

# Middle Jurassic turtles from the Sichuan Basin, China: a review

HAIYAN TONG\*†, IGOR DANILOV‡, YONG YE§, HUI OUYANG¶  
& GUANGZHAO PENG§

\*Research Associate, Institute of Vertebrate Palaeontology and Palaeoanthropology, 142 Xizhimenwai St., Beijing 100044, China. Current address: 30 Rue Carnot, 94270 Le Kremlin-Bicêtre, France

‡Department of Herpetology, Zoological Institute, Russian Academy of Sciences, Universitetskaya Emb. 1, 199034, St Petersburg, Russia

§Zigong Dinosaur Museum, 238 Dashanpu, Zigong, Sichuan 643013, China

¶Chongqing Museum of Natural History, 74 Pipashanzhengjie, Yuzhong district, Chongqing 400013, China

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**Abstract** – The turtle fauna of the Middle Jurassic Xiashaximiao Formation in the Sichuan Basin and the type series of *Chengyuchelys baenoides* Young & Chow, 1953 are revised. By the absence of a mesoplastron and other shell characters, both the holotype and paratype of *Chengyuchelys baenoides* belong to the family Xinjiangchelyidae and come probably from the Upper Jurassic Shangshaximiao Formation. The Middle Jurassic turtle assemblage of the Sichuan Basin is composed of two entities: the Bashuchelyidae fam. nov. (*Bashuchelys* gen. nov., *Chuannanchelys* gen. nov.) and *Protoxinjiangchelys* gen. nov. on the one hand, and *Sichuanchelys* on the other hand, with the former as the dominant group. Bashuchelyids and xinjiangchelyids are closely related to one another, while *Sichuanchelys* is more primitive and has no shared apomorphic features with bashuchelyids. The whole assemblage appears to be endemic to the Sichuan Basin at genus level and distinct from the Late Jurassic turtle fauna of the same basin in its relict nature and absence of the Polycryptodira.

Keywords: Testudines, Middle Jurassic, Sichuan Basin, China, systematics.

## 1. Introduction

The Jurassic redbeds in the Sichuan Basin have yielded an important turtle fauna. Their earliest discovery is dated back to the 1950s. In 1951, a series of turtle shells were discovered during the construction of the railway between the cities of Chengdu and Chongqing (Chengyu railway) and the clearing away of building foundations in Datianwan, in the suburb of Chongqing. Young and Chow studied the material and created three monotypic genera (*Chengyuchelys*, *Tienfuchelys* and *Sinaspideretes*) and three new species of *Plesiochelys* (Young & Chow, 1953). The taxonomy of these turtles in Young & Chow's work (1953) is summarized as follows:

Amphichelyidia

Baenidae?

*Chengyuchelys*

*C. baenoides*

Plesiochelyidae

*Plesiochelys*

*P. latimarginalis*

*P. radiplicatus*

*P. chungkingensis*

*Tienfuchelys*

*T. tzuyangensis*

Pleurodira

Trionychidae

*Sinaspideretes*

*S. wimani*

All these specimens are from the redbeds of the Xiashaximiao or Shangshaximiao formations, dated as Middle Jurassic and Late Jurassic, respectively. But for most of them, the exact locality and horizon are unknown; they may come from either the Middle Jurassic Xiashaximiao Formation or the Late Jurassic Shangshaximiao Formation. Of these taxa, we are particularly interested in *Chengyuchelys baenoides* in the present paper. Other turtles will be reviewed in separate papers.

All subsequent discoveries of Middle Jurassic turtles in the Sichuan Basin are from the Dashanpu locality, Zigong, Sichuan Province (Fig. 1). Since the initial discovery in 1972, to date Dashanpu has yielded about 20 turtle shells. The first study on Dashanpu turtles by Ye in 1982 includes three shells (CMNH C.V. 00678, CMNH C.V. 00679 and IVPP V6507). Ye created *Chengyuchelys zigongensis* on the basis of CMNH C.V.00678, referred IVPP V6507 to *Chengyuchelys baenoides* and CMNH C.V. 00679 to *Chengyuchelys* sp. (Ye, 1982). In 1987, Fang studied four shells from Dashanpu, erected *Chengyuchelys dashanpuensis* on the basis of one of them (field number I-T<sub>19</sub>), referred I-Z<sub>1</sub> to *Chengyuchelys zigongensis* and two others (I-L<sub>1</sub> and I-L<sub>2</sub>) to *Chengyuchelys* sp. (Fang, 1987). Later in his second paper on Dashanpu turtles, Ye reviewed all specimens from Dashanpu available to him at that time, including about 20 shells housed in the Zigong Dinosaur Museum (Ye, 1990b). The family of Chengyuchelyidae was created on that occasion (in Chinese) and also in a separate paper in English published in the same year (Ye, 1990a). The

†Author for correspondence: htong09@yahoo.fr



Figure 1. Map showing the location of Dashanpu in the Zigong region and the Chengyu Railway.

systematics of the Chengyuchelyidae and specimens from Dashanpu are repeated in Ye's monograph on Chinese fossil and recent turtles (Ye, 1994). Some years later, Ye and Pi reported three shells from Dashanpu (one of them was mentioned in Ye, 1990a) and created *Sichuanchelys*, a second genus of Chengyuchelyidae (Ye & Pi, 1997).

In recent years, turtle specimens from the Middle Jurassic Dashanpu locality have been inventoried (Peng *et al.* 2005) and two specimens housed in the Institute of Vertebrate Palaeontology and Palaeoanthropology, Beijing (IVPP) collection have been re-described (Danilov & Parham, 2008). Danilov & Parham (2008) noted that there are no shared derived characters uniting *Chengyuchelys* and *Sichuanchelys* in the Chengyuchelyidae and considered *Chengyuchelys dashanpuensis* as '*Chengyuchelys*' *dashanpuensis*. Brinkman, Li & Ye (2008) in a book on Chinese reptiles followed mostly previous work, but moved *Chengyuchelys dashanpuensis* to *Sichuanchelys* because of the wide vertebral scutes. However, the type series of *Chengyuchelys baenoides* has never been re-examined.

The history of studies on Dashanpu turtles and the type series of *Chengyuchelys baenoides* is summarized in Table 1. The turtle specimens described by Young and Chow in 1953, contrary to their usual citation as being in the IVPP collection (Young & Chow, 1953; Meylan & Gaffney, 1992; Ye, 1994; Peng *et al.* 2005; Brinkman, Li & Ye, 2008; Danilov & Parham, 2008), are all housed in the Chongqing Museum of Natural History. Here we present a review of the Middle Jurassic turtle fauna from the Sichuan Basin. The type series of *Chengyuchelys baenoides* is re-examined. The aim of the present work is to make a detailed description of the specimens in order to review the validity of the taxa and their phylogenetic relationships in a contemporary systematic framework.

In this paper we use traditional nomenclature (ICZN) for turtle taxa (Gaffney & Meylan, 1988; Gaffney, 1996) instead of rank-free nomenclature

(Joyce, Parham & Gauthier, 2004), followed in the paper of Danilov & Parham (2008). Anatomical terms of the shell follow Zangerl (1969).

## 2. Geological background of Dashanpu

The Sichuan Basin, formerly the Sichuan Plateau on the east coast of Tethys, was formed during the Late Triassic Indosinian orogeny. It is situated in the eastern part of the former Sichuan Province, which has been divided into Sichuan Province and the Municipality of Chongqing since 1997. The Jurassic continental deposits are extensively developed in the basin, reaching 1000–2000 m in thickness. From the bottom to the top, the Jurassic sediments are divided into seven formations: the Lower Jurassic Zhenzhuchong and Ziliujing formations, the Middle Jurassic Xintiangou and Xiashaximiao formations, and the Upper Jurassic Shangshaximiao, Suining and Penglaizhen formations. Dashanpu, in the Zigong region, is situated in the southern part of the Sichuan Basin (Fig. 1). The Xiashaximiao Formation in the Zigong area is composed of 90–217 m of purplish red mudstones with 2–3 grey, yellowish grey fine- to medium-grained feldspathic quartzitic sandstone intercalations. The unit is characteristic of alternative fluvial and lacustrine facies deposited under a subtropical–tropical climate, showing relative warm and moist ecological conditions. It overlies unconformably the Middle Jurassic Xintiangou or Ziliujing Formation and underlies conformably the Upper Jurassic Shangshaximiao Formation. In Dashanpu, the sandstones in the lower part of the Xiashaximiao Formation have yielded abundant vertebrate remains belonging to the *Shunosaurus* fauna, including selachians, bony fishes, amphibians, turtles, plesiosaurs, crocodiles, pterosaurs, mammal-like reptiles and theropod, sauropod, ornithopod and stegosaur dinosaurs (Dong, 1992; Peng *et al.* 2005; Wang *et al.* 2008).

## 3. Material

The specimens examined in this work are listed in Table 1, which includes all available specimens from the Middle Jurassic of the Sichuan Basin housed in three important collections: Zigong Dinosaur Museum (ZDM), Chongqing Museum of Natural History (CMNH) and Institute of Vertebrate Palaeontology and Palaeoanthropology, Beijing (IVPP).

The first-hand comparisons are made with the Late Jurassic turtles from the Sichuan Basin, which are referred to '*Plesiochelys*' or *Xinjiangchelys*: '*Plesiochelys*' *latimarginalis* Young & Chow, 1953, '*P.*' *radiplicatus* Young & Chow, 1953, '*P.*' *chungkingensis* Young & Chow, 1953, '*P.*' *jingyanensis* Ye & Fang, 1982, *Tienfuchelys tzuyangensis* Young & Chow, 1953 (Young & Chow, 1953; Ye, 1963, 1986b, 1994; Ye & Fang, 1982; Peng & Brinkman, 1993; Matzke *et al.* 2004, 2005; Peng *et al.* 2005; Brinkman, Li & Ye, 2008); *Xinjiangchelys junggarensis* Ye, 1986a and

Table 1. History of studies on the Middle Jurassic turtle specimens from the Sichuan Basin

Specimens	Young & Chow, 1953	Ye, 1982	Fang, 1987	Ye, 1990a,b, 1994	Ye & Pi, 1997	Peng <i>et al.</i> 2005	Danilov & Parham, 2008	Brinkman, Li & Ye, 2008	This work
CMNH C.996 (V 708)	<i>Chengyuchelys baenoides</i> (holotype)			<i>Chengyuchelys baenoides</i>		<i>Chengyuchelys baenoides</i>	<i>Chengyuchelys baenoides</i>	<i>Chengyuchelys baenoides</i>	Xinjiangchelyidae
CMNH C.997 (V 710)	<i>Chengyuchelys baenoides</i> (paratype)			<i>Chengyuchelys baenoides</i>		<i>Chengyuchelys baenoides</i>	<i>Chengyuchelys baenoides</i>	<i>Chengyuchelys baenoides</i>	Xinjiangchelyidae
CMNH C.1001 (C.V. 00678)		<i>Chengyuchelys zigongensis</i> (type)		<i>Chengyuchelys zigongensis</i>		<i>Chengyuchelys zigongensis</i>	<i>Chengyuchelys zigongensis</i>	<i>Chengyuchelys zigongensis</i>	<i>Bashuchelys zigongensis</i> (Ye, 1982)
CMNH C.1002 (C.V. 00679)		<i>Chengyuchelys</i> sp.		<i>Chengyuchelys</i> sp.		<i>Chengyuchelys</i> sp.			<i>Protoxinjiangchelys</i> sp.
ZDM3007 (ZDM 1 in Ye, 1990a)				<i>Chengyuchelys baenoides</i>		<i>Chengyuchelys baenoides</i>	<i>Chengyuchelys baenoides</i>		<i>Bashuchelys youngi</i> n. gen., n. sp. (holotype)
ZDM 3003				<i>Chengyuchelys baenoides</i>		<i>Chengyuchelys baenoides</i>	<i>Chengyuchelys baenoides</i>		<i>Bashuchelys youngi</i> n. gen., n. sp.
ZDM 3008 (ZDM3 in Ye, 1990a)				<i>Chengyuchelys baenoides</i>		<i>Chengyuchelys baenoides</i>	<i>Chengyuchelys baenoides</i>		<i>Bashuchelys youngi</i> n. gen., n. sp.
ZDM 3012 (I-Z <sub>1</sub> in Fang, 1987)			<i>Chengyuchelys zigongensis</i>	<i>Chengyuchelys zigongensis</i>		<i>Chengyuchelys zigongensis</i>	<i>Chengyuchelys zigongensis</i>		<i>Bashuchelys zigongensis</i> (Ye, 1982)
ZDM 3006 (ZDM 7 in Ye, 1990a)				<i>Chengyuchelys</i> cf. <i>zigongensis</i>		<i>Chengyuchelys zigongensis</i>	<i>Chengyuchelys zigongensis</i>		<i>Bashuchelys youngi</i> n. gen., n. sp.
ZDM 3009				<i>Chengyuchelys</i> cf. <i>zigongensis</i>		<i>Chengyuchelys zigongensis</i>	<i>Chengyuchelys zigongensis</i>		<i>Protoxinjiangchelys salis</i> n. gen., n. sp.
ZDM 3011 (field number: I-T <sub>19</sub> )			<i>Chengyuchelys dashaipuensis</i> (holotype)	<i>Chengyuchelys dashaipuensis</i>		<i>Chengyuchelys dashaipuensis</i>	<i>‘Chengyuchelys’ dashaipuensis</i>	<i>Sichuanchelys dashaipuensis</i>	<i>Chuannanchelys dashaipuensis</i> (Fang, 1987)
ZDM I-L <sub>1</sub>			<i>Chengyuchelys</i> sp.	<i>Chengyuchelys</i> sp.		<i>Chengyuchelys</i> sp.			Not found
ZDM I-L <sub>2</sub>			<i>Chengyuchelys</i> sp.	<i>Chengyuchelys</i> sp.					Not found
ZDM K1-7				<i>Chengyuchelys</i> sp.					Not found
ZDM 3019						<i>Chengyuchelys</i> sp.			Not found
ZDM 3005						<i>Chengyuchelys</i> sp.			<i>Bashuchelys</i> sp.
ZDM 3004				<i>Chengyuchelys</i> sp.		<i>Chengyuchelys</i> sp.			<i>Bashuchelys</i> sp.
ZDM 3002				Chengyuchelyidae indet.		Chengyuchelyidae gen. et sp. indet.			? <i>Sichuanchelys</i> sp.
ZDM 3001				Chengyuchelyidae indet.		<i>Sichuanchelys chowi</i>		<i>Sichuanchelys chowi</i>	<i>Sichuanchelys chowi</i>
ZDM 3014					<i>Sichuanchelys chowi</i> (holotype)	<i>Sichuanchelys chowi</i>		<i>Sichuanchelys chowi</i>	<i>Sichuanchelys chowi</i>
ZDM 3017					<i>Sichuanchelys chowi</i>	<i>Sichuanchelys chowi</i>		<i>Sichuanchelys chowi</i>	<i>Sichuanchelys chowi</i>
ZDM 3018									<i>Sichuanchelys chowi</i>
ZDM 3016									<i>Bashuchelys</i> sp.
ZDM 3013									<i>Bashuchelys</i> sp.
IVPP V6507		<i>Chengyuchelys baenoides</i>		<i>Chengyuchelys baenoides</i>		<i>Chengyuchelys baenoides</i>	<i>Chengyuchelys baenoides</i>		<i>Bashuchelys youngi</i> n. gen., n. sp.
IVPP V8805				<i>Chengyuchelys baenoides</i> , juvenile		<i>Chengyuchelys baenoides</i>	<i>Sichuanchelys</i> sp.		<i>Sichuanchelys</i> sp.

