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Article

Anosteira maomingensis (Testudines: Carettochelyidae) from the Late Eocene of Maoming, Guangdong, southern China: new material and re-description

Haiyan Tong, Paris, **Jiang-Yong Zhang,** Beijing and **Jian-Jun Li,** Beijing

With 6 figures and 2 tables

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Abstract: *Anosteira* is a carettochelytid turtle known from the Eocene of Asia and North America and includes several species. The species *A. maomingensis* Chow & Liu, 1953 was established originally on the basis of two internal molds. The present study is based on new specimens collected by the IVPP in Maoming during 2005-2006 and unpublished specimens housed in the Beijing Museum of Natural History, which include more than twenty shells and a lower jaw. *A. maomingensis* is characterized by its large size, absence of all marginal scutes and reduced pleural scutes, which do not cover the lateral part of the costal plates. The lower jaw has a wide, posteriorly expanded and concave triturating surface, a strong and tall coronoid process lying on the middle of the jaw ramus and deeply excavated lateral surface under the coronoid process.

Key words: Testudines, Carottochelyidae, Anosteirinae, *Anosteira maomingensis*, Eocene, China, systematics, distribution.

1. Introduction

Remains of *Anosteira maomingensis* Chow & Liu, 1955 (Carettochelyidae: Anosteirinae) are abundant in the Late Eocene oil shale of Maoming, Guangdong Province, in southern China. Although the species has been known for more than fifty years, our knowledge on this turtle is still limited, since most specimens collected until now are internal molds contained in the oil shale and the species has never been described in detail. The history of the study started in the 1950s. In 1955, Chow and Liu were the first to study turtle remains from Maoming and erected a new species of *Anosteira*: *A. maomingensis*, on the basis of two internal molds (Chow & Liu 1955). The year after, Chow published a second paper, figured two additional and well preserved shells of that species, discussed some morphological features and the age of the fossils, as well as the systematic position of Anosteirinae (Chow 1956). In 1958, Ye collected more than 20 shells of *A. maomingensis* from Maoming, most (or all) of them being internal molds (Ye 1963, 1994), but no additional study was attempted. The present study is based on the new specimens collected in 2005-2006 by an IVPP team and unpublished specimens housed in the Beijing Museum of Natural History, which consist of several dozens of shells and a lower jaw. All specimens are from Mao-

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Fig. 1. Map showing location of Maoming. A. Oil shale mining in Maoming; B. Outcrop of the fossiliferous beds.

ming. Only the well preserved specimens are considered in this study, the internal molds are not included. Our purpose is to give a detailed and complete description and reconstruction of the shell of *A. maomingensis*. A complete lower jaw is reported for the first time for that species.

The Maoming Basin is one of the most important oil shale basins in China. It is situated in the southwestern part of Guangdong province, southern China (Fig. 1). The vertebrate remains come from the Youkanwo Formation, which consists of mainly brown-black oil shale, deposited in a semi-deep lake environment under a temperate to subtropical climate. On the basis of palynology, the Youkanwo Formation is dated as Eocene-Oligocene (Yu & Wu 1983; Li et al. 2006), while the eomorophid mammal *Lunania* cf. *youngi* discovered at Maoming supports a Late Eocene age for that formation (Wang et al. 2007; Jin 2008). In addition to the abundant carettochelyid turtle *Anosteira maomingensis*, the Youkanwo Formation of Maoming has yielded the geoemydid turtle *Isometremys lacuna* (Chow & Ye, 1962) and the trionychid turtle *Aspideretes impressus* (Ye, 1963), the cyprinid fish *Cyprinus maomingensis* (Liu, 1957), the eusuchian crocodile *Tomistoma petrolica* (Ye 1958; Li 1975) and the eomorophid mammal *Lunania* cf. *youngi* (Wang et al., 2007).

Institutional abbreviations: BMNH: Beijing Museum of Natural History; IVPP: Institute of Vertebrate Paleontology and Paleoanthropology, Beijing.

2. Systematic palaeontology

Cryptodira Cope, 1868
Trionychoidea Fitzinger, 1826
Carettochelyidae Boulenger, 1887
Anosteirinae Lydekker, 1889

Emended diagnosis: A subfamily of Carettochelyidae; scutes retained on shell; vertebral scutes greatly modified, with the second vertebral scute bounded laterally by the first vertebral scute; plastron reduced, cruciform, with wide and short bridge and very narrow and long posterior lobe.

Anosteira Leidy, 1871

Emended diagnosis: A genus of Anosteirinae. Differing from *Kizylkumemys* in the second vertebral scute extending onto the first neural; differing from *Pseudanosteira* in the regular neurals, the large and not divided second vertebral scute.

Type species: *A. ornata* Leidy, 1871.

Included species: *A. ornata; A. mongoliensis; A. manchuriana; A. maomingensis; A. shantungensis; ?A. lingnanica.*

Table 1. Measurements of shell of *Anosteira maomingeneis* (in mm).

