

THE TYPE SERIES OF ‘*SINEMYS*’ *WUERHOENSIS*, A PROBLEMATIC TURTLE FROM THE LOWER CRETACEOUS OF CHINA, INCLUDES AT LEAST THREE TAXA

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Abstract: We re-examine the type series of ‘*Sinemys*’ *wuerhoensis* Yeh (at least 20 specimens, including several shells and skulls on three slabs of matrix and one isolated skull) from the Early Cretaceous Tugulu Group of China. Our study shows that the type series of ‘*S.*’ *wuerhoensis* is actually a chimera made up of at least three distinct taxa. The holotype of this taxon should be assigned to the basal eucryptodire genus *Xinjiangchelys* Yeh. As there are no characters that distinguish ‘*S.*’ *wuerhoensis* from *Xinjiangchelys* species, we consider it to be a *nomen dubium*. This new assignment of ‘*S.*’ *wuerhoensis* expands the temporal range of *Xinjiangchelys*

from the Late Jurassic into the Early Cretaceous in Asia. The majority of the paratypes of ‘*S.*’ *wuerhoensis* (several shells in dorsal and ventral aspect and skulls) are referred to the basal eucryptodire genus *Ordosemys* Brinkman and Peng. We establish a new name for these specimens, *Ordosemys brinkmania* sp. nov. One additional specimen in the type series of ‘*S.*’ *wuerhoensis*, a skull, is referred to cf. *Pantrionychia* Joyce, Parham and Gauthier indet.

Key words: China, Cretaceous, Cryptodira, fossil, Testudines, Tugulu Group, turtle.

SINEMYS WUERHOENSIS Yeh, 1973 was described based on at least 20 specimens (shells and skulls; Text-figs 1–7) from the Early Cretaceous Tugulu Group of Wuerho, Junggar Basin, Xinjiang, China (Text-figs 8–9). The species was referred to the genus *Sinemys* Wiman, 1930 of the family Sinemydidae Yeh, 1963 on the basis of the shared presence of a reduced, fenestrated plastron (Yeh 1973, 1994, 1996). These characters are now known to be plesiomorphic for the ‘macrobaenid’ grade (*sensu* Parham and Hutchison 2003). When Brinkman and Peng (1993a) revised the Sinemydidae, they excluded *Sinemys wuerhoensis* from both *Sinemys* and the Sinemydidae and left it as ‘*Sinemys*’ *wuerhoensis*, a view shared by other authors (Sukhanov 2000). Yet, despite the fact that the type series comprises at least 20 specimens, including skulls and shells, the taxonomic identity of ‘*S.*’ *wuerhoensis* specimens remains uncertain. The goal of this paper is to present new observations, images and taxonomic conclusions about these important specimens. We conclude that: (1) the type specimens of ‘*S.*’ *wuerhoensis* contain at least three distinct taxa; (2) ‘*S.*’ *wuerhoensis* is not a valid

species as the holotype specimen does not have any diagnostic characters; (3) at least seven specimens from the type series represent a new species of basal eucryptodire; (4) one unnumbered skull from the type slab may represent a pantrionychian. In this paper, phylogenetically defined clades are as proposed by Joyce *et al.* (2004), who recommended italicizing names but later (Joyce and Norrell 2005) suggested that phylogenetically defined clade names be put in small upper-case letters to distinguish them from ICZN binomials. This convention is used here on Text-figure 9.

Institutional abbreviations. IVPP, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China.

MATERIAL

Yeh (1973) reported that the type series of *Sinemys wuerhoensis* is represented by more than 13 individuals. There are at least 20 specimens if shells and skulls are counted

separately. Most of these specimens are located on three slabs of matrix.

The first slab (Text-fig. 1) contains seven specimens visible from one side only: IVPP V4074 (the holotype of *Sinemys wuerhoensis*), shell in ventral aspect; IVPP V4074.1, shell in ventral aspect; IVPP V4074.9, shell in ventral aspect; IVPP V4074.10 and V4074.11, skulls in ventral aspect; IVPP V4074.12, shell in ventral aspect (anterior part exposed); IVPP V4074.13, shell in ventral aspect.

The second slab (Text-fig. 3) contains eight specimens visible from one or both sides: IVPP V4074.3, shell in dorsal aspect (partially visible on the other side); IVPP V4074.4, shell in ventral aspect (partially visible on the other side); IVPP V4074.14, lateral part of shell in dorsal view (partially visible on the other side); IVPP V4074.15, anterior part of the shell in dorsal view; IVPP V4074.16, V4074.17 and V4074.18, three skulls in dorsal view; IVPP V4074.19, posterior part of shell in ventral view (partially visible on the other side).

The third slab (Yeh 1973, pl. 1, fig. 1; pl. 3, fig. 3) contains at least three specimens: IVPP V4074.20, shell in dorsal aspect; IVPP V4074.5 and V4074.6, two shells in ventral aspect. There are two separate specimens: IVPP V4074.7 (Yeh 1973, pl. 3, fig. 3), right posterior part of carapace in ventral aspect and IVPP V4074.8, isolated skull. Although the shell/skull attribution in the slabs is not certain, it is likely that skull IVPP V4074.10 belongs to shell IVPP V4074.12, skull IVPP V4074.11 to shell IVPP V4074.9, skull IVPP V4074.16 to shell IVPP V4074.14, and skull IVPP V4074.18 to shell V4074.3 or IVPP V4074.15. Among the specimens studied, the following are better preserved and used in this study: V4074, V4074.1, V4074.3, V4074.4, V4074.8, V4074.16, V4074.17, V4074.18 and V4074.19. The specimens of the third slab and IVPP V4074.7 were not examined.

SYSTEMATIC PALAEOONTOLOGY

TESTUDINES Batsch, 1788

PANCYPTODIRA Joyce, Parham, Gauthier, 2004

EUCYPTODIRA Gaffney, 1975 *sensu* Gaffney 1984

XINJIANGCHELYIDAE Nessov, *in* Kaznyshkin *et al.*, 1990

cf. *Xinjiangchelys* Yeh 1986a

Text-figures 1–2

1973 *Sinemys wuerhoensis* Yeh, p. 8, pl. 1, figs 1–2 [*nomen dubium*].

1993 '*Sinemys*' *wuerhoensis* Brinkman and Peng, p. 2141 [excluded from *Sinemys*].

Material. IVPP V4074 (holotype of *Sinemys wuerhoensis* Yeh, 1973), a shell in ventral aspect on a slab (Text-figs 1–2).

Description. IVPP V4074 represents a shell visible in ventral aspect on a slab. The left side of the specimen, including the bridge and periphery, and the anterior portion of the carapace are covered with matrix. The specimen demonstrates only a few carapace elements such as right peripherals 4–11, left peripherals 5, 6 and 11, a pygal, and a suprapygal (probably suprapygal 2). Other parts of the carapace are either not preserved or covered with matrix.

