–I, occlusal view; D–F, J–L, labial view. Scale bar represents 20 mm.

holotype of *A. simorrense* is a skull fragment, but Cerdeño and Sánchez (2000) have described two skulls and a mandible of this species from Moraleja de Enmedio and Toril-3 in Spain. The Laogou skull shares many characters with the Spanish skulls, such as wide and unconstricted nasals without a horn boss, strongly expanded zygomatic arches, and a wide, flat frontal bone narrowing strongly posteriorly. On the other hand, there are some differences between it and *A. simorrense* from Simorre and Villefranche

d'Astarac. Guérin (1980, tables 46–50) and Cerdeño and Alcalá (1989) measured many mandibles and teeth of *A. simorrese* from different European localities, and their data show that *A. simorrese* is smaller. The lingual cingulum on P3 and P4 of *A. simorrese* is developed only on the protocone, but that of *A. laougouense* is better developed and continuous with the anterior and posterior cingula. The skull of the latter differs from those of *A. simorrese* from the Spanish localities, in which the parietal crests are close or united into a sagittal crest, the nasal notch is at the P4 level, and the anterior border of the orbits is above the boundary between M1 and M2 or at the level of the anterior part of M2.

Cerdeño and Alcalá (1989) described another species of *Alicornops*, *A. alfambrense*, from La Roma 2 at Alfambra in Teruel, Spain, but the material includes only postcranial bones that are different from *A. simorrese* in being larger and in having more robust limbs. A comparison between *A. simorrese*, *A. alfambrense*, and the Laogou rhinoceros shows that *A. alfambrense* is also smaller than *A. laougouense*. Several isolated teeth from Dorn-Dürkheim 1 were identified as *A. alfambrense* (Cerdeño 1997), and they are similar to the teeth of *A. laougouense*. They share the flat labial wall, very strong lingual cingulum and rounded hypocone on the upper premolars. On the other hand, the teeth of *A. alfambrense* differ in being slightly smaller with a lower crown, and in the absence of the labial and lingual cingula on the lower premolars.

The teeth of *Alicornops laougouense* are similar to those of *A. simorrese* from Anatolia (Heissig 1976). They share the well-developed lingual cingulum on the premolars, a slightly constricted protocone on the molars, and oblique protoloph and metaloph. The teeth of *A. simorrese* differ, however, in being smaller and in having a crista to connect with the crochet to form a medifossette on P4.

In the Tribe Aceratheriini, the genera similar to *Alicornops* include *Acerorhinus* Kretzoi, 1942, *Aceratherium* Kaup, 1832, *Plesiaceratherium* Young, 1937, *Hoploaceratherium* Ginsburg and Heissig, 1989, and *Chilotherium* Ringström, 1924.

The skull of *Alicornops laougouense* is similar to some skulls of *Acerorhinus zernowi* from Tunggur in Inner Mongolia, China (Cerdeño 1996), especially AMNH 26520. They share wide, long nasals with a rounded tip and an unstricted base, a lozenge-shaped skull roof, and a narrow braincase. On the other hand, the skull of AMNH 26520 differs from that of *A. laougouense* in having a deeper notch at the level of P4, a shorter distance between the nasal notch and the orbit, and a high and narrow sagittal crest. The other skulls of *A. zernowi* from Tunggur, e.g. AMNH 26216, have an abrupt constriction of the nasal base, which is a typical of *Acerorhinus*. The skull and teeth of *Alicornops laougouense* are easily distinguished from those of *Acerorhinus*. As for *Acerorhinus*, the nasals are long but become narrow abruptly before the orbit, the anterior margin is narrow and very prominent, the facial crest is strong and vertical, the supraorbital tubercle is well developed, the premaxilla is much reduced, the protocone is rounded, and the crista is well developed on the premolars (Borissiak 1914, 1915; Qiu *et al.* 1988; Deng 2000).

The skull and teeth of *Alicornops laougouense* resemble those of *Aceratherium incisivum* from Eppelsheim (Kaup 1832). These include long nasals with a rounded end but without any horn boss, an infraorbital foramen above P3, a shallow nasal notch at the level of P3, large premolars with well-developed lingual cingula, a delicate bridge between the protocone and hypocone of P2, and a broad protocone on the molars. On the other hand in *A. incisivum* the nasals have a markedly upward tip and a slightly constricted base, the zygomatic arch has a smooth lower margin, and the crochets are short.

Alicornops laougouense is similar to *Aceratherium incisivum* from Höwenegg in Hegau, Germany (Hünemann 1989) with respect to strong nasals, a narrow surface between the parietal crests, and marked parastyle folds. However, the skull of *A. incisivum* is long and low, the nasals are short and upwardly directed, with a sharp end and a constricted base, the surface between the parietal crests is narrower, the posterior margin of the palate is at the level of the boundary between M2 and M3, the nasal notch is at the level of the boundary between P4 and M1, the anterior margin of the orbit is at the level of the middle of M1, the crista on the premolars is well developed and connects with the crochet to form a medifossette, and the lingual cingulum on the premolar is discontinuous and developed only on the entrance to the median valley.