Specimen	Length		Width	
Collection number	preserved	Estimated total length	Preserved	Estimated total width
IVPP V15005-1	190	220	150	210
IVPP V15005-2	210	218	135	205
IVPP V15005	205	240	177	222
IVPP V816	255	290	230	262
IVPP V15005-3	184	212	163	186
BMNH Ph000290	214	235	163	210
BMNH Ph000284	230	230	147	207
BMNH Ph000283	210	230	174	195
BMNH Ph000286	235	247	175	224
BMNH Ph000285	190	215	145	195
BMNH Ph000280	198	240	153	223
BMNH Ph000276	190	250	158	230
BMNH Ph000271	225	264	122	243
BMNH Ph000274	175	284	122	260
BMNH Ph000261	197	220	148	194
BMNH Ph000259	175	220	180	200
BMNH Ph000282	240	255	195	230
BMNH Ph000278	145	220	165	205

Distribution: Eocene-Oligocene of Asia and Eocene of North America.

Anosteira maomingensis Chow & Liu, 1955
Figs. 2-5

Emended diagnosis: A species of *Anosteira* of large size, with carapace length ranging from 210 to 290 mm; differing from *A. ornata* in the reduction of the pleural scutes and the absence of marginal scutes; differing from *A. manchuriana* in the trapezoidal nuchal; differing from *A. mongoliensis* in the posterior lobe of the plastron with backward convergent lateral margins; differing from *A. shantungensis* in the reduced pleural scutes and ornamentation on the peripherals consisting of small isolated tubercles.

Type specimens: Holotype: IVPP V809, an internal mold; Paratype: IVPP V810, an internal mold.

Type locality: Maoming, Guangdong Province, China.

Referred material: IVPP collection: IVPP V816. New material: 4 shells: IVPP V15005, IVPP V15005-1, IVPP V15005-2, IVPP V15005-3; an isolated nuchal: IVPP V15005-4; a lower jaw: IVPP V15005-5.

BMNH collection: 13 shells: carapace with associated incomplete plastron: Ph000259, Ph000282, Ph000290; carapace without plastron: Ph000261, Ph000271, Ph000274, Ph000276, Ph000278, Ph000280, Ph000283, Ph000284, Ph000285, Ph000286.

Measurements: See Table 1.

Description: Lower jaw (Fig. 2): The lower jaw (IVPP V15005-5) is almost complete and well preserved; only the lower margin of the right ramus is damaged. The lower jaw measures 76 mm in length and 63 mm in width, with a symphysis length of 19 mm. The lower triturating surface is wide. The anterior part of the triturating surface is an upward facing flat surface, without a symphysial ridge. Posteriorly, the triturating surface becomes wider and concave, with the lingual ridge much higher than the labial ridge. The coronoid process is tall and has a strong and rounded end. It is located at the mid-length of the ramus. The lateral surface of the lower jaw under the coronoid process is deeply excavated, for insertion of M. adductor mandibulae externus pars superficialis (Gaffney 1979). This concavity is divided into two parts by a horizontal blunt ridge. The upper part is triangular and formed by the coronoid. The lower part, formed by the dentary, is anteroposteriorly elongated, extends well into the dentary and forms a deep cavity. The foramen dentofaciale majus is located below the anterior end of the blunt ridge, within the dentary. The articular area bears a longitudinal ridge which divides the surface into two parts: a larger and square-shaped lateral part formed by the surangular, and a rectangular medial part formed by the articular, both being slightly concave. The retroarticular process is well developed, long and turns medially. It is formed by the surangular laterally and the articular medially. The foramen nervi auriculotemporalis is below the articular surface, within the surangular. On the inner surface, the sulcus cargilaginis meckelii is a shallow groove. The fossa meckelii is narrow and long. Posteromedial to the articular surface is the foramen posterius chorda tympani.

Shell (Figs. 3-4): The whole shell surface of *A. maomingensis* is sculptured. The ornamentation on the neurals and iostids consists of roughly anteroposteriorly directed and parallel vermiculated ridges. However, the ornamentation on the neurals and the medial part of the costals is weak and tends to vanish. On the peripheral region, including the dorsal surface of the nuchal and both the dorsal and ventral