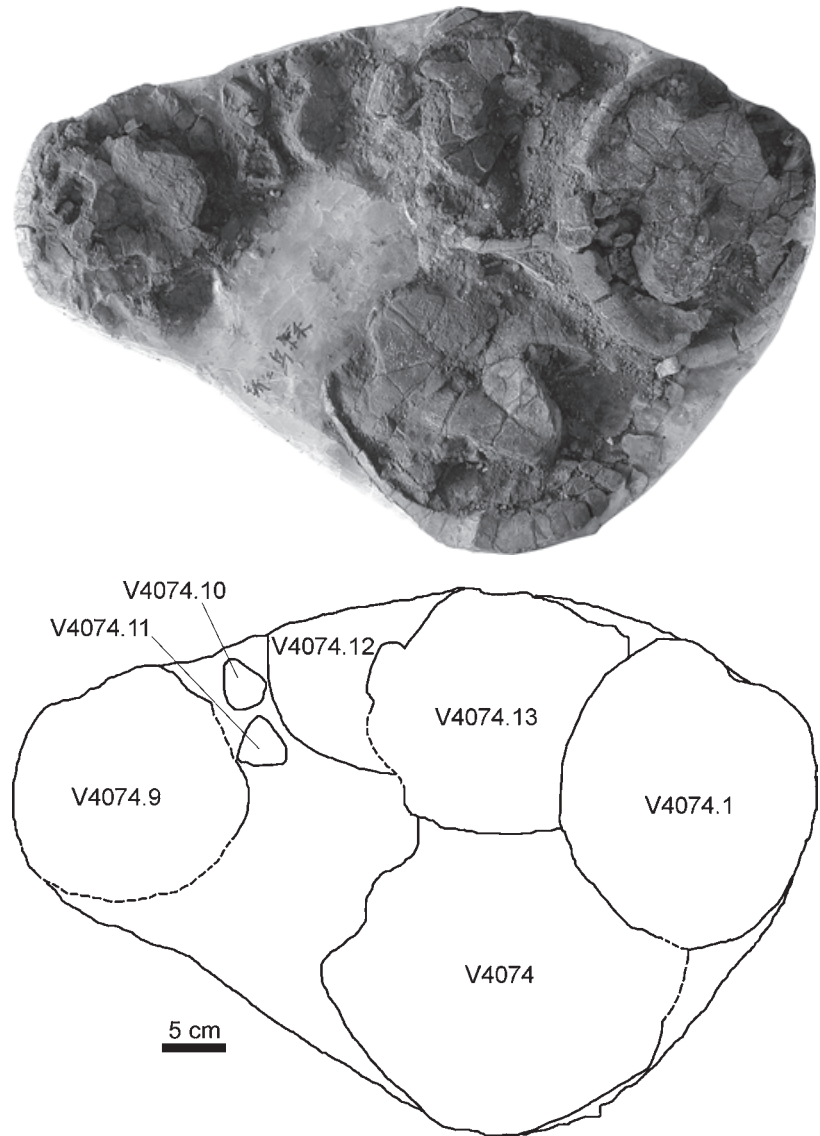
The plastron of IVPP V4074 is almost completely exposed, although its surface is somewhat damaged. Consequently, not all the scale sulci can be clearly traced. The plastron is separated from the carapace by distinct gaps filled with matrix, evincing a ligamentous plastron/carapace connection. The left bridge makes up 37 per cent of the plastron length and 42 per cent of the plastron width at the hyo-hypoplastral suture. The anterior lobe is relatively short and wide (its length is 29 per cent of the plastron length and 63 per cent of the lobe width at the axillary notch), slightly narrowed and truncated anteriorly. The posterior lobe is longer (35 per cent of plastron length and 69 per cent of the lobe width at the inguinal notch) and truncated posteriorly. There is an oval-shaped central (hyo-hypoplastral) fontanelle. Lateral plastral fontanelles are not present.

The right epiplastron is better preserved than the left. Its anterior border is almost transverse and its posterior border forms an angle about 20 degrees with the midline. The entoplastron is subrectangular and elongated. The midline sutures between the hyoplastra and hypoplastra are straight, not interdigitating.

There are intergular and gular scales on the epiplastron. The intergular does not extend onto the entoplastron and is almost half as wide as the gular. The pectoral-abdominal sulcus is located anterior to the central fontanelle. The anals slightly extend onto the hypoplastra, forming an anterior medial projection. The inframarginal scales are represented by four pairs that are visible on the lateral parts of the right hyoplastron and left hypoplastron. The border between inframarginals 1 and 2 lies in one line with the pectoral-abdominal sulcus. Inframarginal 3 lies on hyo- and hypoplastra. For measurements of this specimen, see Table 1.

Remarks. IVPP V4074 is referred to the Xinjiangchelyidae based on the following characters: ligamentous plastron/carapace connection, transversely orientated epiplastra, and the presence of intergular scales. Within the Xinjiangchelyidae, IVPP V4074 is most similar to *Xinjiangchelys* in having a subrectangular entoplastron, small intergulars restricted to epiplastra and anal scales extending onto hypoplastra. Within the genus *Xinjiangchelys*, IVPP V4074 is most similar to *Xinjiangchelys latimarginalis* (Young and Chow, 1953 *sensu* Peng and Brinkman 1993), although distinguished from it by its longer and narrower entoplastron and posterior lobe, more elongated hypoplastron posteromedially and presence of a central

TEXT-FIG. 1. Slab 1, including the holotype of *Sinemys wuerhoensis* Yeh, 1973, *nomen dubium* (IVPP 4074).



fontanelle. The variation within *Xinjiangchelys* is poorly studied so we consider IVPP V4074 to be *Xinjiangchelys* indet. and *Sinemys wuerhoensis* to be a *nomen dubium*.

Occurrence. Wuerho, Junggar Basin, Xinjiang, China. Upper Tugulu Group, Early Cretaceous (Aptian–?Albian).

grade 'MACROBAENIDAE' Sukhanov, 1964
sensu Parham and Hutchison 2003
ORDOSEMYS Brinkman and Peng, 1993b

Ordosemys brinkmania sp. nov.
Text-figures 3–6.

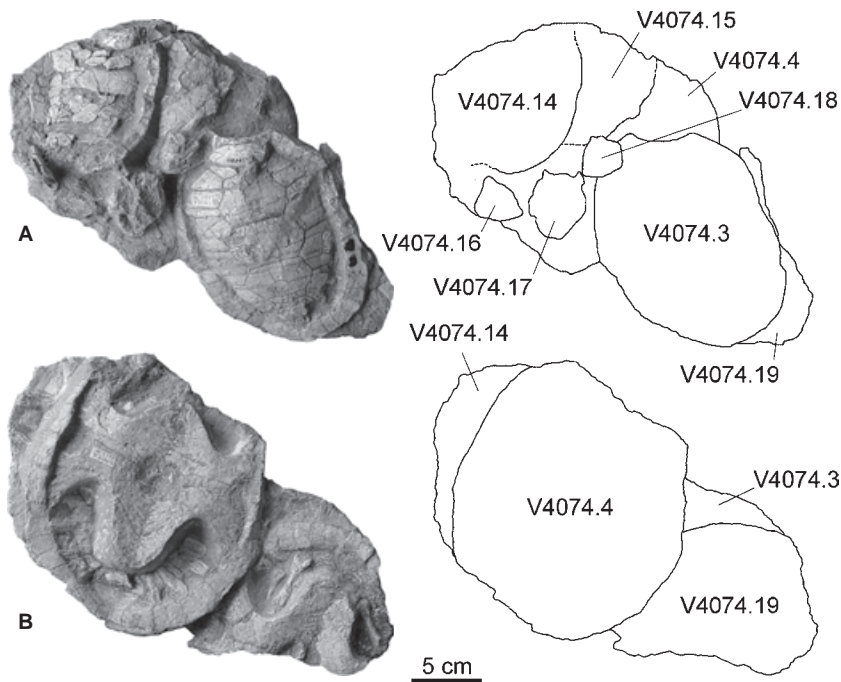
1973 *Sinemys wuerhoensis* Yeh, p. 8, pl. 1, figs 1–2 (in part); pl. 2, figs 2–3; pl. 3, figs 1–5.

Derivation of name. After Dr Donald Brinkman, one of the original describers of *Ordosemys*, an expert on Cretaceous fossil turtles from China, and a generous colleague.