The Laogou rhinoceros is also similar to *Aceratherium incisivum* from Yulaffi in Çorlu-Thrace, Turkey (Kaya and Heissig 2001) in some respects. They share the wide zygomatic arch with a prominent angle at its lower margin, a flat cranial profile, a narrow surface between the parietal crests, and a smooth

antorbital area. On the other hand the nasal notch of *A. incisivum* is deeper (at the level of the boundary between P4 and M1), the anterior margin of the orbit (at the level above the anterior part of M2) and the posterior margin of the palate (at the level in the middle of M3) is further back, the supraorbital tubercle and postorbital process are well developed, and the median valley is closed on each premolar.

Alicornops laogouense and *Aceratherium depereti* from Jilaněik in Turgai, Kazakhstan (Borissiak 1927) are similar with respect to their strong zygomatic arches, high occipital elevation, and flat nasals. However, in *A. depereti*, the nasals are narrow and long, the parietal crests unite posteriorly to form a narrow and high sagittal crest, the anterior margin of the orbits are above the boundary between M2 and M3, the anterior ends of the zygomatic arches are markedly higher than the alveolar margin, the posterior parts of the zygomatic arches are slightly expanded laterally, the metaloph is slightly oblique posteriorly, the crista on the premolars is well developed and connects with the crochet to form a medifossette, the bridge is absent on P2, and the hypocones on the upper cheek teeth are expanded.

The skull and teeth of *A. laogouense* differ from those of *Plesiaceratherium*, *Hoploaceratherium* and *Chilotherium*. In *Plesiaceratherium* the nasals are longer and narrower, with a sharp tip, the nasal notch is deeper, with a shorter distance to the orbit, the parietal crests are weak and fuse posteriorly to form a sagittal crest, the facial crest is well developed, the nasal notch is wide, the tooth crowns are comparatively low, the crochets are shorter, and the labial enamel of the lower premolars is wrinkled (Heissig 1972; Yan and Heissig 1986). In *Hoploaceratherium* the nasals are longer, with a split horn boss, the skull roof is narrower, the nasal notch is deeper (at the level from P4 to M1), the distance between the nasal notch and the orbit is shorter, the surface between the parietal crests is wide, and the lingual cingulum on the upper premolars and the labial one on the lower premolars are discontinuous (Guérin 1980; Heissig 1996). In *Chilotherium* the skull is longer and lower, with a flat profile, the facial crest forms a right angle, the premaxilla is weak, the protocone is strongly constricted, the labial wall of the ectoloph is flat, without a marked parastyle fold, the lingual cingulum on the upper premolars is discontinuous and the labial one on the lower premolars is weak, and the protoloph is strongly oblique.

BIOSTRATIGRAPHY

Alicornops simorreense is one of the most widespread species in MN 6–10 of the European Middle and Upper Miocene. There are records from many West European localities, especially in Upper Aragonian strata (Guérin 1980; Cerdeño and Nieto 1995). It has also been recovered from the Upper Aragonian and Lower Vallesian in Romania (Codrea 1992, 1996), the Lower Vallesian in Moldova (Lungu 1984), and the Middle Miocene in Poland (Kubiak 1981). In addition, it has been recorded from places outside Europe, such as from the Middle Miocene of Turkey (Heissig 1976) and the Vallesian of Pakistan (Guérin, 1980). Ginsburg and Guérin (1979) encountered some fossils in the Lower Aragonian (MN 3) of Wintershof-West in Germany, and identified them as *Alicornops* sp. They may represent a primitive ancestor of *A. simorreense*. Hitherto *A. alfambrensis* is known only from La Roma-2 in Spain and Montredon in Hérault, France (MN 10) (Cerdeño and Sánchez 2000).

The Middle Miocene fauna bearing *A. laogouense* in the Linxia Basin is the same age as the Dingjiaergou fauna from Tongxin in Ningxia, China, which corresponds to MN 6 (Qiu *et al.* 1999). With the discovery of *A. laogouense* in the Linxia Basin, it appears that the genus *Alicornops* dispersed from western through eastern Europe, western and southern Asia, to the Far East. During MN 6 times, its distribution was relatively widespread through the whole of Eurasia.

PALAEOECOLOGY.

In Western Europe, *A. simorreense* lived together with other rhinoceroses, such as *Hoploaceratherium tetradactylum*, *Aceratherium incisivum* and *Lartetotherium sansaniense* in open woodland with associated lakes and swamps (Guérin 1980). The short limb bones and robust metapodials of *A. simorreense* were adapted for life on soft soils in contrast to the long and straight metapodials of other rhinoceroses (Cerdeño 1998).

In China, *A. laogouense* lived together with *Hispanotherium matritense* in a warm environment (Deng

and Downs 2002). A large number of fossils of the Amebelodontidae, which favoured habitats near water, have been found with *A. laougouense* in the Linxia Basin, indicating that lakes and rivers were abundant in the environment in which this species lived.

Acknowledgements. I thank Prof. Z. X. Qiu, Prof. B. Y. Wang, Dr X. M. Wang, and Dr X. J. Ni of IVPP in Beijing for their support in the field and discussion of the manuscript. I am grateful to Prof. Dr K. Heissig and Dr I. Giaourtsakis of BSP in Munich for other help. I thank Mr Y. Xu for Text-figure 4. This work has been supported by the Chinese Academy of Sciences (KZCX2-103, RJZ2001-105), the National Science Foundation of China (40232023), and the Ministry of Science and Technology of China (G2000077700).

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Typescript received 10 July 2002

Revised typescript received 23 June 2003