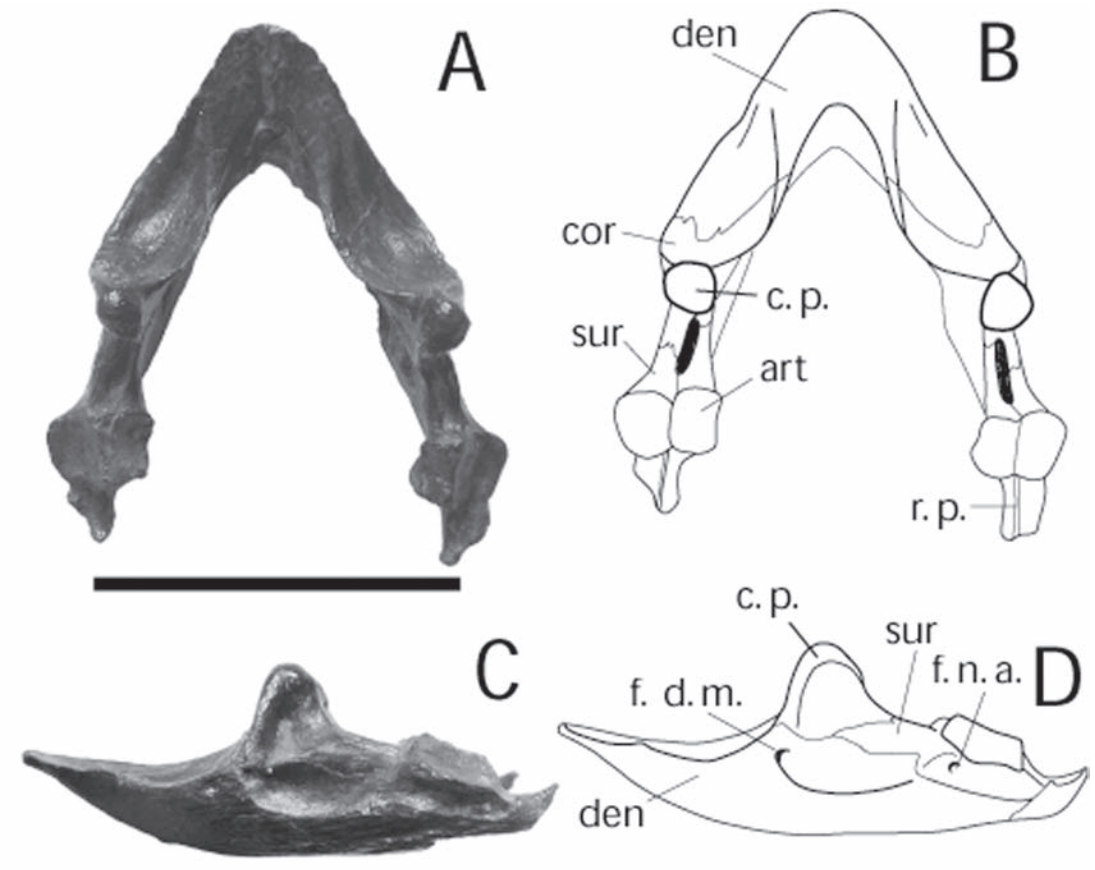

Fig. 2. Lower jaw of *Anosteira maomingensis* in dorsal (A-B) and left lateral (C-D) views. Abbreviations: art, articular; cor, coronoid; c. p. coronoid process; den, dentary; f. d. m., foramen dentofaciale majus; f. n. a., foramen nervi auriculotemporalis; r. p., retroarticular process; sur, surangular. Scale bar = 50 mm.

surfaces of the peripherals, the ornamentation is finer and more interrupted, consisting of small isolated tubercles. The tubercles on the nuchal are, however, larger than those on the peripherals. The vermiculated ridges are also well marked on the plastron, arranged in a radiating manner on the epiplastron, entoplastron, xiphiplastron and the medial part of the hyoplastron and hypoplastron; while they are arranged in a transverse and parallel manner on the bridge.

Carapace: The shell is low and has a heart-shaped outline, with a shallow nuchal emargination. A distinct continuous midline keel is present from the posterior part of the fourth neural to the pygal plate, which becomes sharper and higher from the front to the back. As a result, the posterior part of the carapace has a roof-like cross section. The free margin of the shell is smooth throughout, without serrations. The anterior and anterolateral margin of the carapace is blunt, and the posterior and posterolateral margin, from the seventh peripheral to the pygal, is acute.

The carapace consists of one nuchal, seven neurals, eight costals, one suprapygal, one pygal and ten peripherals. The nuchal is large, much wider than it is long, and has anteriorly convergent lateral margins. Its posterior margin is strongly convex posteriorly. There is a pair of ventral processes on the inner surface of the nuchal, where the postzygapophysis of the eighth cervical vertebra inserts, a characteristic of the Carettochelyidae (Fig. 4). The neurals are narrow. The general neural formula is 4>6>6>6>6>6>5 in most specimens. The first neural is four-sided and very elongated, with its posterior end narrower than the anterior one. The second to sixth neurals are hexagonal, with short anterolateral sides and a narrow posterior end. The seventh neural is pentagonal and roughly as long as wide. How-

Fig. 3. Shell of *Anosteira maomingensis*. A-D, IVPP V15005 in dorsal (A-B) and ventral (C-D) views; E-F, IVPP V15005-1 in ventral view. Scale bar = 50 mm.