Holotype. IVPP V4074.4, a shell in ventral aspect on a slab (Text-figs 3, 4A).

Referred material. IVPP V4074.1, shell in ventral aspect; V4074.3, shell in dorsal aspect (partially visible on the other side); V4074.8 isolated skull; IVPP V4074.14 and V4074.15, poorly preserved shells that may be associated with skulls IVPP V4074.16 or V4074.18; IVPP V4074.16 and V4074.18, skulls in dorsal view; IVPP V4074.19, posterior part of shell in ventral view (partially visible on the other side).

Diagnosis. A species of *Ordosemys* characterized by relatively deep upper temporal emarginations (about 40 per



TEXT-FIG. 2. Slab 2, including the holotype of *Ordosemys brinkmania* sp. nov. A, from one side. B, from the other side.

cent of the skull length), vertebral 1 with an anterior projection, and absence of the hypo-xiphiplastral fontanelle.

Description of the holotype. IVPP V4074.4 (Text-fig. 4A) is a shell in ventral aspect missing the anterior margin of the carapace, epi- and entoplastron; The anterior part of ventral surface of the carapace is covered with matrix. Among the carapace elements visible in ventral aspect are suprapygals 1–3, pygal, costals 5–8 (right and left), and peripherals 4–11 (right) and 7–11 (left).

Suprapygals 1 and 2 are shaped like transverse rectangles. Suprapygals 3 is a trapezoid with the wide end facing anteriorly. All three suprapygals enter the last pair of costal-peripheral fontanelles.

Costals 6 and 7 have wide free ribs entering posterior parts of the respective peripherals (8 and 9). The free rib of costal 8 enters between peripherals 10 and 11. The costal-peripheral fontanelles are well developed.

The plastron is missing the epiplastron and entoplastron. It is separated from the carapace by gaps filled with matrix that evince a loose (ligamentous) plastron/carapace connection. The anterior lobe seems to be short and strongly narrowed anteriorly, although its certain shape is unclear due to the missing anterior elements. The posterior lobe is more elongated (39 per cent of the plastron length and 80 per cent of the lobe width at the inguinal notch) and rounded posteriorly. There are well-developed, almost round, central fontanelles in the plastron. The lateral fontanelles are well developed, but narrow. The hypo-xiphiplastral fontanelle is absent. The midline sutures between the hyoplastra and hypoplastra strongly interdigitate.

The humeral-pectoral sulcus lies just posterior to the entoplastral notch. The pectoral-abdominal sulcus lies close and parallel

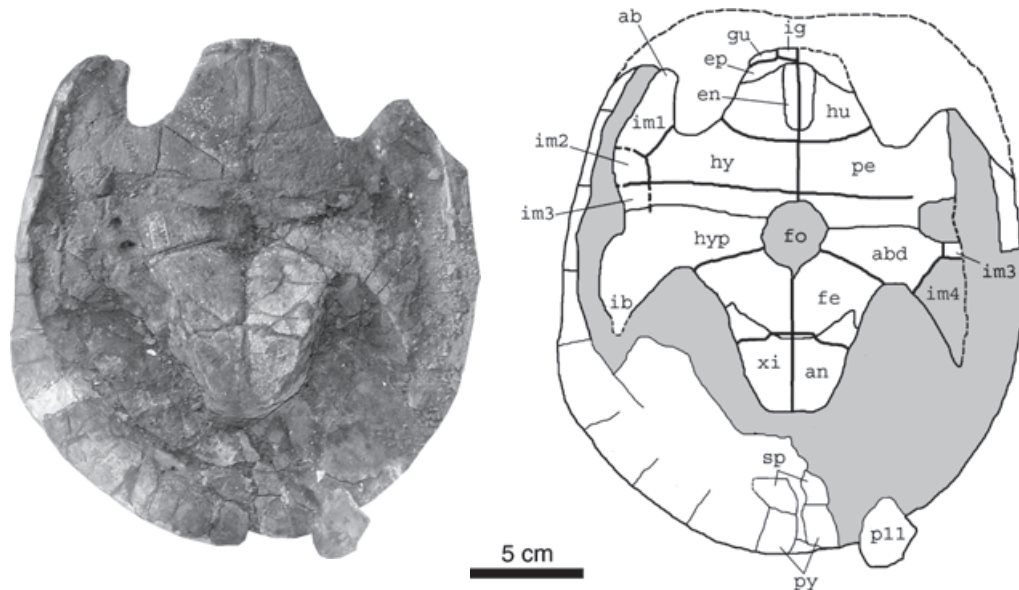
to the hyo-hypoplastral suture and enters the central and lateral fontanelles. The abdominal-femoral sulcus borders the posterior plastral lobe anteriorly, approaches the hyo-hypoplastral suture, and enters the central fontanelle medially. The femoral-anal sulcus is not visible on IVPP V4074.4. The midline lengths of the plastral scales cannot be measured owing to the central fontanelle. No inframarginal scales are visible. For measurements of this specimen, see Table 1.

Description of IVPP V4074.3. This specimen (Text-fig. 4B) represents a carapace in dorsal aspect. The carapace is compressed laterally because of deformation. The costal-peripheral fontanelles are well developed.

The nuchal has a slightly concave anterior border (nuchal emargination). The lateral borders of the nuchal are not clear. The neural series consists of a preneural and neurals 1–8. The preneural/neural 1 suture is clearly visible and located posterior to the vertebral 1/vertebral 2 sulcus. The preneural and neural 1 are short and wide rectangular elements almost equal in size. Neural 1 has point contacts with costal 2 on both sides. Neural 2 is almost rectangular and has point contacts with costal 1 on both sides, point contact with the left costal 3, and a short contact with right costal 3. Neural 3 is rectangular with a point contact with left costal 2. Neurals 4–7 are hexagonal and short sided anteriorly. Neural 8 is rectangular and has point contacts with costal 7 on both sides and with suprapygals 1 posteriorly.

There are three suprapygals. Suprapygals 1 and 2 are transverse rectangles, whereas suprapygals 3 is a trapezoid with the wide side anterior. All three enter the last pair of the costal-peripheral fontanelles. The pygal is a trapezoid widened posteriorly.

There are eight pairs of costals. Costals 1–6 and 8 have almost parallel lateral borders. Costal 7 is slightly widened laterally. The



TEXT-FIG. 3. IVPP V4074, *Xinjiangchelys* sp. (holotype of *Sinemys wuerhoensis*), shell in ventral view. Matrix is indicated by grey in interpretative drawing. Abbreviations: ab, axillary buttress; abd, abdominal; an, anal; ani, aperture narium interna; bo, basioccipital; bp, basisphenoid pit; bs, basisphenoid; c1, c8, costals 1, 8; cb1, cornu branchiale 1; co, condylus occipitalis; ct, cavum tympani; en, entoplastron; ep, epiplastron; f, femur; fcb, foramen caroticus basisphenoidale; fe, femoral; fo, fontanelle; fpcl, foramen posterius canalis caroticus lateralis; fpo, fenestra postotica; fr, frontal; gu, gular; hu, humeral; hy, hyoplastron; hyp, hypoplastron; ica, incisura columella auris; ig, intergular; im1, im2, im3, im4, inframarginals 1, 2, 3, 4; in, inguinal buttress; lj, lower jaw; na, nasal; n1, n8, neural 1, 8; nu, nuchal; p11, peripherals 10; pa, parietal; pe, pectoral; pf, prefrontal; pn, preneural; po, postorbital; ppe, processus pterygoideus externus; pt, pterygoid; py, pygal; qu, quadrate; so, supraoccipital; sp, unknown suprapygal; sp 1, sp 2, sp 3, suprapygal 1, 2, 3; v, vomer; xi, xiphiplastron.

free ribs of the posterior costals are orientated towards the posterior parts of respective peripherals. The posterior peripherals are longer (at free edge) than wide.