*Xinjiangchelys? oshanensis* (Ye, 1973, 1986a; Peng & Brinkman, 1993; Brinkman, Li & Ye, 2008).

Other comparison materials are from the literature: *Condorchelys antiqua* Sterli, 2008 (Sterli, 2008; Sterli & de la Fuente, 2010); *Dinochelys whitei* Gaffney, 1979 (Gaffney, 1979; Brinkman, Stadtman & Smith, 2000); *Eileanchelys waldmani* Anquetin, Barrett, Jones, Moor-Fay & Evans, 2008 (Anquetin *et al.* 2008; Anquetin, 2010); *Glyptops plicatulus* (Cope, 1877) (Gaffney, 1979); *Heckerochelys romani* Sukhanov, 2006 (Sukhanov, 2006); *Hylaeochelys latiscutata* (Owen) Lydekker, 1889 (Milner, 2004); *Indochelys spatulata* Datta, Ghosh & Das, 2000 (Datta *et al.* 2000); *Kayentachelys aprix* Gaffney, Hutchison, Jenkins & Meeker, 1987 (Gaffney *et al.* 1987); *Kirgizemys hoburensis* (Sukhanov & Narmandakh, 1974) (Sukhanov, 2000; Danilov *et al.* 2006); *Mongolochelys efremovi* Khosatzky, 1997 (Khosatzky, 1997); *Ordosemys liaoxiensis* (Ji, 1995) (Tong, Ji & Ji, 2004); *Palaeochersis talampayensis* Rougier, de la Fuente & Arcucci, 1995 (Rougier, de la Fuente & Arcucci, 1995; Sterli, de la Fuente & Rougier, 2007); *Plesiochelys solodurensis* (Bräm, 1965); *Pleurosternon bullockii* (Owen) Lydekker & Boulenger, 1887 (Milner, 2004); *Proganochelys quenstedti* Baur, 1887; *Proterochersis robusta* Fraas, 1913 (Gaffney, 1990); *Siamochelys peninsularis* Tong, Buffetaut & Suteethorn, 2002 (Tong, Buffetaut & Suteethorn, 2002); *Xinjiangchelys junggarensis*, *X. chowi*, *X. qiquensis*, *X. tianshanensis* (Ye, 1986a; Kaznyshkin, Nalbandyan & Nessonov, 1990; Peng & Brinkman, 1993; Nessonov, 1995; Matzke *et al.* 2004, 2005; Brinkman, Li & Ye, 2008).

#### 4. The problem of *Chengyuchelys baenoides* Young & Chow, 1953

The type species of *Chengyuchelys*, *C. baenoides*, was based on two shells: CMNH C.996 (V708 in Young & Chow, 1953, holotype), an incomplete shell with articulated carapace and plastron; and CMNH C.997 (V710 in Young & Chow, 1953, paratype), a shell of a juvenile in which the carapace is mostly preserved as an internal mould, articulated with an incomplete plastron. Both specimens came from sites along the Chengyu Railway and based on the matrix surrounding the fossils, it is supposed that they are from the same stratigraphical layer and close localities, and considered Late Jurassic to Cretaceous in age (Young & Chow, 1953). Young & Chow (1953) indicated the presence of a pair of mesoplastra that is narrowed in the middle and included in the abdominal scute. Based on the presence of the mesoplastron, the general morphology of the shell, as well as the structure of the bridge, which resemble *Baena* from North America, the taxon was tentatively placed in the family Baenidae (Young & Chow, 1953).

The re-examination of these two specimens by one of us (H. T.) reveals that both CMNH C.996 and CMNH C.997 lack the mesoplastron. CMNH C.996 has a well-preserved hyoplastron–hypoplastron suture that can be

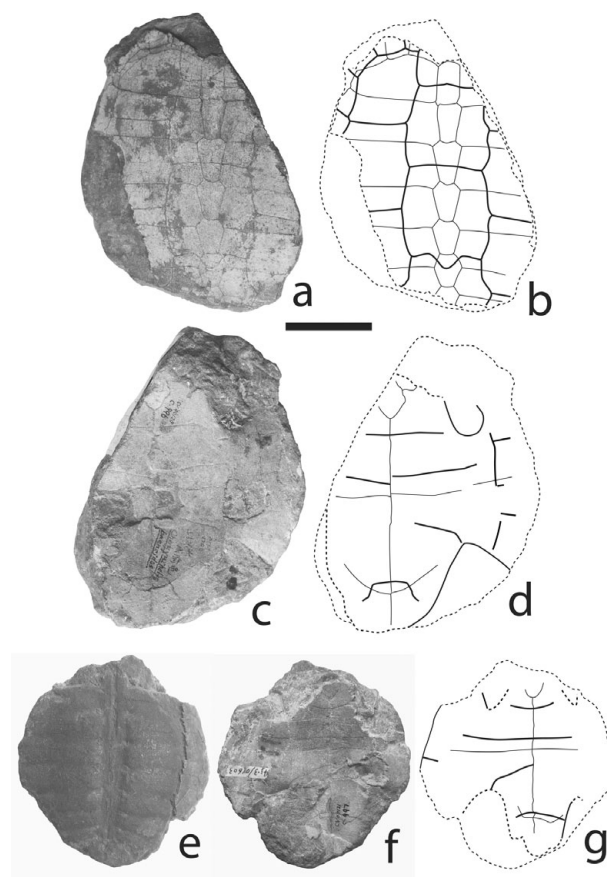


Figure 2. Type series of *Chengyuchelys baenoides* Young & Chow, 1953. (a–d) CMNH C.996 (holotype, V. 709 in Young & Chow, 1953), shell in dorsal (a, b) and ventral (c, d) views; (e–g) CMNH C.997 (paratype, V.710 in Young & Chow, 1953), shell in dorsal (e) and ventral (f, g) views. Scale bar = 50 mm.

followed from the broken right margin to the complete left bridge. However, the supposed posterior suture of the mesoplastron (Young & Chow, 1953, plate 1, fig. 2) is absent (Fig. 2a–d). The case is similar in CMNH C.997: a clear suture between the hyoplastron and hypoplastron can be followed from the left to the right, but no other suture is visible between it and abdominofemoral sulcus (Fig. 2e–g), contrary to Young & Chow (1953, fig. 1).

Comparisons with other turtles from the Middle and Upper Jurassic beds of the Sichuan Basin provide additional information. CMNH C.996 is quite different from turtles from the Middle Jurassic of Dashanpu, but presents the following features shared with the Late Jurassic turtles from the Sichuan Basin previously referred to ‘*Plesiochelys*’ and *Xinjiangchelys*: third to fifth marginals extending onto the costals; fourth vertebral only slightly wider than the third vertebral; wide anterior and posterior lobe; entoplastron relatively broad with straight posterolateral margins; humeropectoral sulcus close to the base of the anterior lobe; pectoral slightly shorter than abdominal. CMNH C.997 differs from CMNH C.996 in the absence of the midline groove on the carapace, the shape of the plastral lobes, especially the posterior lobe which is long and narrow,



and the more anteriorly placed humeropectoral sulcus. Thus, both CMNH C.996 and CMNH C.997 belong to the Xinjiangchelyidae. We refrain from more precise assignment of these specimens pending revision of the Xinjiangchelyidae. Based on their close resemblance to the Late Jurassic turtles of the Sichuan Basin, these specimens likely come from the Upper Jurassic Shangshaximiao Formation.

The close examination of the Middle Jurassic turtles from Dashanpu shows that most of them do have a pair of mesoplastra, which meet on the midline. A new genus *Bashuchelys* is erected below with '*Chengyuchelys*' *zigongensis* as the type species. A new species *Bashuchelys youngi* is also erected for turtles from Dashanpu that have been previously placed in the species *Chengyuchelys baenoides* Young & Chow, 1953, which have a pair of mesoplastra that is narrowed at the midline and covered mostly by the abdominal scute.

### 5. Systematic palaeontology

Order TESTUDINES Linnaeus, 1758  
 Infraorder CRYPTODIRA Cope, 1868  
 Family BASHUCHELYIDAE n. fam.

**Diagnosis.** Primitive Cryptodira with the following combination of characters: one pair of mesoplastra present (1), which are meeting on the midline (2), with the hyoplastron–mesoplastron suture very close to the pectoroabdominal sulcus in the middle (3); regular and elongate neural series (4); wide fourth vertebral scute (5); sulcus between third and fourth vertebrals on sixth neural (6); plastron sutured to carapace (7); bridge fan-shaped with long axillary and inguinal buttresses (8); epiplastra midline contact present (9); humeropectoral sulcus lying far anterior to axillary notch (10); pectoral scute notably longer than abdominal (11); femoroanal sulcus omega-shaped, reaching or extending onto the hypoplastron (12); four inframarginals (13). Differs from Kayentachelyidae and Indochelyidae by characters 3, 4, 8, 9 and 12. Differs from Heckerochelyidae by characters 4, 6, 7, 11 and 12. Differs from Xinjiangchelyidae by characters 1–3.

**Included genera.** *Bashuchelys* n. gen., *Chuamanchelys* n. gen.

Genus *Bashuchelys* n. gen.

**Type species.** *Bashuchelys zigongensis* (Ye, 1982).

**Etymology.** Bashu means Bashan (Ba Mountain) in the Chongqing area and Shushui (the river system on the plain of Sichuan); alternative Chinese name for Sichuan–Chongqing area; chelys: Greek for turtle.

**Diagnosis.** A genus of the Bashuchelyidae with shell length up to 250 mm; carapace elongate oval and low domed (1); 8 neurals (2); 2 suprapyrgals (3), the first larger and wider than the second (4); narrow first to third vertebrals (5); fourth vertebral scute twice as wide as it is long and notably wider than the third vertebral (6); anterior edge of the plastron with one anterior intergular projection and a pair of lateral gular projections (7); short epiplastra midline contact (8); entoplastron leaf-shaped with serrated posterolateral margins (9); one pair of intergulars extending deeply onto the

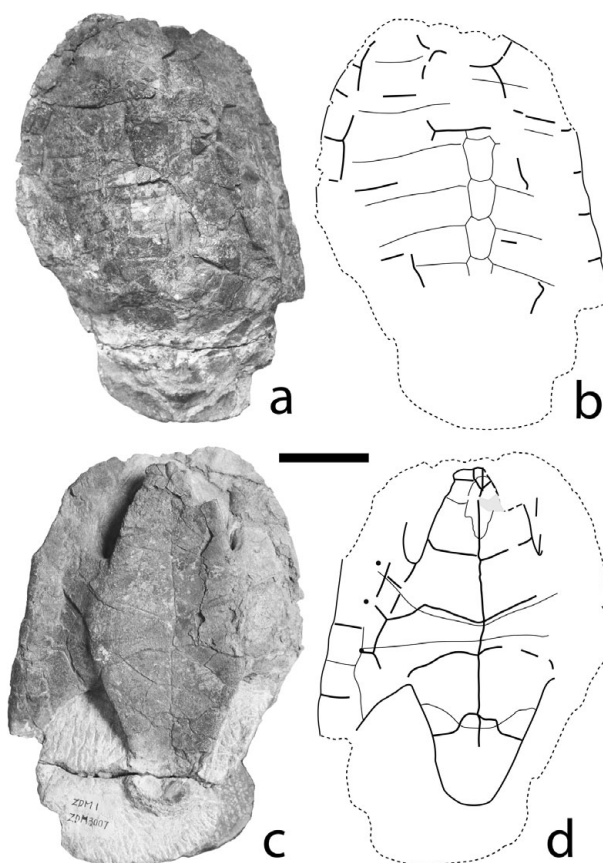


Figure 3. *Bashuchelys youngi* n. gen., n. sp. from the Middle Jurassic Xiashaximiao Formation, Dashanpu, Zigong. ZDM 3007 (holotype), shell in dorsal (a, b) and ventral (c, d) views. Scale bar = 50 mm.

entoplastron (10) (modified from Danilov & Parham, 2008). Differs from *Chuamanchelys* by characters 5–7, 9 and 10.

**Distribution.** Middle Jurassic of the Sichuan Basin, China.

**Included species.** *B. youngi* n. sp.; *B. zigongensis* (Ye, 1982).

*Bashuchelys youngi* n. sp.  
 Figure 3

- 1953 *Chengyuchelys baenoides* Young & Chow, p. 217, figs 1, 2; pl. 1, figs 1, 2.  
 1963 *Chengyuchelys baenoides* Young & Chow; Ye, p. 8.  
 1982 *Chengyuchelys baenoides* Young & Chow; Ye, p. 286, fig. 2.  
 1990a *Chengyuchelys baenoides* Young & Chow; Ye, p. 34, fig. 1.  
 1990b *Chengyuchelys baenoides* Young & Chow; Ye, p. 305.  
 1994 *Chengyuchelys baenoides* Young & Chow; Ye, p. 5, fig. 2.  
 2005 *Chengyuchelys baenoides* Young & Chow; Peng *et al.*, p. 37, fig. 23.  
 2008 *Chengyuchelys baenoides* Young & Chow; Danilov & Parham, p. 307, 316, fig. 2.  
 2008 *Chengyuchelys baenoides* Young & Chow; Brinkman, Li & Ye, p. 35, fig. 35.

Table 2. Measurements (in mm) of turtle specimens from the Middle Jurassic Xiashaximiao Formation, Sichuan Basin

Taxon	Specimen	Carapace		Plastron	
		Preserved	Estimated	Preserved	Estimated
<i>Bashuchelys zigongensis</i>	CMNH C.1001	(190 × 180)	230 × 202	(173 × 154)	178 × 154
	ZDM 3012	247 × (155)	247 × 185	(198 × 117)	200 × 125
<i>Bashuchelys youngi</i>	ZDM 3003	(215 × 165)	218 × 170	145 × 138	170 × 138
	ZDM 3006	217 × 165	225 × 170	170 × 130	172 × 130
	ZDM 3007	225 × 147	–	170 × 120	–
<i>Chuannanchelys dashanpuensis</i>	ZDM 3011	(193 × 125)	195 × 130	135 × 111	–
<i>Protoxinjiangchelys salis</i>	ZDM 3009	200 × 175	–	163 × 150	–
<i>Sichuanchelys chowi</i>	ZDM 3014	150 × 122	–	107 × 106	–
	ZDM 3001	138 × (85)	138 × 110	97 × 70	100 × 85
	ZDM 3017	162 × (133)	162 × 140	127 × 113	–
	ZDM 3018	150 × 130	–	120 × 105	–

*Etymology.* In honour of Yang Zhong-Jian (C. C. Young) who first studied Jurassic turtles from the Sichuan Basin.