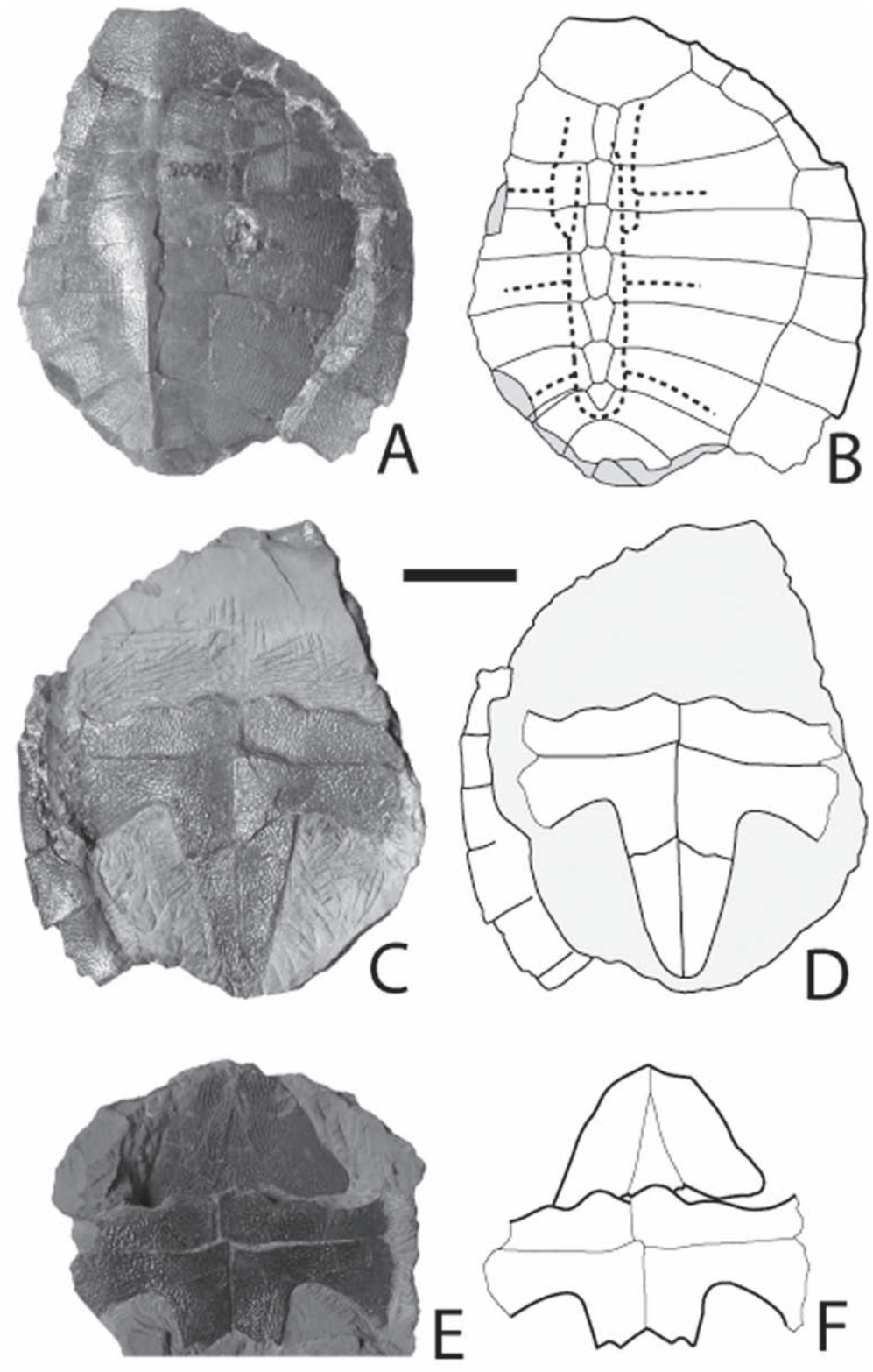

Fig. 3 (Legend see p. 282)