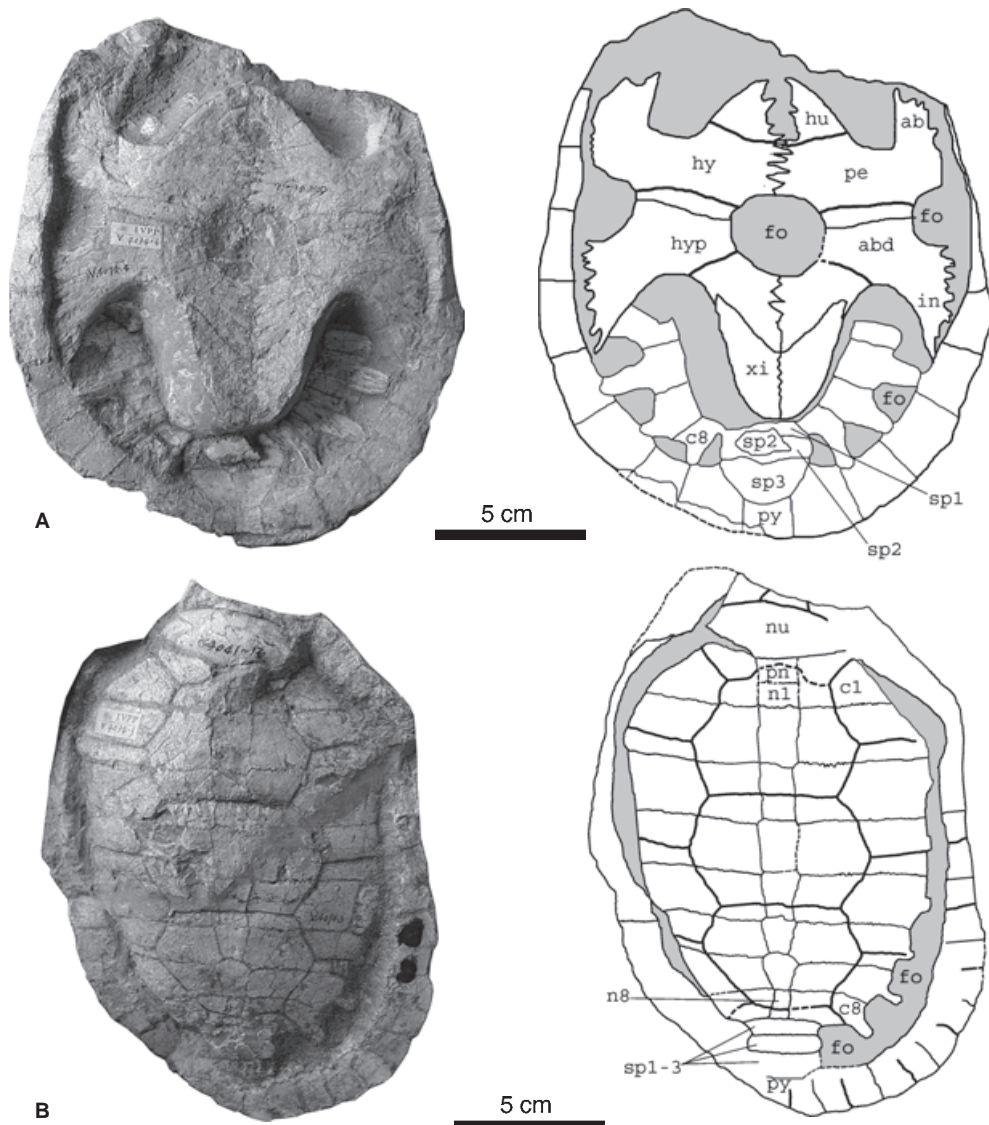
The carapace consists of a complete set of scales: a cervical, vertebrals 1–5, two pairs of pleurals 1–4 and marginals 1–12. The cervical is a wide trapezoid. The vertebrals are wider than long. It is unclear whether the first vertebral is wider than the nuchal. As visible on the left side, the anterior border of vertebral 2 forms an anterior projection, which must cross the preneural somewhere close to the nuchal/preneural suture. The position of the posterior borders of vertebral 5 is not clear. The shape of the pleural scales is unclear because of the deformation. The marginals can be discerned on the right posterior peripherals only. For measurements of this specimen, see Table 1.

Description of IVPP V4074.1. This specimen (Text-fig. 5A) is a shell in ventral aspect. It is almost round. The anterior outline of the carapace, although not complete, demonstrates a small emargination, probably restricted to the nuchal. Most of the ventral surface of the carapace is covered with matrix. The structure of the plastron, in general, corresponds to that of the holotype. The minimum length of the left bridge is 34 per cent of plastron length and 38 per cent of its width at the hyo-hypoplastral suture. The epiplastra and entoplastron are preserved. The epiplastra are narrow elements that form an angle of about 30 degrees with the midline. The entoplastron is narrow and elongate. There are central and lateral fontanelles. The area of the

hypo-xiphiplastral border is damaged, and it is not possible to establish whether the hypo-xiphiplastral fontanelle was present. The gular-humeral sulcus is not discernible. For measurements of this specimen, see Table 1.

Description of IVPP V4074.19. This specimen (Text-fig. 5B) is the posterior part of the shell in ventral aspect. The following elements are visible: the pygal, left peripherals 9–11, right peripheral 11, fragment of left hyoplastron, both hypoplastra, xiphiplastron missing their posterior part and some limb bones. Elements of the shell do not differ from those described above. The specimen is peculiar in having a strongly interdigitating suture between the hypoplastra and by showing discernible femoral-anal sulci. These sulci are straight, extending from the lateral border of the xiphiplastron anteromedially and reaching the hypo-xiphiplastral suture. This specimen also shows limb bones that are represented by right and left femora and a left tibia or fibula. No peculiar features of these elements are visible on the specimen.

Description of IVPP V4074.14 and V4074.15. These specimens (Text-fig. 3) are poorly preserved shells that may be associated with skulls referred to *O. brinkmania* (see below). IVPP V4074.14 is preserved just posterior to skull IVPP V4074.16. Similarly, IVPP V4074.15 may belong to the same individual as IVPP V4074.18. However, given the closely associated manner in which these specimens are preserved, it is also possible that



TEXT-FIG. 4. *Ordosemys brinkmania* sp. nov. A, IVPP V4074.4 (holotype), shell in ventral view. B, IVPP V4074.3, shell in dorsal view. Matrix is indicated by grey in interpretative drawings. See Text-figure 3 for explanation of abbreviations.

IVPP V4074.3 is the shell of IVPP V4074.16. Parham (2005, p. 74) described at least one instance in which a closely associated skull and shell were found to belong to different individuals that in turn belonged to distantly related taxa. Because we cannot see diagnostic characters in IVPP V4074.14 or V4074.15, we refer these poorly preserved shells to *O. brinkmania* very tentatively and only based on their position on the slabs.