*Holotype.* ZDM 3007 (field number ZDM 1), a shell with articulated damaged carapace and almost complete plastron.

*Referred material.* IVPP V6507, anterior portion of a shell with articulated carapace and plastron, and fragments of left pectoral girdle and humerus; ZDM 3003, a shell with articulated carapace and plastron, carapace surface damaged, plastron lacking anterior and posterior ends; ZDM3006 (field number ZDM 7), a shell with articulated damaged carapace and plastron; ZDM 3008 (field number ZDM 3), posterior half of plastron.

*Type locality and horizon.* Dashanpu, Zigong, Sichuan Province, China; Xiashaximiao Formation, Middle Jurassic.

*Diagnosis.* A species of *Bashuchelys*, different from *B. zigongensis* in the mesoplastron being strongly narrowed in the middle and mostly included in the abdominal scute, except laterally.

*Measurements.* See Table 2.

*Description and comparisons.* The carapace is low and has a narrow oval outline. A light midline depression is visible in ZDM 3003 and ZDM 3006, but not in IVPP V6507 and ZDM 3007. As preserved in IVPP V6507, radiating ridges are present on the vertebral region. Other specimens have a worn or damaged shell surface; thus no obvious ornamentation is visible. A shallow cervical notch is preserved in IVPP V6507 (Danilov & Parham, 2008), which is smaller than in '*Plesiochelys jingyanensis*' (Ye & Fang, 1982).

The carapace is damaged in all specimens; the best preserved is IVPP V6507 and ZDM 3007. The nuchal is complete only in IVPP V6507. It is trapezoidal and as wide as the first vertebral scute. In IVPP V6507, only the first, second and anterior end of the third neurals are preserved, and the outline of the fourth through seventh in ZDM 3007 and the first to sixth neurals in ZDM 3003 can be traced out. The first neural, as preserved in IVPP V6507 and ZDM 3003, is hexagonal with short posterolateral sides. The second neural is rectangular in ZDM 3003 and contacts the second costal plate only, while the second neural in IVPP V6507 has five sides, with a short posterolateral side contacting the right third costal plate. The third to sixth neurals are all elongate and hexagonal with short anterolateral sides. This elongated neural pattern differs from the short and irregular neurals of *Kayentachelys* (Gaffney *et al.* 1987) and *Indochelys* (Datta *et al.* 2000). The suprapygal and pygal are not preserved in any specimen. The first costal plate, as preserved in IVPP V6507 and ZDM 3006, is short as in many primitive turtles.

It is shorter than the second costal plate and contacts the first to third peripherals. The second costal has almost parallel anterior and posterior margins, while the third costal is longer laterally than medially in IVPP V6507, ZDM 3006 and ZDM 3007. The peripherals are better preserved in ZDM 3006 and IVPP V6507. There are 11 peripherals. The first peripheral is almost triangular with a short contact with the first costal. The second peripheral is roughly as long as wide. The third to seventh peripherals are longer than wide. The eighth and ninth peripherals are mesiolaterally expanded. The tenth and eleventh peripherals are clearly smaller than the ninth. This peripheral morphology is similar to that of *Bashuchelys zigongensis*. In comparison, in '*P. jingyanensis*' the second to sixth peripherals are shorter and the seventh to eleventh peripherals are mesiolaterally expanded. There is a narrow lateral carapacial fontanelle between the peripherals and costals in IVPP V6507, presumably a juvenile character. This fontanelle is absent in all other specimens (ZDM 3003, ZDM 3006, ZDM 3007).

The cervical scute is preserved only in IVPP V6507; it is triple as reported by Danilov & Parham (2008). The first vertebral is complete in IVPP V6507, and partly preserved in ZDM 3003, ZDM 3006 and ZDM 3007. It is wide and hexagonal, being as wide as the nuchal and contacting the second marginal laterally. The second vertebral is roughly as long as it is wide (IVPP V6507) or slightly longer than wide (ZDM 3003). The third vertebral is as wide as the second, as seen in ZDM 3003 and ZDM 3007. The fourth vertebral scute, although only partly preserved in ZDM 3006 and ZDM 3007, is much wider than the third vertebral scute, as in *B. zigongensis* (Ye, 1982). The fifth vertebral is again narrow, as seen in ZDM 3006. The intervertebral sulci pass through the first neural (IVPP V6507, ZDM 3003), the third neural (ZDM 3003, ZDM 3007) and likely the sixth neural (ZDM 3007), as in *B. zigongensis*, *Kayentachelys aprix* and *Eileanchelys waldmani*, in contrast to *Pleurosternon bullockii* and *Glyptops plicatulus*. The first to third pleural scutes are almost as long as wide. The fourth pleural scute is very narrow as in *B. zigongensis*, a consequence of the enlarged fourth vertebral scute. The first to seventh marginals are preserved in IVPP V6507. Most marginals are preserved in ZDM 3006, and only a few of them are visible in ZDM 3003 and ZDM 3007. The second to fourth marginals are restricted in the peripherals. The fifth marginal extends onto the second costal and the seventh marginal extends onto the fourth costal plate in IVPP V6507 and ZDM 3003, but not in ZDM 3006. As preserved in IVPP V6507, the sixth marginal is clearly narrower than the fifth and the seventh, with its medial sulcus matching the lateral carapacial fontanelle border. In comparison, all lateral marginals are restricted in the peripherals in *Kayentachelys aprix* and *Sichuanchelys chowi*, and the fourth through seventh marginals extend onto the costals in '*P. jingyanensis*' and other xinjiangchelyids.

The plastron is sutured to the carapace in ZDM 3007, ZDM 3006 and ZDM 3003, with the anterior margin reaching or slightly beyond the anterior rim of the carapace. IVPP V6507 has a loose plastron–carapace attachment (Danilov & Parham, 2008). The whole morphology of the plastron is similar to that of *B. zigongensis*. The plastron is elongated, with both anterior and posterior lobes, which are long and have a narrow end. The posterior lobe is longer than the anterior lobe and without an anal notch. The bridge is roughly as long as the posterior lobe, narrow and fan-shaped. As in *B. zigongensis*, the axillary buttress is long, reaching the second peripheral. The inguinal buttress touches the eighth peripheral. As preserved in IVPP V6507 and ZDM 3007, the plastron has an anteriorly directed intergular projection in the middle and a pair of the gular projections that are directed laterally. Such projections are absent in other Jurassic turtles (e.g. *Kayentachelys aprix*, *Heckerochelys romani*). Three musk ducts are visible on the right side in ZDM 3007, on or close to the plastron–carapace suture.

The epiplastron, completely preserved only on the right side of ZDM 3007 and left side of IVPP V6507, has a short midline suture to its mate, preventing the exposure of the entoplastron on the plastron front margin. The entoplastron is complete in IVPP V6507 and nearly so in ZDM 3007. It is leaf-shaped, with serrated posterolateral margins. The entoplastron separates the posterior two thirds of the epiplastron and does not reach the anterior border of the plastron, in contrast to *Kayentachelys aprix* and *Indochelys spatulata*. The mesoplastron is well preserved in ZDM 3007, ZDM 3003 and ZDM 3006, with clear sutures. It is incomplete in IVPP V6507, lacking the left part. ZDM 3008 has the mesoplastron mostly preserved as an imprint on the internal mould. The pair of mesoplastra meets on the midline but is strongly narrowed in the middle. Laterally its length in the bridge region is about three times its midline length or more. The hyoplastron–mesoplastron suture is clearly convex posteriorly. The mesoplastron–hyoplastron suture is straight in ZDM 3007 and convex anteriorly in ZDM 3003, ZDM 3006 and IVPP V6507. The hypoplastron–xiphiplastron suture is convex posteriorly.

The gular is short and wide in ZDM 3007 and roughly as long as it is wide in IVPP V6507. The pair of intergulars is clearly longer than the gulars and extends deeply onto the entoplastron in both IVPP V6507 and ZDM 3007. The humeropectoral sulcus is only slightly convex posteriorly, lying posterior to the entoplastron and well anterior to the axillary notch. The pectoroabdominal sulcus is convex posteriorly in the middle and very close to the hyoplastron–mesoplastron suture. Laterally, it turns sharply in the posterolateral direction, crossing the hyoplastron–mesoplastron suture. The midline length of the femoral scute is longer than that of the abdominal. The abdominofemoral sulcus is convex anteriorly. The anal scute has an omega-shaped anterior margin and is overlapping the hypoplastron in ZDM 3007, ZDM 3003 and ZDM 3006, while in ZDM 3006 the anal scute is restricted to the xiphiplastron, and its anterior sulcus does not reach the hypoplastron–xiphiplastron suture. As preserved in ZDM 3007, ZDM 3003 and ZDM 3006, four inframarginals are present, the fourth being the largest.

*Bashuchelys zigongensis* (Ye, 1982)  
Figures 4a–d, 5

- 1982 *Chengyuchelys zigongensis* Ye, p. 283, fig. 1.  
1987 *Chengyuchelys zigongensis* Ye; Fang, p. 67, pl. 6.  
1990a *Chengyuchelys zigongensis* Ye; Ye, p. 34, fig. 2.  
1990b *Chengyuchelys zigongensis* Ye; Ye, p. 305.

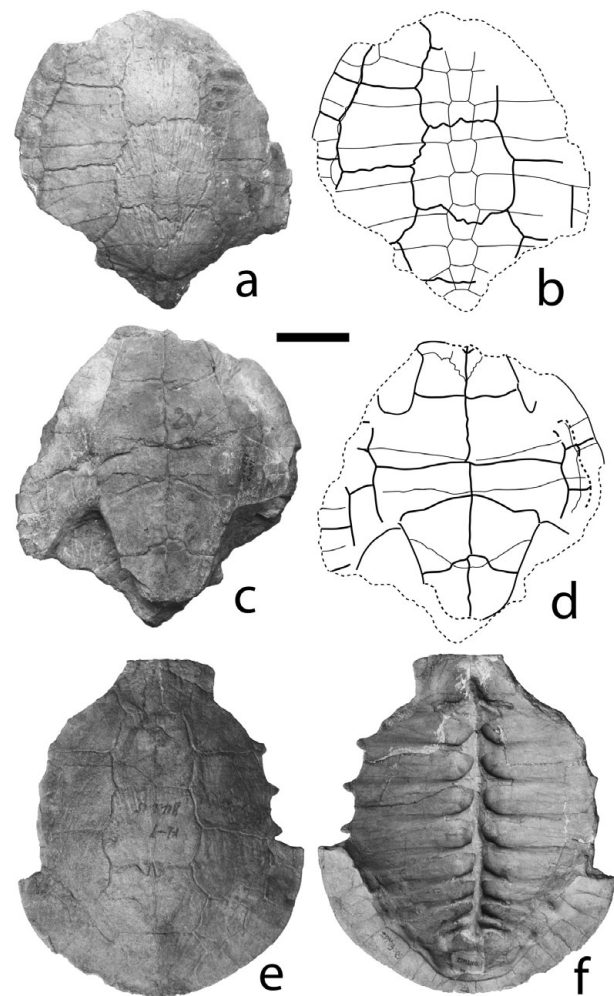


Figure 4. (a–d) *Bashuchelys zigongensis* (Ye, 1982) from the Middle Jurassic Xiashaximiao Formation, Dashanpu, Zigong. CMNH C.1001 (holotype), shell in dorsal (a, b) and ventral (c, d) views; (e, f) *Bashuchelys* sp. from the Middle Jurassic Xiashaximiao Formation, Dashanpu, Zigong. ZDM 3005, carapace in dorsal (e) and ventral (f) views. Scale bar = 50 mm.

- 1994 *Chengyuchelys zigongensis* Ye; Ye, p. 8, fig. 3.  
2005 *Chengyuchelys zigongensis* Ye; Peng *et al.*, p. 38, fig. 24.  
2008 *Chengyuchelys zigongensis* Ye; Brinkman, Li & Ye, p. 36, fig. 36.  
2008 *Chengyuchelys zigongensis* Ye; Danilov & Parham, p. 316.

*Holotype*. CMNH C.1001 (C. V. 00678 in Ye, 1982), an incomplete shell with articulated carapace and plastron.

*Referred material*. ZDM 3012 (field number: I-Z1), an almost complete shell with articulated carapace and plastron, slightly deformed.

*Type locality and horizon*. Dashanpu, Zigong, Sichuan Province, China; Xiashaximiao Formation, Middle Jurassic.

*Diagnosis*. A species of *Bashuchelys*, different from *B. youngi* in the pair of mesoplastra that is not narrowed in the middle and covered by both pectoral and abdominal scutes.

*Measurements*. See Table 2.



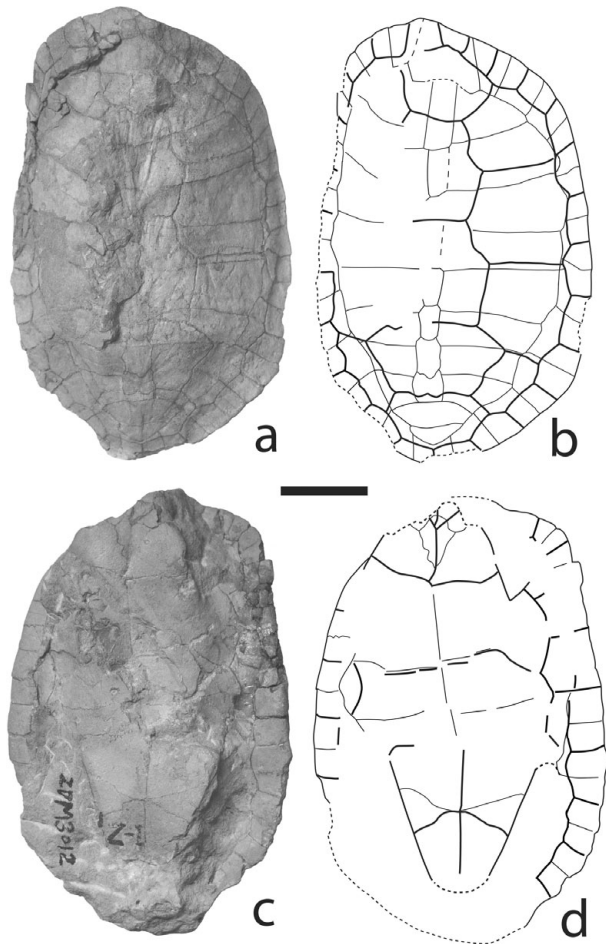


Figure 5. *Bashuchelys zigongensis* (Ye, 1982) from the Middle Jurassic Xiashaximiao Formation, Dashanpu, Zigong. ZDM 3012, shell in dorsal (a, b) and ventral (c, d) views. Scale bar = 50 mm.