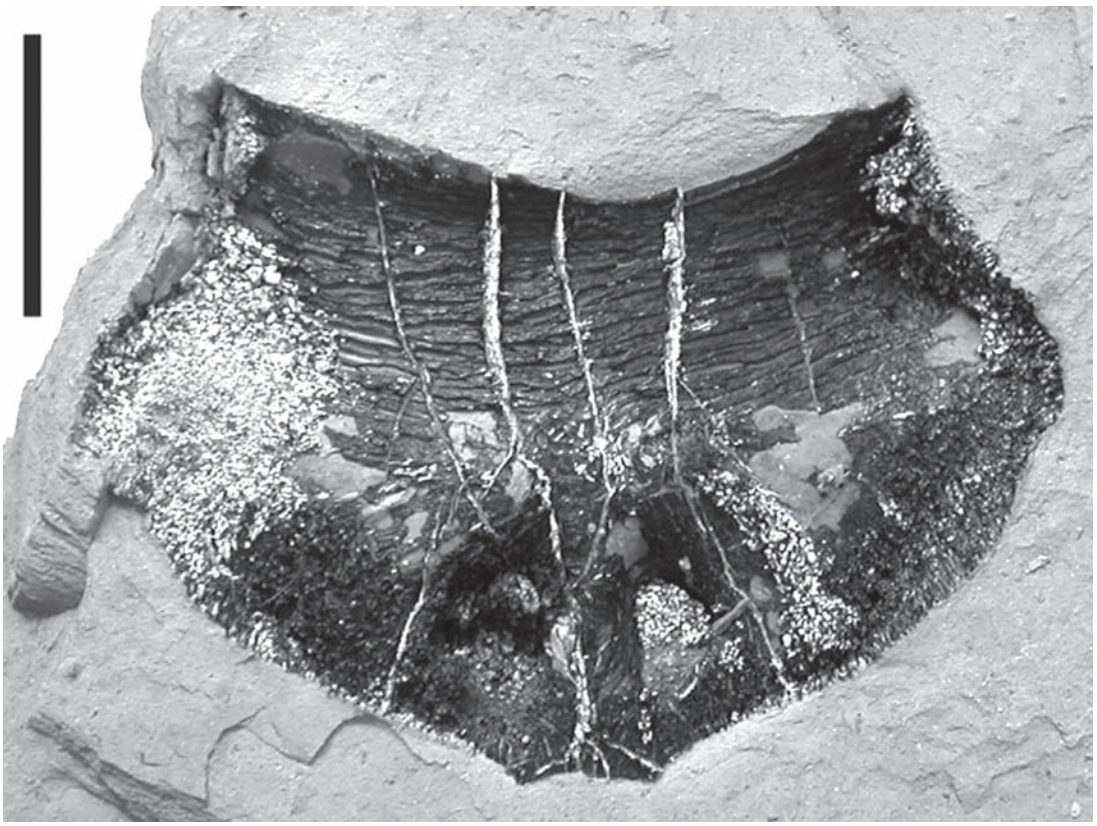

Fig. 4. Internal mold of nuchal of *Anosteira maomingensis* (IVPP V15005-4) showing the pair of ventral processes. Scale bar = 20 mm.

ever, individual variation among the neurals is present in a few specimens. In BMNH Ph000278, the first neural is six-sided, with short posterolateral sides, followed by a four-sided second neural; the following three preserved neurals are hexagonal with short anterolateral sides. IVPP V15005-2 also has a neural formula 6<4>6>6>6>6>5. BMNH Ph000274 has five neurals preserved; the first to third neurals have the normal shape, while the fourth and the fifth neurals are separated by the fifth pair of costal plates which meet on the midline, which is an anomaly. The first costal is much longer than the second one. The second to seventh costals have the lateral end wider than the medial end. The posterior part of the seventh costal and the eighth costal meet on the midline, separating the neural series from the suprapygal. There is a single, large and roughly triangular suprapygal, which has a house-top cross section. The pygal plate is slightly wider than long, with its anterior and posterior margins convex backwards. The peripherals are large. The first peripheral is trapezoidal in shape, with the anterior margin longer than the posterior one. The second peripheral is longer than wide. The third peripheral is roughly square in shape and the fourth to tenth peripherals are slightly wider than long or as long as wide. Ventrally, the fourth and the fifth peripherals contact the hyoplastron and the fifth to seventh peripherals contact the hypoplastron.

The scute sulci are very weak on the carapace; they are barely discernible on most specimens. There are three narrow vertebral scutes. The first vertebral scute extends from the posterior part of the nuchal to the third costal plate in most specimens where it is visible. In a few specimens, such as Ph000282, the first vertebral scute extends on the second costal. In some specimens (Ph000278 and Ph000282), a short midline sulcus is discernible on the top of the second vertebral scute, which indicates that the first vertebral is a little divided. The second vertebral is the largest, extending from the first neural to the seventh costal, posterior to the seventh neural. The anterior part of the second vertebral scute is bounded laterally by the first vertebral scute, as in all Anosteirinae. The third vertebral has a narrow front part and expands posteriorly on the eighth costal. The pleural scutes are variably developed. They are visible on the medial part of the costal plates, extending more or less laterally, but not reaching the lateral end of the costals. There is no trace of the scute sulci on the peripheral plates, nor on the anterior part of the nuchal, which indicates that the marginal and cervical scutes are absent.

Plastron: The plastron is preserved in only a few specimens, and none of them are complete. The plastron is very reduced and cruciform, with a very short and wide bridge. The axillary and inguinal notches are widely open. The anterior lobe, preserved only in IVPP V15005-1, is dis-