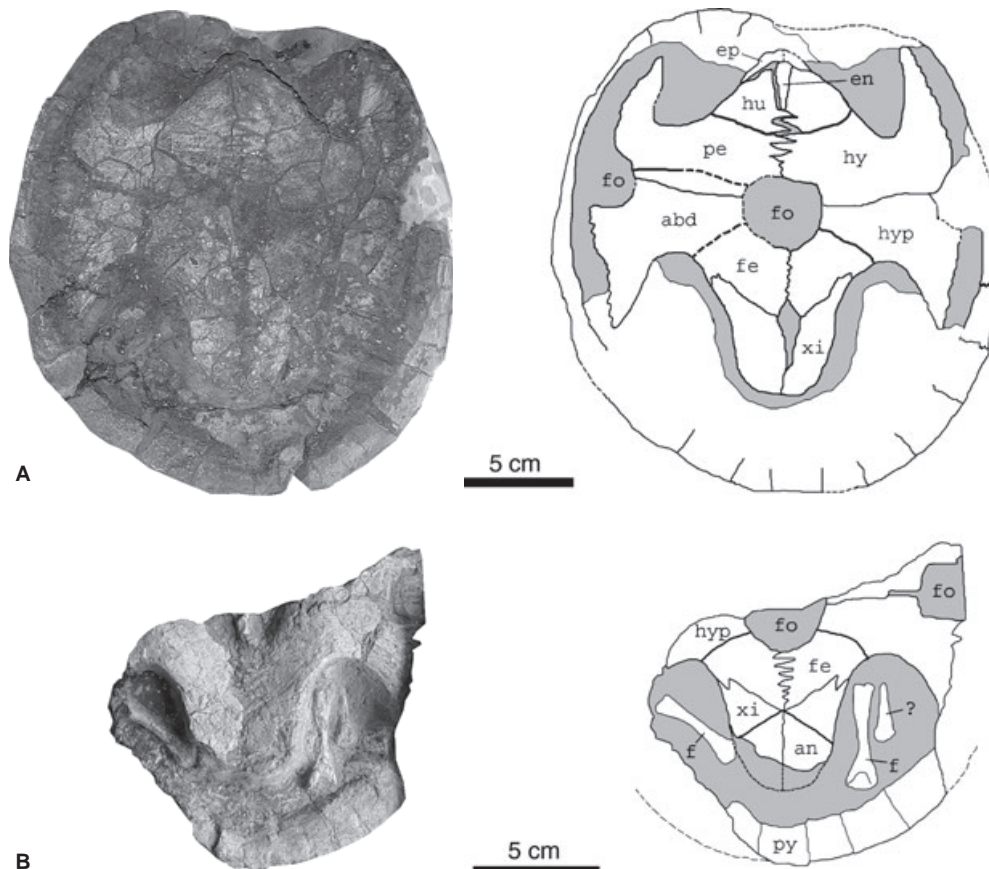
Description of IVPP V4074.8. This specimen (Text-fig. 6A–C) is an isolated, dorsoventrally depressed skull with a lower jaw. The skull is widened posteriorly. The orbits are relatively large (25 per cent of the maximum length of the skull), directed anterolaterally, forming an angle of 35° with the midline. The postorbital bar is longer than the orbit diameter. The upper temporal emargination is moderately deep and makes up about 40 per cent of the condylobasal length of the skull.

The following skull elements are visible in dorsal view (Text-fig. 6A): nasals, prefrontals, frontals, parietals, postorbitals and right branchial horn (cornu branchiale 1). The nasals are small elements contacting prefrontals laterally and frontals posteriorly. The nasals enter the nasal opening anteriorly. The prefrontals are elongated elements forming the dorsal margin of the orbit and are separated by frontals. The frontals form the posterodorsal margin of the orbit. They contact postorbitals posterolaterally and parietals posteriorly. The postorbital is a large bone that forms most of the postorbital bar. The posterior borders of the postorbitals and parietals are not clear.

In ventral view (Text-fig. 6B), the following elements are discernible: vomer, pterygoids, basisphenoid, basioccipital, quadrates and the lower jaw. The vomer separates the choanes. The pterygoids meet each other anterior to the basisphenoid and each bears a processus pterygoideus externus laterally. The basis-

TABLE 1. Measurements (in mm) of some shell specimens of '*Sinemys*' *wuerhoensis*: *, **, right and left measurements, respectively; –, measurement is impossible to make or element is absent.

Parameter	IVPP V4074	IVPP V4074.1	IVPP V4074.3	IVPP V4074.4
Carapace (length/width)	230/207	215/202	153/114	200/–
Preneural (length/width)	–	–	7·0/12·0	–
Neural 1 (length/width)	–	–	7·0/12·0	–
Neural 2 (length/width)	–	–	14·7/10·6	–
Neural 3 (length/width)	–	–	14·6/8·5	–
Neural 4 (length/width)	–	–	13·2/10·6	–
Neural 5 (length/width)	–	–	13·5/10·7	–
Neural 6 (length/width)	–	–	10·5/10·0	–
Neural 7 (length/width)	–	–	12·5/10·2	–
Neural 8 (length/width)	–	–	10·0/6·5	–
Suprapygol 1 (length/width)	–	–	5·5/24·5	–
Suprapygol 2 (length/width)	–	–	5·3/24·7	8·8/33·0
Suprapygol 3 (length/width)	–	–	8·0/–	14·5/31·2
Pygal (length/width)	–	–	12·0/18·5	10·0/18·5
Costals (width along posterior border/medial length/lateral length)*				
Costal 1	–	–	37·0/12·3/23·7	–
Costal 2	–	–	45·0/15·2/17·0	–
Costal 3	–	–	45·0/16·0/16·2	–
Costal 4	–	–	44·0/14·0/16·4	–
Costal 5	–	–	36·0/14·0/15·5	–
Costal 6	–	–	33·5/11·0/12·3	–
Costal 7	–	–	27·0/10·6/16·2	–
Costal 8	–	–	11·5/10·0/17·0	–
Cervical (length/width)	–	–	2·6/13·0	–
Vertebrae (length/maximum width/posterior width)				
Vertebral 1	–	–	24·3/44·0/28·7	–
Vertebral 2	–	–	30·0/45·5/34·0	–
Vertebral 3	–	–	30·0/49·5/32·0	–
Vertebral 4	–	–	33·0/45·7/19·5	–
Plastron (length at midline/width at hyo-hyoplastral suture)	164/146	156/138	–	120/93·0
Bridge minimal length	61·0**	53·0**	–	45·0*
Anterior lobe (length/width at base/width at humeral-pectoral sulcus/width at epi-hyoplastral suture)	47·0/75·0/67·0/53·5	41·0/92·0/65·0/38·0	–	–/58·0/46·0/–
Posterior lobe (length/width at abdominal-femoral sulcus/width at hypo-xiphiplastral suture/width at femoral-anal sulcus)	57·0/83·0/57·5/50·5	62·0/84·0/63·0/–	–	47·0/59·0/42·0/–
Central fontanelle (length/width)	30·0/20·0	34·0/37·0	–	27·0/32·0
Lateral fontanelle (length/width)	–	29·0/17·0**	–	25·0/15·0**
Epiplastron (length at midline/width at posterior border)	6·7/28·0	6·5/22·0	–	–
Entoplastron (length/width)	32·0/15·5	22·5/7·5	–	–
Hyoplastron (length at midline)	34·0	31·0	–	24·0
Hypoplastron (length at midline)	30·0	–	–	25·5
Xiphiplastron (length at midline)	31·5	–	–	22·0
Intergular (length at midline)	5·5	–	–	–
Humeral (length at midline)	36·5	–	–	–
Pectoral (length at midline)	29·0	–	–	–
Abdominal (length at midline)	19·0	–	–	–
Femoral (length at midline)	37·0	–	–	–
Anal (length at midline)	35·5	–	–	–