**Description and comparisons.** CMNH C.1001 lacks the anterior and posterior end of the carapace. The carapace of ZDM 3012 is complete, and has an elongate oval outline. In comparison, '*Plesiochelys*' *latimarginalis* and other xinjiangchelyids have a wider carapace (Young & Chow, 1953; Ye & Fang, 1982; Ye, 1986a; Peng & Brinkman, 1993; Matzke *et al.* 2004, 2005). The carapace is low domed. The midline depression is absent in both CMNH C.1001 and ZDM 3012. The cervical notch is absent as preserved in ZDM 3012. The complete lateral margin of ZDM 3012 shows no gutter formed by the anterolateral peripherals, in contrast to *Xinjiangchelys junggarensis* (Peng & Brinkman, 1993), while a light gutter is present on the bridge peripherals, as in IVPP V6507 (Danilov & Parham, 2008). The carapace surface is decorated by some radiating ridges in the vertebral region and in the anterolateral part, which are lighter than that of '*Plesiochelys*' *radiplicatus* (Young & Chow, 1953). The surface of the plastron is rough.

The nuchal is preserved in ZDM 3012, which is trapezoidal with a long free margin. There are eight neurals in CMNH C.1001; the first is not complete. In ZDM 3012, the complete series of neurals is preserved, but the sutures of the third to fifth neurals are not all discernible. In CMNH C.1001, the first neural is likely rectangular; it does not contact the second costal plate. The second to eighth neurals are all hexagonal, with short anterolateral sides. They are all longer than wide except the seventh. In ZDM 3012, the first neural appears to be hexagonal, with short

posterolateral sides to contact the second costal plates. The sixth and seventh neurals are longer than wide with short anterolateral sides. The eighth neural is nearly as long as wide. There are two suprapyrgals in ZDM 3012 and only part of the first suprapygal is preserved in CMNH C.1001. The first suprapygal is larger and wider than the second and contacts the eleventh peripheral laterally. The pygal is nearly complete in ZDM 3012; it is wider than long, with the anterior suture convex backward. The first costal plate as preserved in ZDM 3012 is short and narrower than the second costal, as in many primitive turtles. The second and third costals are slightly wider laterally than medially, as in IVPP V6507 (Danilov & Parham, 2008). Only the left second to sixth peripherals are preserved in CMNH C.1001. The complete series of 11 peripherals are preserved in ZDM 3012. The first peripheral is four-sided, with the length of its free margin twice that of its contact with the first costal plate. The second and third peripherals are as long as wide. The fourth to seventh peripherals are narrow. The eighth and ninth peripherals are mesiolaterally expanded. The tenth and eleventh peripherals are clearly smaller than the eighth and the ninth. In comparison, *Xinjiangchelys junggarensis* has the seventh through eleventh peripherals mesiolaterally expanded (Ye, 1986a; Peng & Brinkman, 1993).

As preserved in ZDM 3012, there is a single cervical scute which is wider than long, unlike the triple cervical in IVPP V6507 (Danilov & Parham, 2008). The cervical has posteriorly convergent lateral sulci; as a result its free margin is longer than its sulcus to the first vertebral scute. The first to third vertebrae are moderate in width, as in '*P.*' *latimarginalis* (Young & Chow, 1953), and different from the very large vertebrae of *Sichuanchelys chowi* (Ye & Pi, 1997) and *Kayentachelys aprix* (Gaffney *et al.* 1987). The first vertebral scute is complete in ZDM 3012. It is slightly wider than long and as wide as the second vertebral. The second and the third vertebrae are narrower anteriorly than posteriorly in ZDM 3012. In CMNH C.1001, the second vertebral is as wide anteriorly as posteriorly. The third vertebral is slightly wider than the second in both CMNH C.1001 and ZDM 3012. The fourth vertebral is the widest, which is much wider than the third one and nearly twice wider than it is long. This vertebral scute pattern is present in both CMNH C.1001 and ZDM 3012, and similar to *Bashuchelys youngi*. The fifth vertebral, as preserved in ZDM 3012, is almost as wide as the third vertebral and clearly wider than the first suprapygal. It covers the posterior part of the eighth neural and eighth costals, two suprapyrgals, the anterior part of the pygal and the eleventh peripheral plates. The intervertebral sulci pass through the first, the third, the sixth and the eighth neural plates, respectively. The sulcus passing the sixth neural is straight in ZDM 3012, but serrated and convex posteriorly in CMNH C.1001. The first pleural scute covers the first to fourth peripherals, but does not extend onto the nuchal, contrary to IVPP V6507 (Danilov & Parham, 2008). The second pleural scute is larger than the first and the third pleurals and notably wide, as indicated by Ye (1982). It is as long as wide and contacts the fourth to sixth peripherals. The third pleural scute is slightly longer than wide, and covers the seventh to ninth peripherals. The fourth pleural scute is very narrow; it covers the ninth and tenth peripherals. As preserved in ZDM 3012, there are 12 marginal scutes. The first to the third and the eighth to the twelfth marginals are much narrower than the corresponding peripherals, although the fourth to seventh marginals are nearly as wide as the peripherals. In comparison, the medial tips of the marginals extend onto costal two to five in *Xinjiangchelys junggarensis* (Peng & Brinkman, 1993) and all marginals are narrower than



peripherals in *Kayentachelys aprix* (Gaffney *et al.* 1987) and *Sichuanchelys chowi*.

The plastron is sutured to the carapace in both CMNH C.1001 and ZDM 3012, in contrast to IVPP V6507 (Danilov & Parham, 2008) and *Xinjiangchelys junggarensis* (Peng & Brinkman, 1993). The plastron is elongate, with a long fan-shaped bridge and narrow axillary and inguinal notches. The plastron of *Xinjiangchelys junggarensis* is shorter, with shorter anterior and posterior lobes. The morphology of the anterior lobe is comparable to that of *Bashuchelys youngi*, although its anterior end is slightly damaged in both CMNH C.1001 and ZDM 3012. The gular projection is preserved on the left side of ZDM 3012 and the right side of CMNH C.1001. The intergular projection, as seen in *Bashuchelys youngi*, is not preserved in any specimen. The anterior margin of the plastron extends slightly beyond the anterior margin of the carapace, as in IVPP V6507. The anterior lobe is shorter than the posterior lobe. In ZDM 3012, the posterior lobe is long and narrow, with posteriorly convergent lateral margins. The posterior lobe in CMNH C.1001 is wider than that of ZDM 3012. The anal notch is absent. The axillary buttress is long, reaching the posterior part of the second peripheral. The inguinal buttress reaches the eighth peripheral.

The incomplete epiplastron is preserved on the right side of CMNH C.1001 and left side of ZDM 3012. It has a short contact with its mate. The entoplastron is complete in ZDM 3012 and lacks the anterior end in CMNH C.1001. It is leaf-shaped, with serrated sutures and a pointed posterior end. It does not reach the anterior margin of the plastron. The hyoplastron contacts the second through fifth peripherals. In CMNH C.1001, the mesoplastron is well preserved, with clear anterior and posterior sutures. In ZDM 3012, the sutures are more difficult to follow, especially the anterior one. In both specimens, the mesoplastron is large and not narrowed in the middle, covered by both pectoral and abdominal scutes. However, its anterior suture lies very close to the pectoroabdominal sulcus, as in *Heckerochelys romani* (Sukhanov, 2006). In *Glyptops plicatus*, *Dinochelys whitei*, *Kayentachelys aprix*, *Pleurosternon bullockii* and *Helochelydra anglica*, the anterior border of the mesoplastron lies at about same distance to the pectoroabdominal sulcus as its posterior border (Gaffney, 1979; Gaffney *et al.* 1987; Milner, 2004). The mesoplastron contacts the fifth and sixth peripherals. The hypoplastron contacts the sixth through eighth peripherals. The hypoplastron–xiphoplastron suture is strongly convex posteriorly in both specimens.

The pair of intergulars extends deeply onto the entoplastron in both specimens as in *Bashuchelys youngi*. The humeral is long, with a straight humeropectoral sulcus, which lies far anterior to the axillary notch as in *Bashuchelys youngi*. The pectoral scute is clearly longer than the abdominal scute. In comparison, the humeropectoral sulcus lies close to the base of the anterior lobe and the pectoral and abdominal have a similar length in *Xinjiangchelys junggarensis* and '*P. latimarginalis*'. The femoral is as long as the pectoral. The femoroanal sulcus is roughly omega-shaped, reaching the hypoplastron–xiphoplastron suture in ZDM 3012, and extending onto the hypoplastron in CMNH C.1001. As preserved in CMNH C.1001 and the left side of ZDM 3012, there are four inframarginals. The midline sulcus is straight in ZDM 3012 and slightly sinuous in CMNH C.1001.

*Bashuchelys* sp.

1990b *Chengyuchelys* sp. Ye, p. 306.

1994 *Chengyuchelys* sp. Ye, p. 12.

2005 *Chengyuchelys* sp. Peng *et al.*, p. 42.

*Referred material.* ZDM 3004, incomplete carapace lacking peripherals; ZDM 3005 (Fig. 4e, f) and ZDM 3013, two incomplete carapaces lacking anterior and lateral peripherals; ZDM 3016, incomplete carapace with damaged surface, lacking some peripherals.

*Locality and horizon.* Dashanpu, Zigong, Sichuan Province, China; Xiashaximiao Formation, Middle Jurassic.

*Description.* The carapace is oval. The almost complete right margin in ZDM 3016 shows slightly upturned anterolateral margins with the carapace being wider posteriorly than anteriorly. ZDM 3005 and ZDM 3016 have a well-preserved anterior margin of the carapace, showing that the cervical notch is absent. The carapace surface has radiating ridges on the vertebral region in all four specimens. The free rib end is present on the lateral end of the costals in ZDM 3005. The sutures are not all discernible. The cervical is preserved in ZDM 3005; it is wider than long. The first to third vertebrals are moderate in width in ZDM 3005, ZDM 3013 and ZDM 3016, while the third vertebral in ZDM 3004 is wider. In all four specimens, the fourth vertebral scute is notably wider than other vertebrals. There is an additional small scute between the second and third vertebrals in ZDM 3004. As preserved in ZDM 3005 and ZDM 3016, the sulcus between the third and fourth vertebrals is W-shaped and lying on the sixth neural. The anterior and lateral marginals are longer than wide, and the posterior marginals are square. The sulci between the marginal and pleural scutes are visible on the second costal in ZDM 3005, and on the fourth costal in ZDM 3004 and ZDM 3005.

The inner surface of the carapace is exposed in ZDM 3005 (Fig. 4f). The first thoracic rib extends laterally to half the width of the first costal as in *Xinjiangchelys junggarensis* (Peng & Brinkman, 1993; Brinkman, Li & Ye, 2008), in contrast to *Ordosemys leios* (Brinkman & Peng, 1993). All rib heads are large and triangular. The axillary buttress reaches the lateral margin of the first costal, while the inguinal buttress inserts on the limit of the sixth costal and eighth peripheral.

*Remarks.* These specimens are referable to *Bashuchelys* in that the fourth vertebral scute is notably wider than the other vertebrals, closely resembling the two *Bashuchelys* species described above. As the two species of *Bashuchelys* are distinct only by the mesoplastron, these specimens are referred to *Bashuchelys* without specific assignment. ZDM 3004 and ZDM 3005 have been identified as *Chengyuchelys* sp. in Peng *et al.* 2005.

Genus *Chuannanchelys* n. gen.

*Chuannanchelys dashanpuensis* (Fang, 1987)

Figure 6

1987 *Chengyuchelys dashanpuensis* Fang, p.65, figs on p. 66, pl. VI, figs I–T<sub>19</sub>.

1990b *Chengyuchelys dashanpuensis* Fang; Ye, p. 306.

1994 *Chengyuchelys dashanpuensis* Fang; Ye, p.10, fig. 4.

2005 *Chengyuchelys dashanpuensis* Fang; Peng *et al.*, p. 41, fig. 26.

2008 '*Chengyuchelys*' *dashanpuensis* Fang; Danilov & Parham, p. 316.

2008 *Sichuanchelys dashanpuensis* (Fang); Brinkman, Li & Ye, p. 37, fig. 38.

*Etymology.* Genus name from Chuannan (south Sichuan).

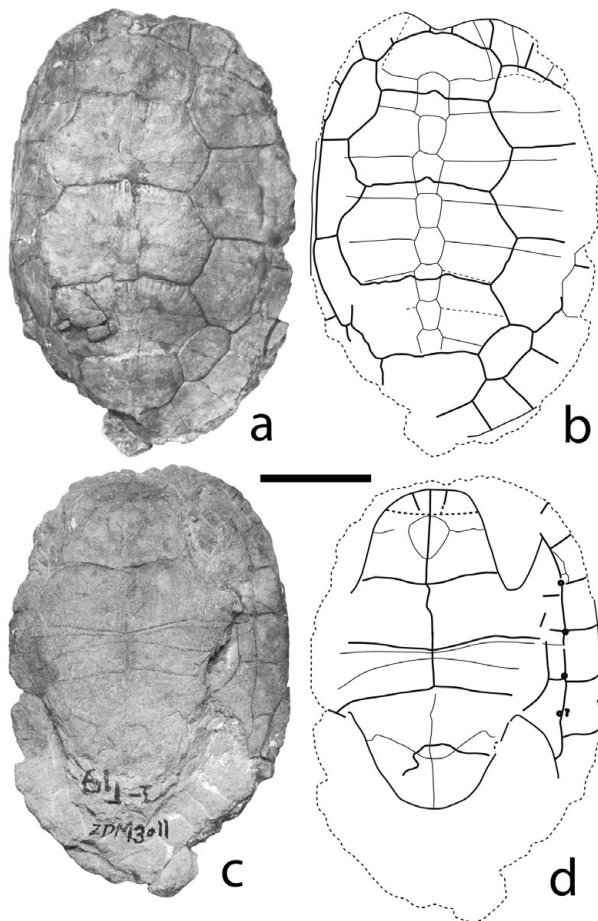


Figure 6. *Chuannanchelys dashanpuensis* (Fang, 1987) from the Middle Jurassic Xiashaximiao Formation, Dashanpu, Zigong. ZDM 3011 (holotype), shell in dorsal (a, b) and ventral (c, d) views. Scale bar = 50 mm.

**Holotype.** ZDM 3011 (I-T<sub>19</sub> in Fang, 1987), an almost complete shell with articulated carapace and plastron, lacking part of peripherals.

**Type locality and horizon.** Dashanpu, Zigong, Sichuan Province, China; Xiashaximiao Formation, Middle Jurassic.

**Diagnosis.** A genus of the Bashuchelyidae, carapace length about 200 mm, with the following combination of characters: carapace elongated oval and low (1) with shallow cervical notch (2); all vertebrals broad, second to fourth vertebrals almost twice as wide as long (3); plastron with wide anterior lobe, and short and wide posterior lobe (4); one pair of reduced mesoplastra meeting on the midline and included entirely in the abdominal scute (5); epiplastron squarish (6) with long midline contact (7); entoplastron diamond-shaped and slightly longer than wide (8); intergulars excluded from entoplastron (9). Differs from *Bashuchelys* by characters 3–9.

**Measurements.** See Table 2.

**Description and comparisons.** Although the shell is well preserved, some sutures are not discernible. The carapace is slightly deformed. It is elongate oval and low. The cervical notch is wide and shallow, larger than in *Bashuchelys* spp., but clearly smaller than in *Sichuanchelys chowi*. There are some light wrinkles on the carapace surface, within the vertebral scutes.