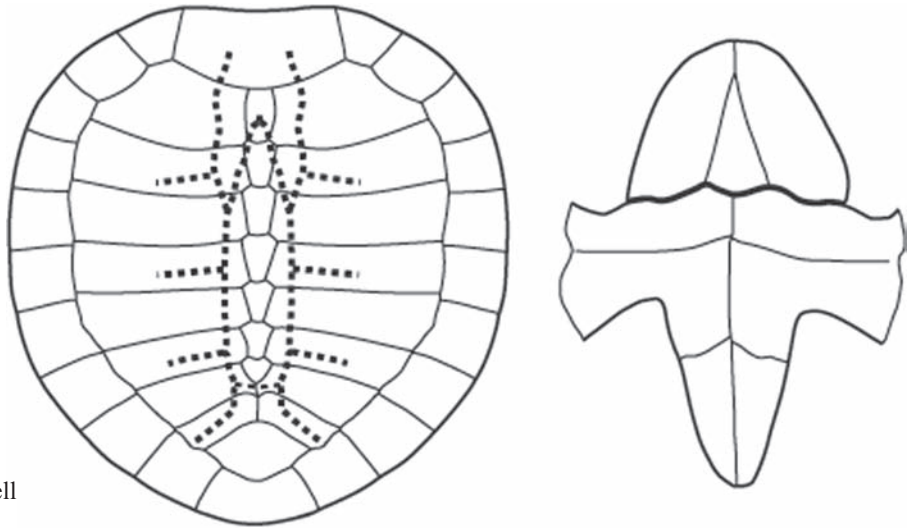

Fig. 5. Reconstruction of the shell of *Anosteira maomingensis.*

articulated from the hyoplastra and pushed inwards. The anterior lobe is much wider than the posterior lobe. It is composed of a pair of epiplastra and one entoplastron, all anteroposteriorly elongated. The epiplastron is much larger than the entoplastron, with a short midline suture to its mate, anterior to the entoplastron. The entoplastron is a narrow triangular. The hyoplastron is shorter than the hypoplastron. The anterior margin of the hyoplastron is undulated, with a large midline notch to receive the entoplastron and a lateral notch for the epiplastron attachment. The anterior surface of the hyoplastron bears horizontal parallel ridges on these notches, which indicates a hinge between the anterior lobe and the hyoplastra. The lateral portion of the hyoplastron is short, with a very weak axillary process. The hypoplastron has a longer lateral portion, with a more developed inguinal process in comparison with the axillary process. The xiphiplastron, preserved in IVPP 15005, Ph000259 and Ph000282, is very long and narrow, with lateral margins that converge backward and a pointed posterior end, without anal notch; while the xiphiplastron of IVPP V15005-2 is shorter, with a more rounded posterior end.

There are no traces of scute sulci on the plastron.

3. Comparisons and discussion

The family Carettochelyidae consists of two subfamilies: Anosteirinae and Carettochelyinae. Anosteirinae are characterized by the retention of scutes on the shell, greatly modified vertebral scutes, with the second vertebral extending forwards onto the second or the first neural and bounded laterally by the first vertebral, and a very reduced and cruciform plastron, with a wide and short bridge and a very narrow and long posterior lobe. The other subfamily, Carettochelyinae, has lost all scutes in the adult and has a wider plastron and wider posterior lobe in comparison with Anosteirinae.

Erected by Leidy in 1871, the genus *Anosteira* contains one species (*A. ornata*) from the Eocene of North America (Leidy 1871; Hay 1908; Joyce et al. 2004) and several species from China. In China, in addition of *A. maomingensis*, four other *Anosteira* species have been described: *A. mongoliensis* Gilmore, 1931 from the Late Eocene of Ulan Shireh, Inner Mongolia (Gilmore 1931); *A. manchuriana* Zangerl, 1947 from the Late Eocene of Fushun, Liaoning (Zangerl 1947); *A. shantungensis* Cheng, 1961 from the Late Eocene-Early Oligocene of Linqu, Shandong (Cheng 1961), and *A. lingnanica* from the probable Paleogene of Nanxiong, Guangdong (Young & Chow 1962). In addition, Chow (1959) reported a single peripheral plate of *A.* sp. from the Eocene of Xinyu, Jiangxi. Most of the Chinese *Anosteira* species are based on a single specimen or shell fragments. *A. maomingensis* includes the most abundant material, including several dozen shells and one lower jaw.

The lower jaw of *Anosteira maomingeneis* is reported for the first time. This lower jaw presents carettochelyid characters, including the tall and strong coronoid process situated at the mid-length of the jaw ramus and the deep excavation on the lateral surface of the lower jaw, under the coronoid process. The lower jaw of *A. maomingensis* closely resembles that of *Kizylkumemys schultzi* (Nessov, 1977), an anosteirine from the Late Cretaceous of Central Asia, in the posteriorly expanded and concave triturating surface. *K. schultzi* differs from *A. maomingensis* in

Table 2. Comparisons between *Anosteira maomingensis* and other species of *Anosteira* and *Pseudanosteira*
* Estimated size.

Characters	*A. maomingensis*	*A. manchuriana*	*A. mongoliensis*	*A. shantungensis*	*A. ornata*	*Peudanosteira*
Nuchal shape	Trapezoidal	Yoke-shaped	Trapezoidal	Trapezoidal	Trapezoidal	?
Cervical notch	Shallow	Anterior margin of nuchal convex	Deep	Shallow	Shallow	?
Neurals	Common formula: 4>6>6>6>6>6>5	6>6>6>6>6>6> 5	?	6<4>6>6>6>6>5	4>6>6>6>6>6>5	Differenciated
Marginal scutes	Totally absent	?	?	At least absent on peripheral 1 to 3	Present on peripheral 5 to pygal	Present on peripheral 4 to 10
Costal scute sulci	Not extending to the lateral end of the pleural plates	?	?	Extending to the lateral end of the pleural plates	Extending to the lateral end of the pleural plates	Extending to the lateral end of the pleural plates
Vertebral 1 midline division	Divided or not	Not divided	?	Divided	Divided	Divided
Vertebral 1 posterior extension	Extending onto costal 3 or costal 2	Extending onto costal 2	?	Extending onto costal 3	Extending onto costal 3	Extending onto costal 3
Number of vertebral scutes	3	3	?	3	3	5
Posterior lobe shape	Narrow with pointed posterior end and backward convergent margins	As *A. maomingensis*	Parallel margins	?	More similar to *A. mongoliensis*	?
Ornamentation on peripheral plates	Small isolated tubercles	?	Vermiculated ridges and tubercles	Vermiculated ridges and tubercles	Vermiculated ridges and tubercles	Vermiculated ridges and tubercles
Carapace size (L x W in mm.)	210x172* – 290x240*	85x57 as preserved	?x110	124x121*	125x105	190x175