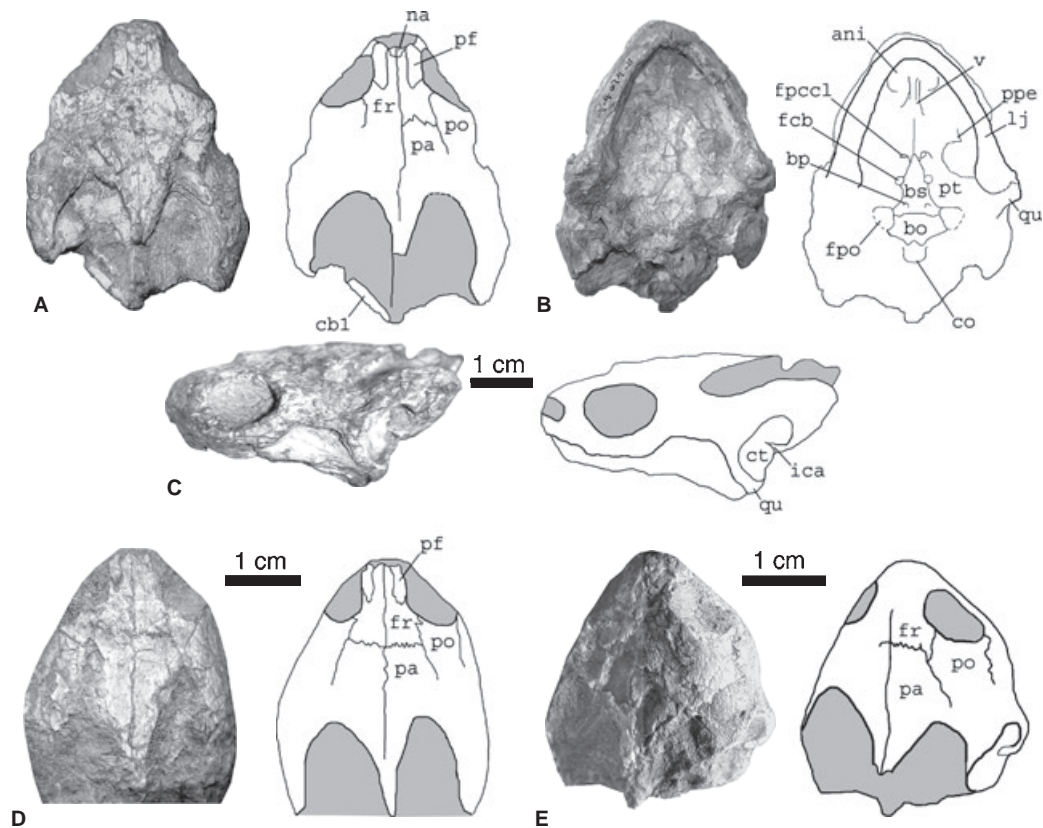
TEXT-FIG. 5. *Ordosemys brinkmania* sp. nov. A, IVPP V4074.1, shell in ventral view. B, IVPP 4074.19, posterior part of the shell in ventral view. Matrix is indicated by grey in interpretative drawings. See Text-figure 3 for explanation of abbreviations.

phenoid has the shape of an elongated triangle. It bears a pair of pits close to its posterior border. The basioccipital, together with the basisphenoid and pterygoids, limits the fenestra postotica (filled with matrix). The posterior part of the canalis caroticus internus is covered by the medial flange of the pterygoid. The open part of the canalis is located at the anterior half of the pterygoid/basisphenoid suture, but does not form a distinct foramen basisphenoidale. The foramen caroticus basisphenoidale (medial branch of the internal carotid artery; see Sukhanov 2000 for terminology of carotid canals) is located at the middle of the pterygoid/basisphenoid suture. The foramen posterius canalis caroticus lateralis (lateral branch of the internal carotid artery) opens in the pterygoid at the level of the anterior tip of the basisphenoid. No details of the lower jaw morphology can be determined from the specimen. In lateral view (Text-fig. 6C), the lateral temporal emargination and quadrate are visible, but the state of the incisura columella auris (enclosed or open) is unclear. For measurements of this specimen, see Table 2.

Description of IVPP V4074.16 and V4074.18. These are skulls in dorsal aspect (Text-fig. 6D–E) that generally agree in their morphology with IVPP V4074.8. The prefrontals, frontals, parietals and postorbitals are discernible in IVPP V4074.16 but only frontals, parietals and postorbitals in IVPP V4074.18.

Remarks. According to D. Brinkman (pers. comm. 2006), the morphology of the posterior portion of the carapace of two specimens that we were unable to examine, IVPP V4074.2 and V4074.7, is different from those described above. Both show that neural 8 is absent and the most anterior of the suprapygal bones contacts neural 7. This morphology is interpreted here as a variation, although new material is needed to support or reject this interpretation.

Specimens IVPP V4074.1, V4074.4 and V4074.19 differ from IVPP V4074 (the holotype of *Sinemys wuerhoensis*) in the following characters: lanceolate and more oblique epiplastra, a narrow and elongated entoplastron, strongly interdigitating interhyo- and hypoplastral sutures, lateral fontanelles present, pectoral-abdominal sulcus entering the central fontanelle, anal scales restricted to xiphiplastra, and a femoral-anal sulcus that is differently shaped. These differences alone are enough to consider the material under discussion as representing a different taxon. These characters cannot be interpreted as a result of ontogenetic change during growth, as Yeh (1973) did, because the specimens are similar in



TEXT-FIG. 6. *Ordosemys brinkmania* sp. nov. A–C, IVPP V4074.8, isolated skull: A, dorsal view; B, ventral view; C, lateral view. D, IVPP 4074.16, skull in dorsal view. E, IVPP 4074.18, skull in dorsal view. Matrix is indicated by grey in interpretative drawings. See Text-figure 3 for explanation of abbreviations.

TABLE 2. Measurements (in mm) of some skull specimens of '*Sinemys*' *wuerhoensis*. For designations, see Table 1.

Parameter	IVPP V4074.8	IVPP V4074.17
Skull length from the snout to occipital condyle	37.8	–
Skull length from the snout to tip of supraoccipital crest	47.5	45.0
Skull width maximal	36.6	35.0
Orbit diameter	12.0	7.4

size and in the degree of development of the central fontanelles.

Specimen IVPP 4074.3 differs from known members of the Xinjiangchelyidae (new attribution of IVPP 4074 holotype, see above) in the shape of neurals (subrectangular and less narrow) as well as the presence of a preneural and three suprapyrgals. In the latter characters, IVPP 4074.3 agrees with IVPP V4074.4 and is therefore referred to the same taxon. Skull specimens IVPP

V4074.8, 4074.16 and 4074.18 differ from members of the Xinjiangchelyidae with known skull morphology [*Xinjiangchelys* (Kaznyshkin *et al.* (1990); *Annemys* Sukhanov and Narmandakh, 2006 (Sukhanov 2000)] in bearing a closed canalis caroticus internus and prefrontals not meeting at the midline.

The specimens under discussion here are referred to *Ordosemys* (*sensu* Tong *et al.* 2004) based on the shared presence of nasals, prefrontals separated by frontals, presence of the preneural, and three suprapyrgals. Although some of these characters occur in other basal eucryptodires, they are only found together in *Ordosemys*. The possession of three suprapyrgals is considered diagnostic for *Ordosemys*, because this character is present in *O. leios* Brinkman and Peng, 1993b and *O. liaoxiensis* (Ji, 1995) (specimen IVPP V11554; Danilov and Parham, unpublished data). Moreover, *Ordosemys* is the only 'macrobaenid' with a preneural, so the referral of this species to that clade seems likely. We have established a new species based on the diagnostic characters.