The nuchal is trapezoid. There are eight neurals, with the neural formula of 6<4>6<6<6<6<6<6. They are all longer than wide, in contrast to mostly short and wide neurals in *Kayentachelys aprix* and *Indochelys spatulata*. The suprapygals and pygal are not discernible. There are eight costal plates. The first costal is shorter than the second. The third costal is wider laterally than medially as in *Bashuchelys* spp. The peripherals are not all discernible. The first peripheral is roughly rectangular with the second being as long as wide. Other peripheral sutures are not visible.

The cervical is short and wide, with its width two times its length, similar to *Kayentachelys aprix*. In contrast to *Glyptops plicatulus*, *Bashuchelys* spp. and xinjiangchelyids, all five vertebrals are wide as in *Kayentachelys aprix*, *Indochelys spatulata*, *Heckerochelys romani*, *Dinochelys whitei* and *Eileanchelys waldmani*. The first vertebral is wider than the nuchal and has a rather long contact with the second marginal. The second through fourth vertebrals are nearly twice as wide as long, different from *Bashuchelys* spp. in which only the fourth vertebral is wide. There are 12 marginals. The first marginal is longer than wide. The second marginal is as long as wide. The third through seventh marginals are elongate and the ninth to eleventh marginals are square.

In contrast to *Heckerochelys romani*, the plastron is sutured to the carapace as in *Kayentachelys aprix* and *Eileanchelys waldmani*. In comparison with *Bashuchelys* spp., the plastron of *Chuannanchelys dashanpuensis* is wider with wider anterior and posterior ends. The anterior lobe is longer than the posterior lobe but shorter than the bridge. The anterior lobe has a wide front end and smooth anterior border, without gular and intergular projections as seen in *Bashuchelys youngi*. The bridge is fan-shaped as in *Bashuchelys* spp. and xinjiangchelyids. The posterior lobe is wider and shorter than in *Bashuchelys*. The axillary and inguinal buttresses are long as in *Bashuchelys*. Three musk ducts are visible on the left side, on the plastron–carapace suture. A fourth one may be present (see Fig. 6d).

The epiplastron is large and squarish, with the transverse epiplastron–hyoplastron suture, unlike *Sichuanchelys chowi*. The entoplastron is ovoid, with a narrow posterior end. It is different from the leaf-shaped entoplastron of *Bashuchelys* spp. and the very small one of *Sichuanchelys chowi*. The hyoplastron is very long. A pair of mesoplastra is present, meeting on the midline. The mesoplastron is narrowed in the middle and entirely included in the abdominal scute, even laterally, in contrast to *Bashuchelys youngi* and *Sichuanchelys chowi*, in which the mesoplastron extends onto the pectoral laterally. The hypoplastron–xiphoplastron suture is convex posteriorly.

There are one pair of gulars and one pair of intergulars. In contrast to *Bashuchelys* spp. and *Sichuanchelys chowi*, the posterior border of the gulars and intergulars form a straight sulcus and are placed just before the entoplastron as in xinjiangchelyids. The humeropectoral sulcus is posterior to the entoplastron and lying far anterior to the axillary notch as in *Bashuchelys* spp. The pectoral scute is clearly longer than the abdominal. The femoroanal sulcus is omega-shaped and extends onto the hypoplastron as in *Bashuchelys* spp. and most xinjiangchelyids. Four inframarginals are preserved on the left side, the last one being the largest.

Family XINJIANGCHELYIDAE Nessov in Kaznyshkin,  
Nalbandyan & Nessov, 1990  
*Protoxinjiangchelys salis* n. gen. et n. sp.  
Figure 7

1990b *Chengyuchelys zigongensis* Ye, p. 306.



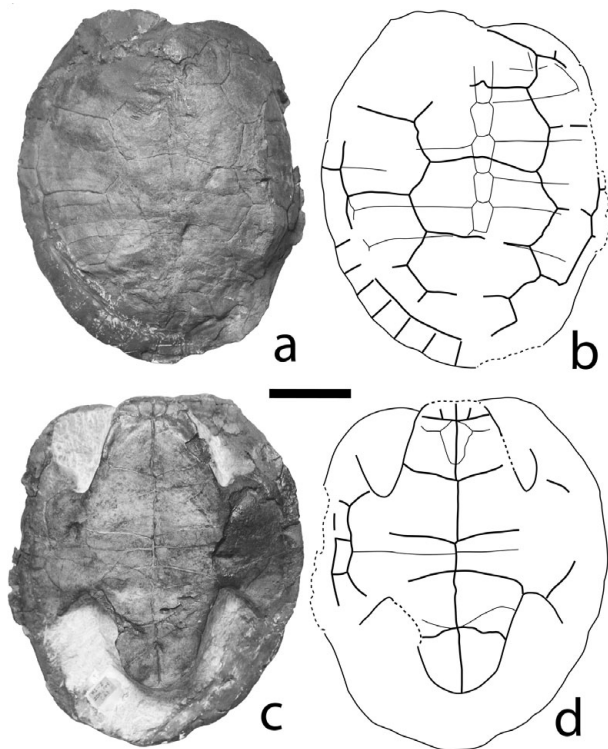


Figure 7. *Protixinjiangchelys salis* n. gen., n. sp. from the Middle Jurassic Xiashaximiao Formation, Dashanpu, Zigong. ZDM 3009 (holotype), shell in dorsal (a, b) and ventral (c, d) views. Scale bar = 50 mm.

1994 *Chengyuchelys* cf. *zigongensis* Ye, p. 9.

2005 *Chengyuchelys zigongensis* Ye; Peng *et al.*, p. 40, fig. 25E–F.

**Etymology.** Genus name: proto, first or primitive in Latin, in reference of its primitive status relative to *Xinjiangchelys*. Species name: *salis*, salt in Latin, in reference of the underground salt mine in the Zigong area.

**Holotype.** ZDM 3009, a complete shell with articulated carapace and plastron.

**Type locality and horizon.** Dashanpu, Zigong, Sichuan Province, China; Xiashaximiao Formation, Middle Jurassic.

**Diagnosis.** Primitive xinjiangchelyid with carapace length of about 200 mm; carapace oval and low (1), with shallow cervical notch (2); all vertebral scutes wide (3); plastron sutured to carapace (4), with narrow and long anterior and posterior lobes (5); epiplastron squarish with long midline contact (6); entoplastron elongate diamond-shaped (7); pair of intergulars excluded from entoplastron (8); humeropectoral sulcus lying far anterior to axillary notch (9); pectoral scute longer than abdominal (10); femoroanal sulcus reaching hypoplastron–xiphoplastron suture (11). Differs from bashuchelyids in the absence of the mesoplastron; differs from *Xinjiangchelys* by the characters 3, 4, 9 and 10; differs from *Tienfuchelys* by the characters 3, 7, 9 and 10; differs from *Siamochelys* by the characters 3, 4, 7, 9 and 10.

**Measurements.** See Table 2.

**Description and comparisons.** The carapace is slightly crushed, with the periphery regions damaged and restored. The plastron has the left bridge damaged.

The carapace is low and has an oval outline, which is wider than in *Bashuchelys* spp. The cervical notch is shallow and wide, comparable to that of *Chuannanchelys dashanpuensis*, but shallower than in '*Plesiochelys*' *jingyanensis*. The carapace surface has no ornamentation. The nuchal is partly preserved, which appears to be similar to that of *Chuannanchelys dashanpuensis*. The first to fifth and incomplete sixth neurals are preserved, with the neural formula of 4>6>6>6>6>6. The first through fifth neurals are all elongate. The remaining neurals are not discernible, nor are the suprapyrgals and pygal. The costal plates are not all distinguishable. The first costal plate is short as in *Bashuchelys* spp. The peripheral plate sutures are not visible, except the medial suture of the seventh and eighth peripherals; they are slightly wider than the corresponding marginals.

The cervical is not preserved. The morphology of the vertebrals closely resembles that of *Chuannanchelys dashanpuensis*. The first and fifth vertebrals are narrower than the second vertebral. The second to fourth vertebrals are all clearly wider than long, being almost twice as wide as long. The intervertebral sulci pass through the first, the third and sixth neurals. The pleural scutes are longer than wide, except the second one which is square.

The morphology of the plastron resembles that of *Bashuchelys* spp. The plastron is sutured to the carapace. It is narrow and elongate as in *Bashuchelys* spp., but longer and narrower than in '*P.*' *jingyanensis*. The anterior lobe is long and extends slightly beyond the anterior carapace margin as in *Bashuchelys youngi*. It is longer than the posterior lobe. The anterior margin of the plastron is slightly damaged, the gular and intergular projections as seen in *Bashuchelys youngi* seem to be absent; the margin is scallop-shaped as in '*P.*' *jingyanensis*. The bridge is wide, fan-shaped and moderate in length. It is slightly longer than the anterior lobe. The posterior lobe is narrow, without an anal notch. The squarish epiplastron has a long midline suture to its mate. The entoplastron is diamond-shaped and longer than wide, with the anterolateral rims clearly shorter than the posterolateral ones; the posterolateral margin is straight on the right and only slightly undulated on the left, in contrast to *Bashuchelys* spp. The hyoplastron is longer than hypoplastron at the midline. The mesoplastron is absent.

The gular is smaller than the intergular. The posterior margin of gulars and intergulars is a straight sulcus situated at the anterior margin of the entoplastron as in '*P.*' *jingyanensis*. In comparison, the intergulars in *Bashuchelys* spp. extend deeply onto the entoplastron. The humeropectoral sulcus is convex backwards, lying posterior to the entoplastron and far anterior to the axillary notch as in *Bashuchelys* spp. In '*P.*' *jingyanensis*, this sulcus is close to the axillary notch. The pectoral is much longer than the abdominal at the midline, and similar in length to the femoral. The femoroanal sulcus is convex anteriorly and reaches the hypoplastron–xiphoplastron suture, but does not cut it. Four narrow inframarginal scutes are preserved on the right side, the last being the largest.

#### *Protixinjiangchelys* sp.

1982 *Chengyuchelys* sp. Ye, p.286.

1990b *Chengyuchelys* sp. Ye, p.306.

1994 *Chengyuchelys* sp. Ye, p. 10.

2005 *Chengyuchelys* sp. Peng *et al.*, p. 42.

**Referred material.** CMNH C.1002 (C.V. 00679 in Ye, 1982), an incomplete shell with articulated carapace and plastron.



**Remarks.** Ye (1982) reported an incomplete shell with articulated carapace and plastron (C. V. 00679) from Dashanpu and referred it to *Chengyuchelys* sp. This specimen, now under the number of CMNH C.1002, is catalogued as being from the Late Jurassic of Jiulongpo, Chongqing. The specimen has broad vertebrals, although the third and fourth vertebrals are slightly wider than the second vertebral, different from *Protoxinjiangchelys salis* and *Chuannanchelys dashanpuensis*. The sulcus between the third and fourth vertebrals is on the fifth neural instead of on the sixth neural as in *Bashuchelys* spp., *Protoxinjiangchelys salis* and *Chuannanchelys dashanpuensis*. As in *Bashuchelys* spp. and *Protoxinjiangchelys salis*, the plastron has long anterior and posterior lobes; the humeropectoral sulcus lies far anterior to the axillary notch, the pectoral is longer than the abdominal, and the femoroanal sulcus is omega-shaped and extending onto the hypoplastron. The mesoplastron is absent as in *Protoxinjiangchelys salis*, in contrast to *Bashuchelys* spp. and *Ch. dashanpuensis*. Based on these characters, CMNH C.1002 is likely from the Middle Jurassic Dashanpu locality as indicated originally by Ye (1982). It is referred to *Protoxinjiangchelys* sp. because of the absence of the mesoplastron.

Family SICHUANCHELYIDAE n. fam.

**Diagnosis.** Same as for *Sichuanchelys*.

Genus *Sichuanchelys* Ye & Pi, 1997

**Type species.** *S. chowi* Ye & Pi, 1997.

**Emended diagnosis.** Primitive turtle of small size, with a carapace length about 160 mm (1); carapace low, as long as wide and tapering posteriorly (2), with a large and deep cervical notch (3) and a shallow midline depression (4); shell surface without obvious ornamentation (5); most neurals elongate hexagonal with short anterolateral sides (6); peripherals very broad (7); vertebral scutes extremely broad, and second and third vertebrals with width being nearly three times length (8); pleural scutes narrow (9); all marginals narrow, lateral marginal scutes extremely narrow (10); plastron broad and sutured to carapace (11); anterior border of plastron slightly notched and made of a pair of weak interangular projections (12); one pair of mesoplastra present, which is narrowed in the midline and included mostly in the abdominal scute except laterally (13); epiplastron with very short midline contact (14) and long posterolateral process (15); entoplastron small and triangular and not reaching the anterior plastral margin (16); one pair of intergulars extending onto the entoplastron (17); anal scute included in the xiphiplastron (18); four inframarginals (19). Differs from *Bashuchelys* by the characters 1–3, 7–10, 12, 15, 16 and 18. Differs from *Protoxinjiangchelys* and *Chuannanchelys* by characters 2–4, 7, 10, 12, 14–18. Differs from *Kayentachelys* and *Indochelys* by characters 1–3, 6, 7, 10, 13–16.

**Distribution.** Middle Jurassic of Sichuan; ?Middle to Late Jurassic of Xinjiang.

*Sichuanchelys chowi* Ye & Pi, 1997  
Figures 8–10

**Holotype.** ZDM 3014, a complete shell with articulated carapace and plastron; part of carapace surface damaged.

**Referred material.** ZDM 3001, complete but deformed shell with articulated carapace and plastron; ZDM 3017, almost complete shell with articulated carapace and plastron, left part of carapace surface damaged; ZDM 3018, almost

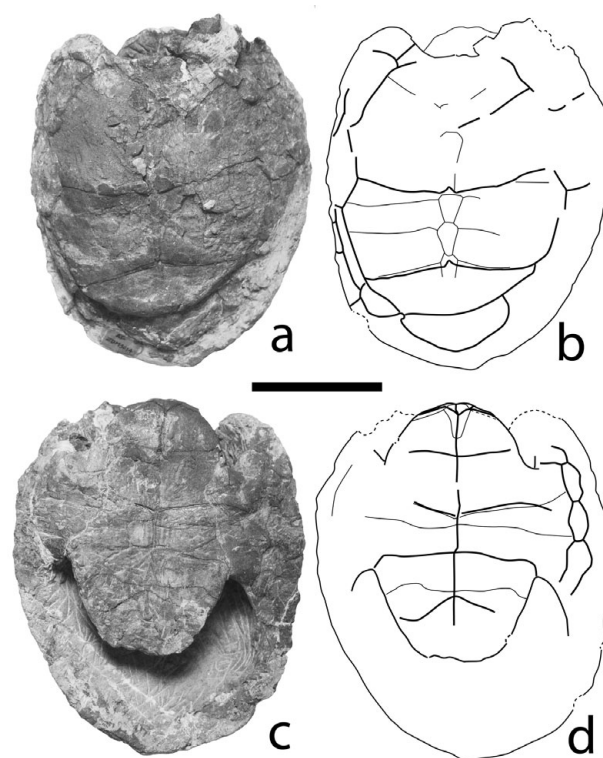


Figure 8. *Sichuanchelys chowi* Ye & Pi, 1997 from the Middle Jurassic Xiashaximiao Formation, Dashanpu, Zigong. ZDM 3014 (holotype), shell in dorsal (a, b) and ventral (c, d) views. Scale bar = 50 mm.