the shallower and not divided excavation on the lateral surface.

The comparison of the shell of *A. maomingensis* with other *Anosteira* species and *Pseudanosteira* is shown in Table 2. Our comparisons show that the North American anosteirines, *A. ornata* and *Pseudanosteira*, differ from *A. maomingensis* mainly by the retention of the marginal scutes and less reduced pleural scutes, while there are very few differences between the Chinese species. *A. maomingensis* is clearly larger than most *Anosteira* species (except *A. lingnanica*), with a carapace length ranging from 210 to 290 mm. which represents the sub-adult and adult individuals (see Tables 1-2). It differs from *A. mongoliensis* in the shape of the posterior lobe and from *A. manchuriana* in the shape of the nuchal plate. *A. shantungensis* differs from *A. maomingensis* in the less reduced pleural scutes and the ornamentation on the peripheral plates, which is more similar to that of *A. ornata* and *Pseudanosteira* (Table 2). Some features seen in *A. shantungensis*, such as a neural formula of 6<4>6>6>6>6>5, also occur in *A. maomingensis* as individual variations. According to some authors (Nessov 1976; de Broin 1977, 1987), *A. lingnanica* is not referable to the genus *Anosteira*, but more closely related to *Allaeochelys*, an Eocene European carettochelyine. A re-examination of the specimens of *A. lingnanica* is needed, but we were unable to locate them in the IVPP collection.

From the observations described above, some features of the shell morphology of *A. maomingensis* can be considered:

Anosteira, like other members of Anosteirinae, has reduced scutes on the shell. In *A. maomingensis*, there is no trace of scute sulci on the peripheral plates, which indicates that the marginal scutes are totally lost in this species. The cervical scute is also absent. The pleural scutes are reduced, and do not cover the lateral end of the costal plates, since the interpleural scutes sulci are visible only on the medial part of the costal plates and do not extend to their lateral end. The reduction of the pleural scutes and total loss of marginal scutes make *Anosteira maomingensis* more advanced than American anosteirines. In both *A. ornata* and *Pseudanosteira*, complete pleural scutes are retained and the marginal scutes are present, except the most anterior ones (Hay 1908; Clark 1932). There are no scutes on the plastron of *A. maomingensis*, as in other *Anosteira* species.

A. maomingensis has a hinge between the anterior lobe (epiplastron-entoplastron) and the hyoplastron, like *Allaeochelys* (de Broin, 1977) and the extant carettochelyid, *Carettochelys insculpta* (Pritchard, 1979). This is indicated by the parallel ridges on the contact surface between the anterior lobe and the hyoplastron. It explains why the anterior lobe is often missing in articulated shells. However, in *A. maomingenesis*, the hyoplastron, hypoplastron and xiphiplastron are tightly sutured together, as well as the right and left parts; there was no flexibility along the midline and along each bridge as seen in *Carettochelys* (Pritchard 1979).

The study of a large number of specimens of *A. maomingeneis* allows the observation of morphological variations among a single population. These include the extension of the first vertebral scutes (the first vertebral scute extends posteriorly onto the third costal plate in most specimens, while in a few specimens it extends onto the second costal plate) and the midline division of the first vertebral scute (in some specimens, a short midline sulcus is visible on the top of the second vertebral scute, which indicates that the first vertebral scute is partially divided; such a sulcus is however not visible in all specimens). Although the common neural formula is 4>6>6>6>6>6>5, two specimens (IVPP V15005-2 and BMNH Ph000278) have a neural formula of 6<4>6>6>6>6>5. The interrupted neural series observed in BMNH Ph000274 is considered as an anomaly.