Occurrence. Wuerho, Junggar Basin, Xinjiang, China. Upper Tugulu Group, Early Cretaceous (Aptian–?Albian).

CRYPTODIRA Cope, 1868

cf. *Pantrionychia* Joyce, Parham and Gauthier, 2004 indet.

Text-figure 7

Material. IVPP V4074.17, a poorly preserved skull in dorsal aspect.

Description. The skull is longer than wide. It is widest at mid-length, and narrowed anteriorly and posteriorly. Only the left orbit is preserved. It is relatively small (16 per cent of maximum length of the skull) and directed dorsally. The postorbital bar (visible on the left side) is short, less than the orbit diameter. The upper temporal emargination is deep, making up more than half of the skull length. The supraoccipital crest has a wide horizontal plate distally. The structure of the skull roof cannot be determined because of the poor preservation of the specimen. For measurements of this specimen, see Table 2.

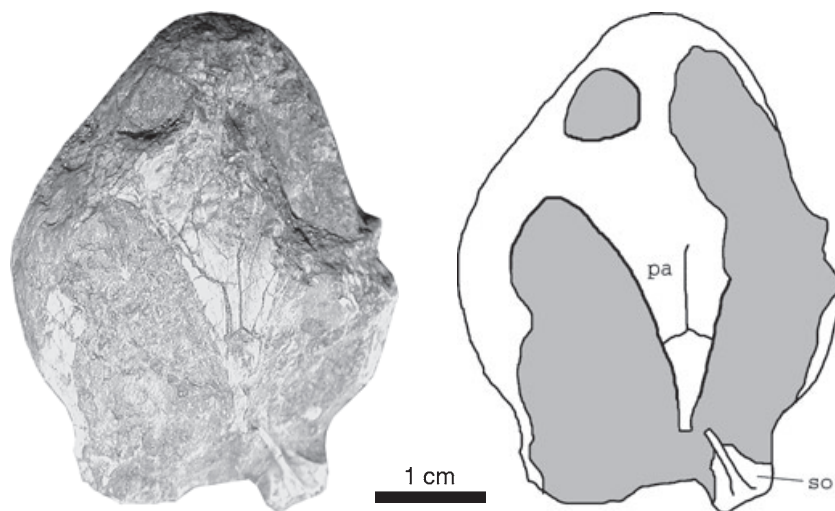
Remarks. IVPP V4074.17 differs from other skulls in the IVPP V4074 slabs examined by its shape (widened in the middle part and not posteriorly), its significantly deeper upper temporal emarginations, shorter postorbital bars, and its smaller and dorsally orientated orbits. The same characters distinguish it from the other 'macrobaenids', the *Xinjiangchelyidae* (new attribution of IVPP 4074 holotype, see above) and the *Testudinoidea*. On the other hand, the characters mentioned above are diagnostic for some members of the *Pantrionychia* (Meylan 1987; Meylan and Gaffney 1989). Although poor preservation of the specimen does not allow a definitive attribution, the small and anteriorly removed orbits along with the deep upper temporal emargination are evocative of the *Trionychidae* Fitzinger, 1826 (Meylan 1987).

Occurrence. Wuerho, Junggar Basin, Xinjiang, China. Jianmuxin Formation, Upper Tugulu Group, Early Cretaceous (Aptian–?Albian).

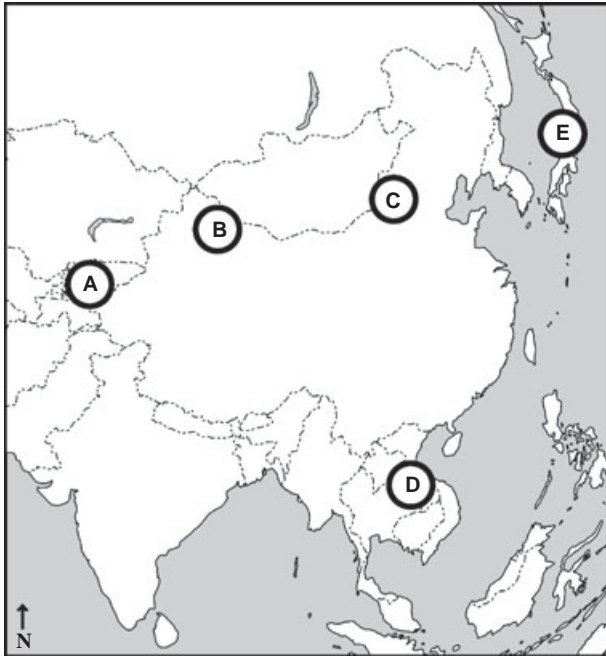
DISCUSSION

A diverse Early Cretaceous turtle fauna in the Tugulu Group

Prior to this study, the turtle assemblage of the Tugulu Group consisted of four species of basal eucryptodires: (1) *Wuguia efremovi* (Khosatzky, 1996); (2) *Wuguia hutubeiensis* Matzke, Maisch, Pfretzschner, Sun and Stöhr, 2004a; (3) *Dracochelys bicuspis* Gaffney and Ye, 1992; (4) '*Sinemys*' *wuerhoensis* Yeh, 1973. *Wuguia hutubeiensis* was reported from the Lower Tugulu Group (Hutubei Formation, Hauterivian–Barremian), *D. bicuspis* and '*S.*' *wuerhoensis* are from the Upper Tugulu Group (Lianmuxin Formation, Aptian–?Albian) (Maisch *et al.* 2003), while *Wuguia efremovi* (= *Dracochelys wimani* Maisch, Matzke and Sun, 2003; see Danilov and Sukhanov 2006) is known from both the Lower and the Upper Tugulu Group (Danilov and Sukhanov 2006). According to our revision, the type series of '*S.*' *wuerhoensis* includes three taxa formerly unknown in the Tugulu Group: *Xinjiangchelys* sp., *Ordosemys brinkmania* and cf. *Pantrionychia* indet. Including these taxa, the Tugulu Group consists of up to six species, with five of these occurring exclusively in the Upper Tugulu Group (Text-figs 8–9). Our findings make the Tugulu Group fauna one of the most diverse of Early Cretaceous turtle faunas in Asia and the Upper Tugulu Group (Lianmuxin Formation) fauna as diverse as that from the Kitadani Formation in Japan. Text-figure 8 summarizes the taxonomic content and localities of the most diverse (i.e. \geq three species) Early Cretaceous turtle faunas in Asia. This shows that the Tugulu Group assemblage differs from those in Kirghizia, Laos and Japan by being dominated by basal eucryptodires such as *xinjiangchelyids* and 'macrobaenids' *sensu* Parham and Hutchison (2003). While basal eucryptodires occur in all of these



TEXT-FIG. 7. IVPP 4074.18, cf. *Pantrionychia* indet., skull in dorsal view. Matrix is indicated by grey in interpretative drawing. See Text-figure 3 for explanation of abbreviations.



TEXT-FIG. 8. Map showing the geographical distribution of the Early Cretaceous turtle faunas of Asia. See Text-figure 9 for explanation of A–E.

localities, the non-Chinese faunas are dominated by pantrionychians.