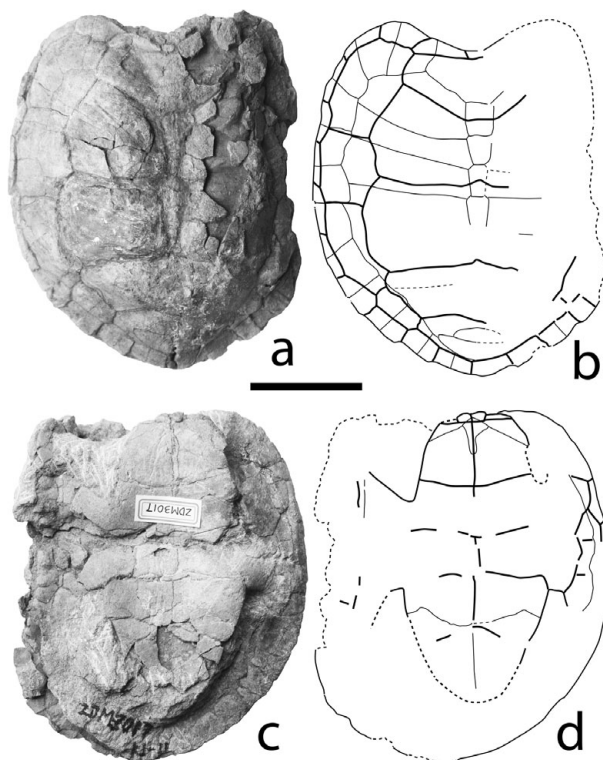


Figure 9. *Sichuanchelys chowi* Ye & Pi, 1997 from the Middle Jurassic Xiashaximiao Formation, Dashanpu, Zigong. ZDM 3017, shell in dorsal (a, b) and ventral (c, d) views. Scale bar = 50 mm.

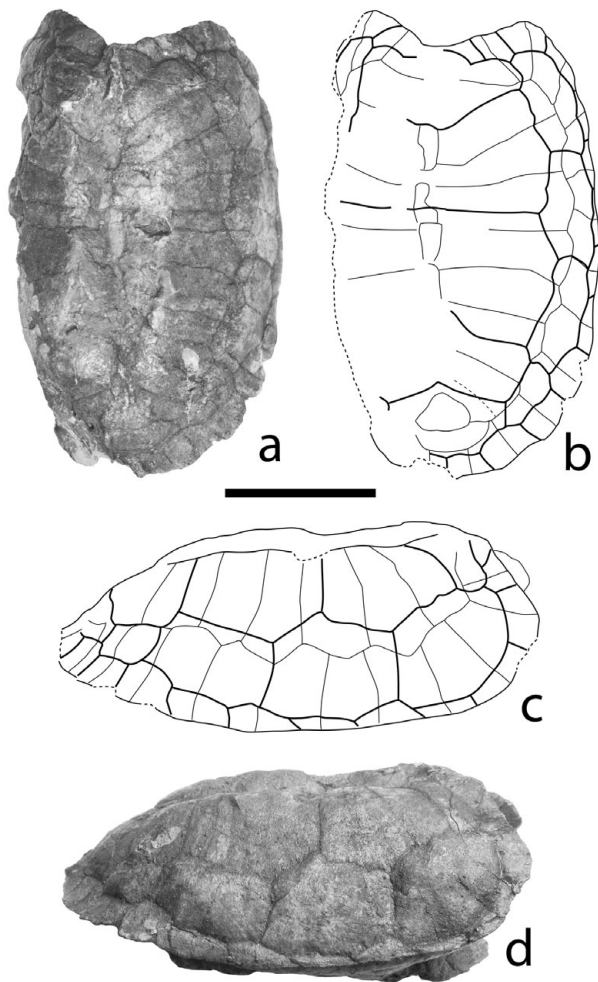


Figure 10. *Sichuanchelys chowi* Ye & Pi, 1997 from the Middle Jurassic Xiashaximiao Formation, Dashanpu, Zigong. ZDM 3001, shell in dorsal (a, b) and right lateral (c, d) views. Scale bar = 50 mm.

complete shell with articulated carapace and plastron, posterior peripheral region of carapace damaged.

*Type locality and horizon.* Dashanpu, Zigong, Sichuan Province; Xiashaximiao Formation, Middle Jurassic.

*Diagnosis.* Only species, same as for genus.

*Measurements.* See Table 2.

*Description and comparisons.* Carapace is low and broad, with a deep and large cervical notch and a slight midline depression. The carapace outline is similar to that of *Kayentachelys aprix* (Gaffney *et al.* 1987), but the posterior end of *Sichuanchelys* is narrower and its cervical notch is much more developed. The posterior edge of the carapace is slightly serrated, as preserved in ZDM 3001 and ZDM 3017. The shell surface is smooth without any ornamentation.

Although all specimens are almost complete shells, sutures are not always clearly preserved. The nuchal is preserved in all specimens. Although incomplete in most specimens (ZDM 3014, ZDM 3017, ZDM 3018), its shape can be easily reconstructed. The nuchal is trapezoidal, its width being twice its midline length, with the posterolateral margins strongly convergent backwards. The shape of the nuchal in ZDM 3001 is different; it is wider and shorter with an almost straight posterior margin. The second to fifth

neurals are preserved in ZDM 3001, the second to sixth neural are preserved in ZDM 3014 and the first to fourth neurals are preserved in ZDM 3017. The first neural is rectangular and wide. The second through sixth neurals are elongated hexagonal with short sides in front. The remaining neurals are not preserved. The neural formula is thus  $4 < 6 > 6 > 6 > 6 > 6$ . As preserved in ZDM 3001 and ZDM 3017, two suprapygals are present. The first suprapygal is roughly triangular and does not reach the peripheral, in contrast to *Bashuchelys zigongensis*. The second suprapygal is clearly wider than the first and contacts the eleventh peripheral and pygal. The pygal, as preserved in ZDM 3001 and ZDM 3017, is wider than long. In comparison, *Kayentachelys aprix* has broad neurals of irregular length and shape, and the first two suprapygals are smaller than the third suprapygal. The first costal plate is well preserved on the right side of ZDM 3001 and on the left side of ZDM 3017. It is large and clearly longer than the second costal, in contrast to *Bashuchelys* spp., *Chuannanchelys dashanpuensis*, *Kayentachelys aprix* and other primitive turtles in which the first costal is as long as the second costal. Eight costals are present in *Sichuanchelys chowi* in contrast to nine costals in *Kayentachelys*. Eleven peripherals are present, all very broad. The peripherals in *Sichuanchelys chowi* are broader than that of *Kayentachelys aprix*; the first to sixth peripherals extend medially to half the width of the pleural scutes; the seventh and eighth peripherals extend medially to two thirds of the pleural width. The ninth and tenth peripherals are almost as wide as the corresponding marginal plus the fourth pleural scute, with their medial suture matching or close to the vertebral–pleural sulcus (ZDM 3001) or extending onto the fourth vertebral scute (ZDM 3017). The tenth and eleventh peripherals, as well as the pygal, extend onto the fifth vertebral scute.

The cervical scute is complete in ZDM 3017. It is small and slightly wider than long. The vertebrales are all extremely wide, the second to fourth vertebrales being almost three times as wide as long. The first vertebral scute has a particular shape in that it is clearly longer in the midline than laterally, with its posterior border strongly convex backwards, different from the nearly straight posterior sulcus of the first vertebral in *Kayentachelys aprix*. All pleural scutes are narrow, especially the fourth; their width decreases from the front to the back. Twelve marginal scutes are present. They are all narrow, particularly the third through eighth, with their width being one third of the corresponding peripheral, and included in the peripherals except the first and the twelfth.

The plastron is sutured to the carapace, with the anterior margin extending to the anterior margin of the carapace. The plastron in ZDM 3014 and ZDM 3018 is broad, with short anterior and posterior lobes, while the plastron of ZDM 3001 and ZDM 3017 appears to be narrower. The anterior rim of the plastron is turned dorsally smoothly, with a pair of light swellings formed by the intergulars, as in *Kayentachelys aprix*. The anal notch is absent. The axillary and inguinal buttresses are long.

The epiplastron shape can be traced out in ZDM 3017 and ZDM 3014. It is an anteromedially–posterolaterally elongate element, with a very short midline suture to its mate before the entoplastron. Its posterior contact with the entoplastron and hyoplastron is a straight, long and oblique suture. This shape of the entoplastron is comparable to sinemydid/macrobaenid *Ordosemys liaoxiensis* and *Kirgizemys hoburensis*, but different from *Kayentachelys aprix* and most other turtles, which have an anteriolaterally directed epiplastron–hyoplastron suture. The entoplastron is a small triangular plate with a very narrow posterior end. The mesoplastron is well preserved in ZDM 3014, with clear sutures. The mesoplastra meet on the midline; it is



short on the midline and becomes much longer laterally, with the lateral length being twice the midline length. It is mostly included in the abdominal scute except laterally on the bridge. The hyoplastron–mesoplastron suture is slightly convex posteriorly. The hypoplastron and xiphoplastron have a similar length. The hypoplastron–xiphoplastron suture is slightly convex posteriorly.

As preserved in ZDM 3014 and ZDM 3017, the intergular is paired, covering the anterior part of the entoplastron. The gular is wide and short, shorter than the intergular. The humeropectoral sulcus is placed far behind the entoplastron and clearly anterior to the axillary notch as in *Bashuchelys* spp. and *Kayentachelys aprix*, in contrast to *Xinjiangchelys*. The pectoroabdominal sulcus is very close to the hyoplastron–mesoplastron suture as in *Bashuchelys* spp. The femoroanal sulcus is convex anteriorly but not reaching the hypoplastron–xiphoplastron suture. The midline sulcus is straight. As preserved in ZDM 3014 and ZDM 3017, four inframarginal scutes are present.

*Sichuanchelys* sp.

1990b *Chengyuchelys baenoides* Young & Chow; Ye, p. 305.

1990b Chengyuchelyidae indet. Ye, p. 307, fig. 1.

1994 *Chengyuchelys baenoides* Young & Chow; Ye, p. 7.

1994 Chengyuchelyidae indet. Ye, p. 12.

2005 Chengyuchelyidae gen. et sp. indet. Peng *et al.*, p. 45, fig. 29.

2008 *Sichuanchelys* sp. indet. Danilov & Parham, p. 312, fig. 3.

*Referred material.* IVPP V8805, a shell of a juvenile; ZDM 3002, posterior half of a carapace.

*Locality and horizon.* Dashanpu, Zigong, Sichuan Province, China; Xiashaximiao Formation, Middle Jurassic.

*Remarks.* IVPP V8805 has been referred to *Chengyuchelys baenoides* by Ye (1990b). Danilov & Parham (2008) redescribed the specimen and referred it to *Sichuanchelys* sp. based on the extremely wide vertebral scutes and narrow mesoplastra.

ZDM 3002 was described as Chengyuchelyidae indet. by Ye (1990b) and Chengyuchelyidae gen et sp. indet. by Peng *et al.* (2005). The second through fifth neurals are elongate and hexagonal, with short anterolateral sides. The second to fourth vertebrals are very broad, the third one being the broadest. The intervertebral sulcus between the third and fourth vertebrals lies on the fifth neural. The seventh and eighth marginals are elongate and narrower than the corresponding peripherals. This specimen is tentatively referred to *Sichuanchelys* based on the extremely broad vertebrals.

## 6. Phylogenetic relationships of Dashanpu turtles

The turtle assemblage of the Middle Jurassic Dashanpu locality contains five species belonging to four genera and three families. Three genera (*Bashuchelys*, *Chuananchelys* and *Protoxinjiangchelys*) are closely related to one another, and share a combination of primitive and derived characters. Among them, the regular elongate neural series, fan-shaped bridge with long axillary and inguinal buttresses and omega-shaped femoroanal

sulcus reaching or extending onto the hypoplastron are apomorphic relative to other primitive turtles. The sulcus between the third and the fourth vertebrals on the sixth neural is considered primitive since it is widely spread in primitive turtles such as *Kayentachelys aprix*, *Indochelys spatulata*, *Eileanchelys waldmani* and *Condorchelys antiqua*. The humeropectoral sulcus lying far anterior to the axillary notch and the pectoral scute notably longer than the abdominal are two characters that are related to one another. It is derived relative to *Proganochelys quenstedti* and *Heckerochelys romani* and appears in bashuchelyids and also in *Kayentachelys aprix*. Despite the narrow first to third vertebral scutes, *Bashuchelys* is more primitive relative to *Chuannanchelys* and *Protoxinjiangchelys* in the gular and intergular projections, leaf-shaped entoplastron, short epiplastra midline contact and pair of intergulars extending deeply onto the entoplastron. Although the mesoplastron in *B. youngi* and *B. zigongensis* is different from one another, it appears more reduced than in *Kayentachelys aprix*, *Heckerochelys romani*, *Glyptops plicatulus* and *Pleurosternon bullockii* (Table 3) in that the hyoplastron–mesoplastron suture is very close to the pectoroabdominal sulcus in the middle. The gular and intergular projections are primitive features that are present in the Late Triassic turtles *Proganochelys quenstedti* and *Proterochersis robusta*, which differ in that the intergular projections are paired or triple (Gaffney, 1990). The leaf-shaped entoplastron in *Bashuchelys* spp. closely resembles that of *Kayentachelys aprix* and *Indochelys spatulata*. However, *Bashuchelys* is more advanced relative to *Kayentachelys* and *Indochelys* in the epiplastra meeting on the midline, preventing the entoplastron from being exposed on the plastral front margin; eight elongate and regular neurals; and narrow first to third vertebrals (Gaffney *et al.* 1987; Datta *et al.* 2000). As none of specimens has the dorsal surface of the plastron exposed; the epiplastron dorsal process remains unknown in *Bashuchelys*.

Two *Bashuchelys* species are united by a combination of primitive and derived characters (see diagnosis of the genus). As many carapace features are unknown in *B. youngi* because of the poor preservation of that part, the two species of *Bashuchelys* are distinguished from one another mainly by the morphology of the mesoplastron. Better preserved material is needed to provide more distinctive characters. *B. youngi* n. sp. is, however, more derived than *B. zigongensis* (Ye, 1982) in the more strongly reduced mesoplastron that narrows in the middle and is included mostly in the abdominal scute, and in the fifth marginal extending onto the second costal and the seventh marginal extending onto the fourth costal, although this character is present in two specimens among four (IVPP V6507 and ZDM 3003). Both species of *Bashuchelys* have the plastron sutured to the carapace. Danilov & Parham (2008) reported a loose carapace–plastron attachment in IVPP V6507, a specimen referred to ‘*Chengyuchelys baenoides*’ (here referred to *Bashuchelys youngi*).