4. Palaeogeography

Originating from Asia, the Anosteirinae are known since the Early Cretaceous, with the most ancient representative recorded from the Early Cretaceous Sao Khua Formation of the Khorat Plateau, NE Thailand (Tong et al. 2004). The only known Cretaceous genus, *Kizylkumemys*, was widespread in Asia, being recorded from Central Asia (Nessov 1977, 1984; Sukhanov 2000), Japan (Hirayama 1998) and Southeast Asia. *Kizylkumemys khoratensis* is common in the mid-Cretaceous Khok Kruat Formation in NE Thailand (Tong et al. 2005, 2006). Lapparent de Broin (2004) reported 'Carettochelyidae indet.' from the mid-Cretaceous 'Grès supérieur Formation' of Laos, which might also be *Kizylkumemys*. Originally described as Trionychidae (Young & Chow 1953), *Sinaspideretes wimani* fromt the ?Upper Jurassic of Sichuan, China was later tentatively assigned to

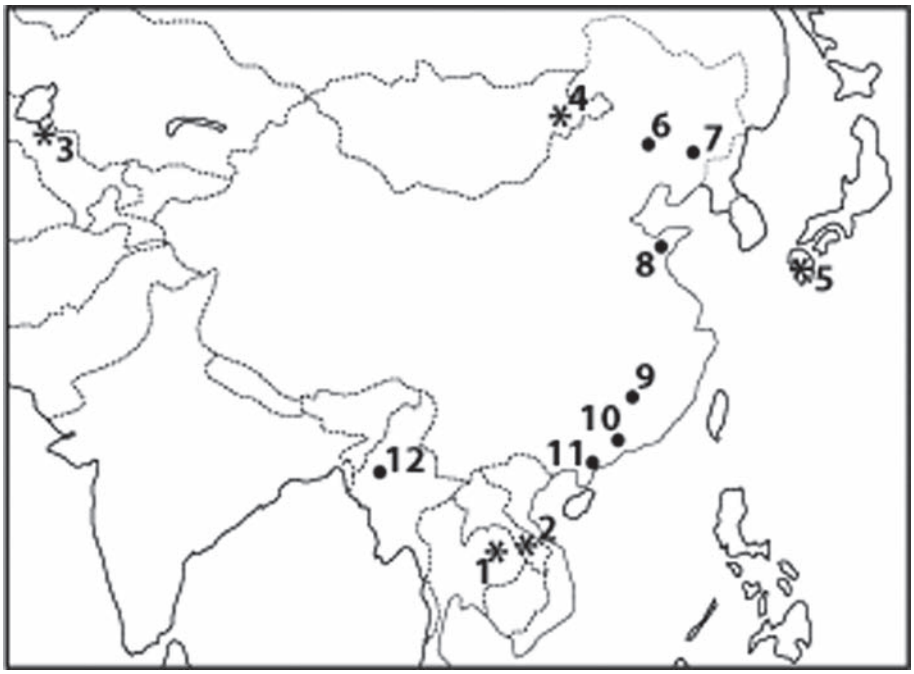

Fig. 6. Distribution of Anosteirinae in Asia. 1, *Kizylkumemys* sp. (Sao Khua Formation (Early Cretaceous) and *K. khoratensisi* (Khok Kruat Formations (late Early Cretaceous)), Khorat Plateau, NE Thailand; 2, Carettochelyidae indet., Grès supérieurs Formation (Early Cretaceous), Savannakhet Province, Laos; 3, *Kizylkumemys schultzi*, Late Cretaceous, Uzbekistan; 4, '*Anosteira shuwalovi*', Late Cretaceous, Mongolia; 5, Anosteirinae gen. et sp. indet. Mifune Group (Late Cretaceous), Kumamoto Prefecture, Japan; 6, *Anosteira mongoliensis*, Late Eocene, Inner Mongolia, China; 7, *A. manchuriana*, Late Eocene, Fushun, Liaoning Province, China; 8, *A. shantungensis*, Late Eocene-Early Oligocene, Linqu, Shandong Province, China; 9, *A.* sp., Eocene, Xinyu, Jiangxi Province, China; 10, *A. lingnanica*, ?Paleogene, Nanxiong, Guangdong Province, China; 11, *A. maomingensis*, Late Eocene, Maoming, Guangdong Province, China; 12, *A.* sp., Pondaung Formatiom (Middle Eocene), Myanmar.

Carettochelyidae (Meylan & Gaffney 1992). This incomplete shell has a sculptured surface and scute sulci on the carapace. The scute morphology, as figured by Meylan & Gaffney (1992), is inconsistent with that of carettochelyids, more particularly anosteirines. *Sinaspideretes* is likely a more basal trionychoid, as are adocids or nanhsiungchelyids. The Paleogene genus *Anosteira* occurs in both Asia and North America. The Asian distribution of *Anosteira* is mainly in China. The only Asian *Anosteira* hitherto recorded out of Chine is *A.* sp. from the late Middle Eocene Pondaung Formation of Myanmar (Hutchison et al. 2004). The distribution of Asian Anosteirinae is shown in Fig. 6. It is worth noting that the Cretaceous carettochelyids are mostly restricted in the palaeogeographically peripheral region of the continent (Tong et al. 2009). This is apparently also the case for the Paleogene *Anosteira* in Asia.

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Addresses of the authors:

Haiyan Tong, 30 rue Carnot, 94270 Le Kremlin-Bicêtre; France;
e-mail: htong09@yahoo.fr;

Jiang-Yong Zhang, Institute of Vertebrate Paleontology and Paleoanthropology, Academia Sinica, 142 Xizhimenwai Street, P. O. Box 643, Beijing 100044, China;

Jian-Jun Li, Beijing Museum of Natural History,
126 Tianqiao South Street, Beijing 100050, China.