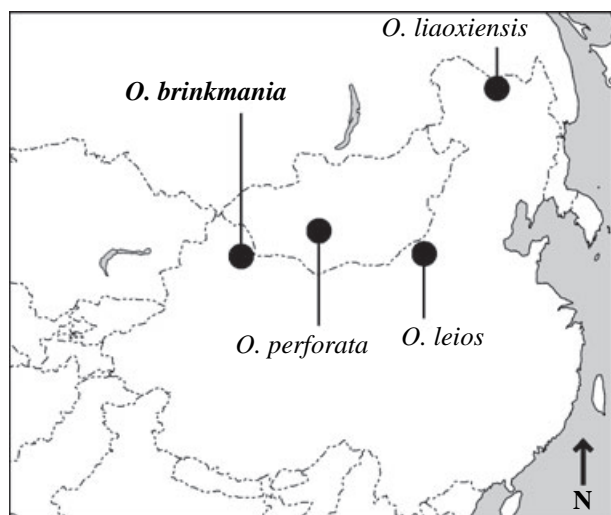
The assignment of *Sinemys wuerhoensis* to *Xinjiangchelys* expands the temporal range of the xinjiangchelyids in Asia to the Early Cretaceous. Formerly, xinjiangchelyids were known from the Middle–Upper Jurassic in Asia (Peng and Brinkman 1993; Sukhanov 2000; Matzke *et al.* 2004b) and from the Lower Cretaceous in Europe (Hirayama 2000). Recently, specimens referred to ‘aff. *Xinjiangchelys* sp.’ were reported from the Lower Cretaceous (Aptian–Albian) of Laos (Lapparent de Broin 2004; Text-figs 8–9), but this material has not been described so far.

Comments on *Ordosemys*

Ordosemys was established by Brinkman and Peng (1993b) based on a partial skeleton from the Early Cretaceous Lao-handong Formation of Laolonghuose, Inner Mongolia. An isolated skull of *Ordosemys* sp. was described from the same area (Brinkman and Wu 1999). Recently, *Manchurochelys liaoxiensis* Ji, 1995, from the Yixian Formation of Liaoning Province, was placed in *Ordosemys* (Tong *et al.*

A		B		C	D	E		
Kirghizia		China			Laos		Japan	
ALBIAN	Alamyshik Fm <i>Kirgizemys exaratus</i> ¹ (basal eucryptodire) <i>Ferganemys verzhilini</i> ² (stem-TRIONYCHIA) <i>‘Trionyx’ kyrgyzensis</i> ³ (PANTRIONYCHIDAE)	Tugulu Group	Lianmuxin Fm <i>Dracochelys bicuspis</i> ⁴ (basal eucryptodire) <i>Wuguia efremovi</i> ⁵ (basal eucryptodire) <i>Ordosemys brinkmania</i> (basal eucryptodire) <i>Xinjiangchelys</i> sp. (basal eucryptodire) cf. Pantrionychia indet.	Luohandong Fm <i>Ordosemys leios</i> ⁷ (basal eucryptodire) <i>Sinemys gamera</i> ⁸ (basal eucryptodire) indeterminate taxon ⁷	Grès supérieurs Fm aff. <i>Xinjiangchelys</i> ⁹ (basal eucryptodire) <i>Shachemys laosiana</i> ⁹ (stem-TRIONYCHIA) CARETTOCHELYIDAE indet. ⁹ PANTRIONYCHIDAE indet. ⁹	Tetori Group	Kitadani Fm basal eucryptodire ¹⁰ NANHSIUNGHELYIDAE ¹⁰ (stem-TRIONYCHIA) ADOCIDAE ¹⁰ (stem-TRIONYCHIA) PANTRIONYCHIDAE indet. ¹⁰ PANTESTUDINOIDEA indet. ¹⁰	ALBIAN
APTIAN								APTIAN
BARR.								BARR.
HAUT.			Hutubei Fm <i>Wuguia efremovi</i> ⁵ (basal eucryptodire) <i>Wuguia hutubeiensis</i> ⁶ (basal eucryptodire)					HAUT.
VAL.							Kuwajima Fm basal eucryptodire ¹¹ stem-TRIONYCHIA indet. ¹¹ PANTESTUDINOIDEA indet. ¹¹	VAL.
BERR.								BERR.

TEXT-FIG. 9. Chart showing the temporal and geographical distribution Early Cretaceous turtle faunas of Asia. Taxa from the type series of *Sinemys wuerhoensis* (as shown by this study) are given in bold. For other records, the authorities for named taxa (1–10) and reports of unnamed taxa (8, 11–12) are as follows: 1, Nesson and Khosatzky (1973); 2, Nesson and Khosatzky (1977); 3, Nesson (1995); 4, Gaffney and Ye (1992); 5, Danilov and Sukhanov (2006); (6) Matzke *et al.* (2004b); 7, Brinkman and Peng (1993b); 8, Brinkman and Peng (1993a); 9, Lapparent de Broin (2004); 10, Hirayama (2002); 11, Hirayama (2000). See Text-figure 8 for locations of A–E.



TEXT-FIG. 10. Map showing the geographical distribution of the widespread Early Cretaceous basal eucryptodire *Ordosemys*.

2004). This genus should also include *Asiachelys perforata* Sukhanov and Narmandakh, 2006 (Sukhanov 2000). *Asiachelys perforata* is based on a specimen from the Early Cretaceous (Albian) Khulsangol Formation of Khuren Dukh (= Hüren Dukh), Mongolia, that matches *O. leios* and *O. liaoxiensis* in many respects. Our referral of this specimen to *Ordosemys* is based on similar proportions of the plastron and the presence of central, lateral and hypophiplastral fontanelles. *Ordosemys brinkmania* is the fourth species of the genus, as well as the most western record (Text-fig. 10).

Until recently, our understanding of Early Cretaceous turtle faunas was hindered by an overly split taxonomy. For example, the four species referred to *Ordosemys* were placed in four different genera: *Ordosemys*, *Manchurochelys*, '*Sinemys*' and '*Asiachelys*.' However, we now recognize *Ordosemys* to be one of the widely distributed basal eucryptodire lineages during the Early Cretaceous in Asia. Another is represented by *Kirgizemys* Nessov and Khosatzky, 1973 (Danilov *et al.* 2006). This is further example of the objective superiority of polytypic genera over the subjective generation of redundant binomials (Parham and Feldman 2002; Lynch and Parham 2003; Feldman and Parham 2004). Although *Ordosemys* and *Kirgizemys* are coeval, they have only been found together at one site (Khuren Dukh). Additional research, including comparisons of associated faunas and environments, will be necessary to explain the geographical distributions of these basal eucryptodires.

CONCLUSIONS

Our re-examination of the type series of '*Sinemys*' *wuerhoensis* Yeh, 1973 shows that it is actually a chimera made

up of at least three distinct taxa. The holotype of this taxon is assigned to the stem-cryptodire genus *Xinjiangchelys* and represents the youngest (Cretaceous) occurrence of a xinjiangchelyid in Asia. Since there are no characters that distinguish this *Xinjiangchelys* from other species of this genus, we consider '*S.*' *wuerhoensis* to be a *nomen dubium*.

Most of the paratypes of '*S.*' *wuerhoensis* are referred to the basal eucryptodire genus *Ordosemys*. We have established a new species for these specimens, *O. brinkmania* sp. nov. One additional specimen in the type series of '*S.*' *wuerhoensis*, a skull, is referred to cf. *Pantrionychia* indet.

Over the past few years, several Cretaceous turtle taxa, or Operational Taxonomic Units in cladistic analyses, have been shown to be chimeras (e.g. *Dracochelys/Han-gaiemys*: Parham and Hutchison 2003; *Otseopygis/Euclastes*: Parham 2005; *Lindholmemys*/adocid: Danilov and Parham 2005; Danilov and Parham herein). There are separate explanations for each of these, but in general they stem from either a historically poor understanding of turtle fossils or else a less than rigorous association of specimens. Correcting these problems requires a detailed examination of problematic specimens. We encourage more palaeontologists to revisit neglected specimens in order to reconcile them with the emerging narrative of Mesozoic turtle radiations.

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