Table 3. Comparisons of turtles from the Middle Jurassic of the Sichuan Basin and other primitive turtles

Character/taxon	<i>Bashuchelys</i>	<i>Chuannanchelys dashanpuensis</i>	<i>Protosinjiangchelys salis</i>	<i>Sichuanchelys chowi</i>	' <i>Plesiochelys</i> ' Sichuan	<i>Xinjiangchelys</i> spp.	<i>Heckerochelys romani</i>	<i>Kayentachelys aprix</i>	<i>Indochelys spatulata</i>	<i>Siamochelys peninsularis</i>	<i>Pleurosternon bullockii</i>	<i>Plesiochelys solodurensis</i>	<i>Glyptops plicatulus</i>	<i>Dinochelys whitei</i>	<i>Eileanchelys waldmani</i>	<i>Condorchelys antiqua</i>	<i>Proganochelys quenstedti</i>
Carapace length (max. in mm)	247	193	217	162	270	285	400–500	200	227	315	500		460	320	250–300	?	600
Carapace shape	Narrow oval	Oval	Oval	Broad oval	Rounded	Oval to rounded	Narrow oval	Broad oval	Rounded	Rounded	Rounded	Oval	Rounded	Oval	?	?	Broad oval
Shell surface ornamentation	Light radiating wrinkles	Light wrinkles	Smooth	Smooth	Smooth or with radiating wrinkles	Smooth	Weakly developed	Smooth	Smooth	Vermiculated sculpture	Pitted	Smooth	Vermiculated sculpture	Smooth	Smooth	?	Radiating wrinkles
Cervical notch	Absent	Small	Small	Very large and deep	Small	Small	Small	Large	Small	Small	Absent	Small	Small	Small	Small	?	Large
Midline depression	Absent	Absent	Absent	Present	Present or absent	Present or absent	Present	?	Present	Present	Absent	Absent	?	Absent	?	?	Absent
Thickening of anterolateral carapace edge forming a gutter	Absent	Absent	Absent	Absent	Present	Present	Absent	Absent	Absent?	Present	Absent	Absent	Absent	Absent	?	?	Absent
Neurals	8, regular, elongate	8? regular, elongate	8? regular, elongate	8? regular, elongate	8, regular, elongate	8, regular, elongate	8 or 9, irregular	9, irregular short	9? irregular short	8, regular, elongate	8, regular, elongate	8, regular, elongate	8, regular, elongate	8, regular, elongate	9? elongate	8	?
Vertebrales width	Moderate and broad	Broad	Broad	Very broad	Moderate	Moderate	Very broad	Very broad	Very broad	Narrow	Broad	Broad	Moderate	Very broad	Very broad	Very broad	Very broad
Vertebral 4/vertebral 3 width	V4 >> V3	V4 = V3	V4 = V3	V4 < V3	V4 = V3	V4 = V3	V4 = V3	V4 < V3	V4 = V3	V4 = V3	V4 < V3	V4 < V3	V4 < V3	V4 < V3	?	V4 = V3	V4 < V3
Vertebral 3/Vertebral 4 sulcus position	On neural 6	On neural 6	On neural 6	On neural 6	On neural 5 or neural 6	On neural 5	On neural 5	On neural 6	On neural 6?	On neural 5	On neural 5	On neural 5	On neural 5	On neural 6	On neural 6	On neural 6	?
Marginals overlapping costals 2–4	Yes & no	?	?	No	Yes	Yes	?	No	?	?	Yes	No	Yes	Yes	?	?	?
Plastron/carapace attachment	Sutured	Sutured	Sutured	Sutured	Sutured	Ligamentous	Ligamentous	Sutured	Sutured?	Ligamentous	Sutured	Sutured	Sutured	Sutured	Sutured	?	Sutured
Anterior margin of plastron	One pair of gular and one intergular projections	Smooth	?	One pair of light intergular projections	Scalloped	Scalloped	Smooth	One pair of light intergular projections	?	Slightly scalloped	Smooth	Scalloped	Smooth	Scalloped	?	?	Triple intergular and paired gular projections
Epiplastron shape	Squarish	Squarish	Squarish	Triangular with long posterolateral process	Squarish	Squarish	Triangular with long posterolateral process	Squarish	Squarish	Squarish	Squarish	Squarish	Squarish	Squarish	?	?	Squarish with long posterolateral process
Entoplastron reaching plastron front margin	No	No	No	No	No	No	No	Yes	Yes	No	No	No	No	No	No	?	Yes
Entoplastron shape (length/width)	Leaf-shaped (L > W)	Diamond-shaped (L > W)	Diamond-shaped (L > W)	Elongate small triangular (L > W)	Oval (L > W)	Oval (L > W)	Leaf-shaped, very narrow (L > W)	Leaf-shaped (L > W)	Leaf-shaped (L > W)	Diamond-shaped (L < W)	Diamond-shaped (L < W)	Triangular, small	Rounded (L = W)	(L = W)	Arrow-shaped (L > W)	?	Arrow-shaped (L > W)
Mesoplastron narrowed in midline and included mostly in abdominal	Present	Present	Absent	Present	Absent	Absent	Present	Present	Present	Absent	Present	Absent	Present	Present	Present	?	Present
Intergulars extending onto entoplastron	Yes, deeply	No	No	Yes, slightly	No	No	Yes, slightly	Yes, deeply	Yes	No	Yes, slightly	Yes	Yes, slightly	No	Yes	?	Yes, deeply
Humeropectoral sulcus position	Far anterior to axillary notch	Far anterior to axillary notch	Far anterior to axillary notch	Far anterior to axillary notch	Close to axillary notch	Close to axillary notch	Anterior to axillary notch	Far anterior to axillary notch	?	Close to axillary notch	Close to axillary notch	Close to axillary notch	Close to axillary notch	Close to axillary notch	?	?	Close to axillary notch
Pectoral scute longer than abdominal	Yes	Yes	Yes	No	No	No	No	Yes	?	No	No	No	No	No	?	?	No
Femoronal sulcus omega-shaped reaching or extending onto hypoplastron	Yes	Yes	Yes	No	Present in most specimens	Present in most specimens	No	No	?	Yes	No	No	No	Yes	No	?	No
Midline plastral sulcus	Straight	Straight	Straight	Straight	Sinuuous	Sinuuous	?	Straight	Straight?	Sinuuous	Straight	Straight	Straight	Straight	?	?	Straight
Inframarginals	4	4	4	4	4	4	At least five	4	?	3	3	4	4	Absent	?	?	?

Our observations reveal that all other *Bashuchelys* specimens examined have a sutured carapace–plastron attachment. Despite its large size, IVPP V6507 may be a juvenile, or neotenuous because of the presence of the carapacial lateral fontanelles.

The trio of *Bashuchelys*, *Chuannanchelys* and *Protoxinjiangchelys* share several apomorphic characters with the Late Jurassic turtles from the Sichuan Basin previously referred to ‘*Plesiochelys*’ and *Xinjiangchelys* from Northern China and Central Asia: a fan-shaped bridge with long axillary and inguinal buttresses and an omega-shaped femoroanal sulcus reaching or extending onto the hypoplastron. In addition, the first thoracic rib in *Bashuchelys* extends to half the width of the first costal as in *Xinjiangchelys*. The close relationship between *Bashuchelys* (*Chengyuchelys*) and *Xinjiangchelys* has been noted by Danilov & Parham (2008).

‘*Chengyuchelys*’ *dashanpuensis* is moved to a new genus *Chuannanchelys*. Danilov & Parham (2008) considered the retention of this species in the genus *Chengyuchelys* as untenable. It was transferred to *Sichuanchelys* by Brinkman *et al.* (2008) because of the reduced mesoplastron covered entirely by the abdominal scute and the wide vertebral scutes. We exclude this species from *Sichuanchelys* since it lacks the autapomorphic features of the latter such as the wide peripheral plates, all marginals narrow, particularly the lateral ones which are extremely narrow, and a small triangular elongate entoplastron and elongate epiplastron with extremely short midline contact. As mentioned above, *Chuannanchelys* is closely related to *Protoxinjiangchelys* and *Bashuchelys*. Despite the wider plastron and presence of a mesoplastron, *Chuannanchelys* is similar to *Protoxinjiangchelys* in the wide vertebral scutes, the diamond-shaped entoplastron with short anterolateral borders, long epiplastral midline contact, and gular and intergular posterior margins forming a straight sulcus, lying before the entoplastron. Except for the first character, all others are derived relative to *Bashuchelys* and present in ‘*Plesiochelys*’ from the Sichuan Basin and *Xinjiangchelys*.

*Protoxinjiangchelys* is included in the family Xinjiangchelyidae based on the absence of a mesoplastron and other plastral features. Peng & Brinkman (1993) described a partial carapace with almost complete plastron (IVPP V9537–10) from the Late Jurassic of Penfengshan in the Junggar Basin as *Xinjiangchelys* sp. This specimen is more primitive relative to other *Xinjiangchelys* spp. but resembles *Protoxinjiangchelys* in the narrow plastron and position of humeropectoral sulcus.

*Sichuanchelys* was originally included in the family Chengyuchelyidae because of the shell outline, the smooth surface, the neural shape, the presence of a pair of mesoplastra meeting on the midline, a wide bridge and the presence of 3–4 inframarginals (Ye & Pi, 1997). This classification is followed by other authors (Peng *et al.* 2005; Brinkman, Li & Ye, 2008). Based on the shell outline and scalation pattern, Danilov & Parham (2008)

recognized the close similarity between *Sichuanchelys* and *Kayentachelys*. The following characters are shared by *Sichuanchelys* and *Kayentachelys*: (a) wide carapace with wide cervical notch; (b) very wide vertebral scutes; (c) narrow lateral marginals which are clearly narrower than the peripherals; (d) small intergular projections and (e) the sulcus between the third and fourth vertebrals on the sixth neural. With the exception of the first character, all others appear to be primitive. The wide vertebrals are present in most Triassic to Middle Jurassic turtles, including *Proganochelys*, *Proterochersis*, *Hecherochelys*, *Indochelys*, *Eileanchelys* and *Chondorchelys*. The narrow lateral marginals are like *Proganochelys* and *Proterochersis*. The intergular projections seem to be remnants from primitive turtles such as *Proganochelys* or *Proterochersis*, and are also present in *Bashuchelys*. As mentioned above, the sulcus between the third and fourth vertebral on the sixth neural is widespread in primitive turtles. *Sichuanchelys* is more advanced relative to *Kayentachelys* in the following aspects: (1) eight regular and elongate neurals; (2) entoplastron not exposed on the plastral front margin; (3) mesoplastron reduced; (4) huge cervical notch; (5) all marginals narrow; (6) all peripherals mesiolaterally expanded; (7) reduced entoplastron; (8) long first costal plate; and (9) long first vertebral scute with posteriorly convex posterior border. The last six characters are autapomorphic for *Sichuanchelys* and distinct from *Kayentachelys* and also *Bashuchelys*. However, *Sichuanchelys* retains a primitive epiplastron that is anteromedially–posterolaterally elongated, with an oblique and straight suture with the entoplastron and hypoplastron. This condition is reminiscent of *Proganochelys* and *Proterochersis*, and also similar to *Hecherochelys*, some sinemydids/macrobaenids, cheloniids and *Platysternon*. In *Kayentachelys*, *Bashuchelys* and most other turtles, the epiplastron is squarish, and the epiplastron–entoplastron and epiplastron–hypoplastron suture forms an angle.

We performed the phylogenetic analysis with the addition of the four taxa from the Middle Jurassic of the Sichuan Basin (*Bashuchelys*, *Chuannanchelys dashanpuensis*, *Protoxinjiangchelys salis* and *Sichuanchelys chowi*) in the data matrix of Joyce (2007) according to parameters used therein (15 ordered characters and three excluded ‘rogue’ taxa), and modified by Danilov & Parham (2006, 2008). The latter modifications include a DNA-based constraint tree for living taxa (Danilov & Parham, 2006: p. 577, fig. 4), the addition of two taxa, *Yehguia tatsuensensis* (Ye, 1963) and *Chengyuchelys* (based on observations of IVPP-V6507 and published data on ‘*C.*’ *zigongensis*), and one new character ‘Marginal B’. Here we remove *Chengyuchelys* from the analysis (see Section 4) and do not use a constraint tree as it has no influence on the position of the examined taxa. Based on our new observations, three additional characters have been added: ‘Anal B’, ‘Pectoral B’ and ‘Gular B’ (see Appendix 1). In addition, one more taxon

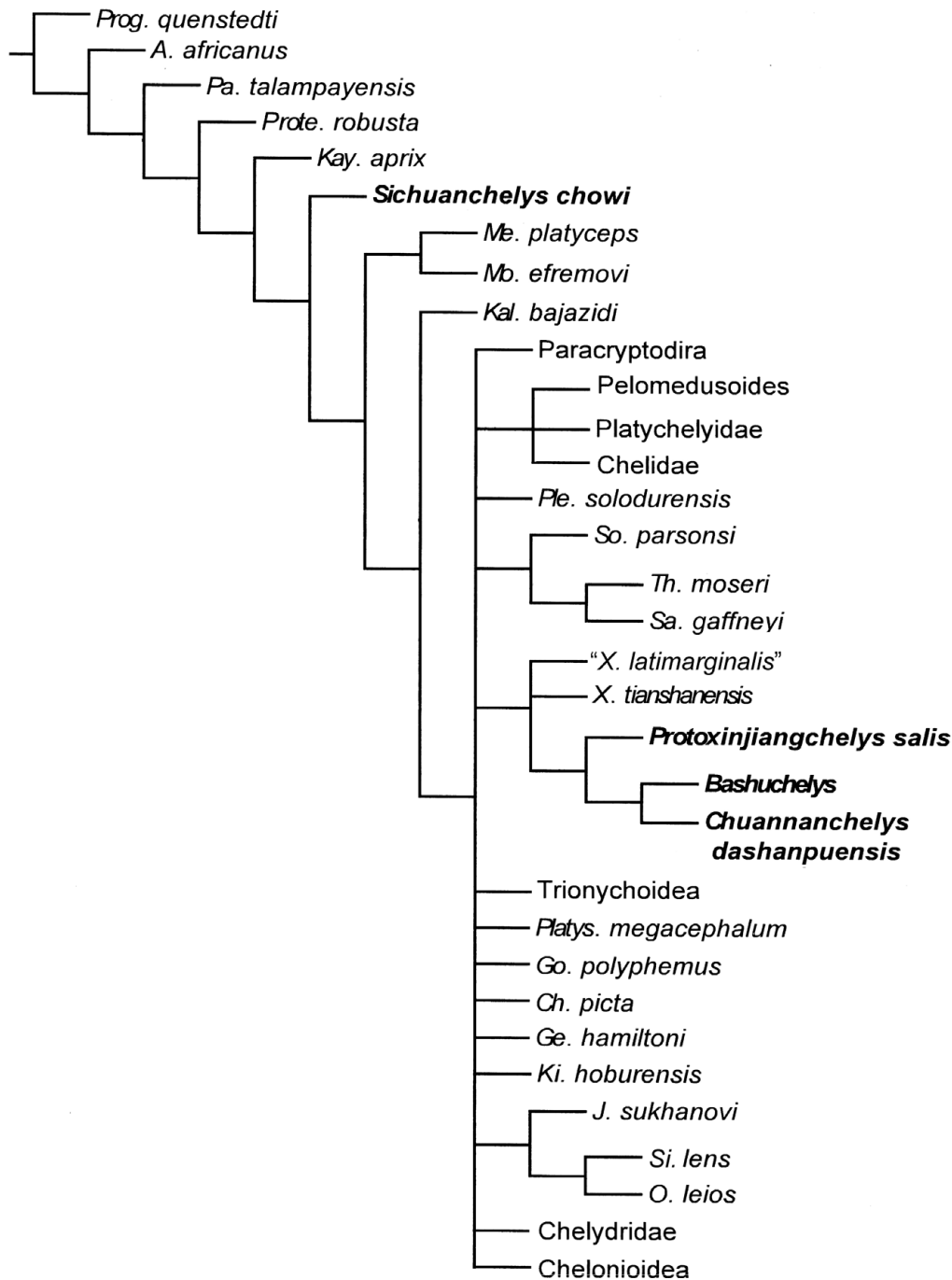


Figure 11. Strict consensus of 36 most parsimonious trees showing the phylogenetic position of Middle Jurassic turtles from Dashanpu recovered by our cladistic analysis. The following taxa have been condensed for space reasons and simplicity: Chelidae, Chelonioidea, Chelydridae, Paracryptodira, Pelomedusoides, Platycheilyidae, Trionychoidea, Pleurodira. Abbreviations: *A.* – *Australochelys*; *Ch.* – *Chrysemys*, *Ge.* – *Geoclemys*, *Go.* – *Gopherus*, *J.* – *Judithemys*; *Kal.* – *Kallokibotia*; *Kay.* – *Kayentachelys*; *Ki.* – *Kirgizemys*; *Me.* – *Meiolania*; *Mo.* – *Mongolochelys*; *O.* – *Ordosemys*; *Pa.* – *Palaeochersis*; *Platys.* – *Platysternon*; *Ple.* – *Plesiochelys*; *Prog.* – *Proganochelys*; *Prote.* – *Proterochersis*; *Sa.* – *Santanachelys*; *Si.* – *Sinemys*; *So.* – *Solnhofia*; *Th.* – *Thalassemys*; *X.* – *Xinjiangchelys*.

(*Xinjiangchelys tianshanensis*) is included. This makes a total of 74 taxa and 140 characters. Forty-two characters in *Bashuchelys* (*B. zigongensis* + *B. youngi*), 40 characters in *Chuannanchelys dashanpuensis*, 41 characters in *Protoxinjiangchelys salis* and 40 characters in *Sichuanchelys chowi* have been coded (Appendix 2). The cladistic analysis using NONA ver. 2 and Winclada ver. 1.00.08 by Ratchet algorithm with 1000 iterations resulted in 36 trees of 478 steps (CI = 0.36, HI = 0.64, RI = 0.72, Fig. 11).

Our cladogram shows two important points concerning the turtles studied herein. First, bashuchelyids are closely related to xinjiangchelyids, similar to the finding of Danilov & Parham (2008), although relationships of bashuchelyids + xinjiangchelyids with most other turtles (Paracryptodira, Pleurodira and Eucryptodira) are unresolved, whereas in Danilov & Parham (2008) *Chengyuchelys* + *Xinjiangchelys latimarginalis* were placed among stem cryptodires (correspond to Eucryptodira in this paper). Second,



*Sichuanchelys* is placed in a more basal position, only one step more advanced than *Kayentachelys*. *Sichuanchelys* is united with turtles more advanced than *Kayentachelys* by a single unambiguous synapomorphy, Entoplastron A, 1 (anterior entoplastral process absent, medial contact of epiplastra present). The clade bashuchelyids + xinjiangchelyids is united with 11 unambiguous synapomorphies, all of which are considered homoplastic in our analysis: Basisphenoid B, 1 (paired pits on ventral surface of basisphenoid present); Extragular A, 0 (intergular present); Anal A, 0 (anals only cover parts of the xiphiplastra); Cervical Vertebra B, 0 (posterior cervicals without strongly developed ventral keels); Cervical Vertebra C, 0 (cervical centra VIII is not significantly shorter than VII); Cervical Articulation A, 0 (cervical central articulations not formed); Cleithrum A, 1 (cleithra (dorsal processes of epiplastra) present); Scapula C, 1 (glenoid neck on scapula present); Marginal B, 1 (marginals overlap onto costals); Anal B, 1 (omega-shaped femoroanal sulcus); and Gular B, 1 (weak or absent extension of intergulars onto the entoplastron). Among the above mentioned characters only shell ones are known in all members of the clade, whereas characters of the skull and non-shell postcrania are owing to the presence of *X. tianshanensis* in this clade. The clade (*Protoxinjiangchelys* (*Bashuchelys* + *Chuannanchelys*)) is united by two unambiguous synapomorphies, which are also considered homoplastic in our analysis: Vertebral C, 0 (position of sulcus between third and fourth vertebrae on sixth neural) and Pectoral B, 1 (pectoral longer than abdominal). *Bashuchelys* and *Chuannanchelys* are united by two characters: Neural A, 1 (neural formula  $6 > 4 < 6 < 6 < 6 < 6$ ) and Mesoplastron A, 0 (one pair of mesoplastra present that fully hinders any contact between the hyoplastra and hypoplastra). Thus, contrary to expected, the bashuchelyids are at a more advanced position relative to the xinjiangchelyids in the cladogram. This shortcoming regarding the bashuchelyids position is probably due to the high homoplasy in the dataset and the large amount of missing data in the specimens from the Sichuan Basin. The early age and the primitive characters such as the presence of a mesoplastron and sutured plastron–carapace attachment in bashuchelyids relative to *Xinjiangchelys* would support their more basal position as ((*Bashuchelys* + *Chuannanchelys*) (*Protoxinjiangchelys* (*Xinjiangchelys* + more advanced taxa))) or (*Bashuchelys* (*Chuannanchelys* (*Protoxinjiangchelys* (*Xinjiangchelys* + more advanced taxa)))). The further discovery of skull material will provide crucial information about the phylogenetic relationships of Middle Jurassic turtles from the Sichuan Basin.

## 7. Conclusion

By the absence of a mesoplastron and other shell characters, both the holotype and paratype of *Chengyuchelys baenoides* Young & Chow, 1953 belong to the family Xinjiangchelyidae and probably come

from the Upper Jurassic Shangshaximiao Formation. The family Chengyuchelyidae is thus abandoned. The Middle Jurassic Dashanpu turtle assemblage represents the most diverse turtle fauna of that period and contains five species, belonging to four genera and three families. This assemblage is composed of two entities: *Bashuchelys* spp., *Chuannanchelys* and *Protoxinjiangchelys* on the one hand and *Sichuanchelys* on the other hand, with the former as the dominant group. Our study supports the close relationship between bashuchelyids and xinjiangchelyids suggested by Danilov & Parham (2008). *Protoxinjiangchelys*, the most primitive representative of the Xinjiangchelyidae, represents the intermediate form between bashuchelyids and the more advanced xinjiangchelyids. *Sichuanchelys* has no shared apomorphic characters with bashuchelyids but is close to *Kayentachelys*. The whole assemblage appears to be endemic to the Sichuan Basin at genus level until the presence of *Sichuanchelys* in the Jurassic Shishugou Formation of the Junggar Basin, Xinjiang is confirmed (Brinkman & Matzke, 2009). Although closely related, this Middle Jurassic turtle fauna is distinct from the Late Jurassic turtle assemblage of the Sichuan Basin in its relict nature and absence of representatives of the Polycryptodira.

Together with the abundant Late Jurassic turtle remains, the Sichuan Basin has produced one of the most important Jurassic turtle assemblages in a key period of turtle evolution. The inland lake ecosystem of the Sichuan Basin under the subtropical–tropical climate during the Jurassic period probably favoured the development of the basal eucryptodiran turtles.

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**Pectoral B. Character definition:** Pectoral significantly longer than abdominal: 0 = absent; 1 = present. **Codings:** Hypothetical ancestor, 0; *Proganochelys quenstedtii*, 0; *Proterochersis robusta*, 1; *Palaeochersis talampayensis*, ?; *Australochelys africanus*, ?; *Kayentachelys aprix*, 0; *Sichuanchelys chowi*, 0; *Meiolania platyceps*, ?; *Mongolochelys efremovi*, 0; *Kallokibotion bajazidi*, 0; *Platycheles oberndorferi*, 1; *Caribemys oxfordiensis*, ?; *Notoemys laticentralis*, 0; *Elseya dentata*, 0; *Chelodina oblonga*, 0; *Phrynosops geoffroanus*, 0; *Erymnochelys madagascariensis*, 0; *Pelomedusa subrufa*, 0; *Podocnemis expansa*, 0; *Dorsetochelys delairi*, ?; *Pleurosternon bullockii*, 0; *Glyptops plicatulus*, 0; *Dinochelys whitei*, 0; *Neurankylus eximius*, 0; *Trinitichelys hiatti*, 0; *Plesioabaena antiqua*, 0; *Boremys pulchra*, 1; *Baena arenosa*, 0; *Chisternon undatum*, 0; *Portlandemys mcdowellii*, ?; *Plesiochelys solodurensis*, 0; *Solnhofia parsonsi*, ?; *Thalassemys moseri*, 0; *Santanachelys gaffneyi*, ?; *Bashuchelys*, 1; *Chuannanchelys dashanpuensis*, 1; *Protoxinjiangchelys salis*, 1; *Xinjiangchelys latimarginalis*, 0; 'X.' *tianshanensis*, 0; *Kirgizemys hoburensis*, 0; *Judithemys sukhonovi*, 1; *Dracochelys bicuspis*, ?; *Sinemys lens*, ?; *Ordosemys leios*, ?; *Toxochelys latiremis*, ?; *Caretta caretta*, 0; *Chelonia mydas*, 0; *Mesodermochelys undulatus*, –; *Dermochelys coriacea*, –; *Protochelydra zangerli*, –; *Macrolemys temminckii*, –; *Chelydra serpentina*, –; *Platysternon megacephalum*, 0; *Mongolemys elegans*, 0; *Gopherus polyphemus*, 0; *Chrysemys picta*, 0; *Geoclemys hamiltonii*, 0; *Emarginachelys cretacea*, –; *Baptemys wyomingensis*, –; *Dermatemys mawii*, –; *Hoplochelys crassa*, –; *Staurotypus triporcatus*, –; *Sternotherus odoratus*, –; *Kinosternon flavescens*, –; *Zangerlia neimongolensis*, 0; *Basilemys variolosa*, 0; *Adocus beatus*, 0; *Yehguia tatsuensis*, 0; *Peltochelys duchastelli*, 0; *Sandownia harrisi*, ?; *Apalone spinifera*, –; *Lissemys punctata*, –; *Anosteira ornata*, –; *Carettochelys insculpta*, –.

**Gular B. Character definition:** Extension of gulars (intergulars in this paper) on the entoplastron: 0 = strong; 1 = weak or absent. **Codings:** Hypothetical ancestor, 0; *Proganochelys quenstedtii*, 0; *Proterochersis robusta*, 0; *Palaeochersis talampayensis*, ?; *Australochelys africanus*, ?; *Kayentachelys aprix*, 0; *Sichuanchelys chowi*, 0; *Meiolania platyceps*, 0; *Mongolochelys efremovi*, 1; *Kallokibotion bajazidi*, 0; *Platycheles oberndorferi*, 0; *Caribemys oxfordiensis*, 0; *Notoemys laticentralis*, 0; *Elseya dentata*, 0; *Chelodina oblonga*, 0; *Phrynosops geoffroanus*, 0; *Erymnochelys*



*madagascariensis*, 1; *Pelomedusa subrufa*, 0; *Podocnemis expansa*, 0; *Dorsetochelys delairi*, ?; *Pleurosternon bullockii*, 0; *Glyptops plicatulus*, 1; *Dinochelys whitei*, 1; *Neurankylus eximius*, 0; *Trinitichelys hiatti*, 0; *Plesiobaena antiqua*, 1; *Boremys pulchra*, 1; *Baena arenosa*, 0; *Chisternon undatum*, 1; *Portlandemys mcdowellii*, ?; *Plesiochelys solodurensis*, 0; *Solnhofia parsonsi*, ?; *Thalassemys moseri*, ?; *Santanachelys gaffneyi*, ?; *Bashuchelys*, 0; *Chuannanchelys dashanpuensis*, 1; *Protoxinjiangchelys salis*, 1; *Xinjiangchelys latimarginalis*, 1; *'X' tianshanensis*, 1; *Kirgizemys hoburensis*, 1; *Judithemys sukhanovi*, ?; *Dracochelys bicuspis*, ?; *Sinemys lens*, ?; *Ordosemys leios*, ?; *Toxochelys latiremis*, ?; *Caretta caretta*, ?; *Chelonia mydas*, ?; *Mesodermochelys undulatus*, –; *Dermochelys coriacea*, –; *Protochelydra zangerli*, 1; *Macrolemys temminckii*, 1; *Chelydra serpentina*, 1; *Platysternon megacephalum*, 1; *Mongolemys elegans*, 1; *Gopherus polyphemus*, 0; *Chrysemys picta*, 0; *Geoclemys hamiltonii*, 0; *Emarginachelys cretacea*, 0; *Baptemys wyomingensis*, 0; *Dermatemys mawii*, 0; *Hoplochelys crassa*, 0; *Staurotypus triporcatus*, 0; *Sternotherus odoratus*, –; *Kinosternon flavescens*, –; *Zangerlia neimongolensis*, 1; *Basilemys variolosa*, 1; *Adocus beatus*, 1; *Yehguia tatsuensis*, 1; *Peltochelys duchastelli*, 0; *Sandownia harrisi*, ?; *Apalone spinifera*, –; *Lissemys punctata*, –; *Anosteira ornata*, –; *Carettochelys insculpta*, –.

## Appendix 2. Characters coded for taxa added to the matrix of Joyce (2007) with modifications of Danilov & Parham (2008)

*Sichuanchelys chowi*: Carapace A, 0; Carapace B, 0; Neural A, 0; Peripheral A, 1; Peripheral B, 0; Costal A, 0; Costal B, 0; Costal C, 0; Cervical A, 0; Supramarginal A, 2; Marginal B, 0; Vertebral A, 1; Vertebral B, 0; Vertebral C, 0; Plastron A, 0; Plastron B, 0; Plastron C, 0; Entoplastron A, 1; Entoplastron C, 1; Entoplastron D, 0; Entoplastron E, 0; Epiplastron A, 0; Mesoplastron A, 0; Xiphiplastron A, 0; Xiphiplastron B, 0; Plastral Scutes A, 0; Plastral Scutes B, 0; Gular A, 0; Extragular A, 0; Extragular B, 0; Extragular C, 1; Intergular A, 0; Humeral A, 0; Pectoral A, 0; Abdominal A, 0; Anal A, 0; Inframarginal A, 0.

*Bashuchelys*: Carapace A, 0; Carapace B, 0; Nuchal B, 0; Neural A, 1; Peripheral A, 1; Peripheral B, 0; Costal A, 0; Costal C, 0; Cervical A, 2; Supramarginal A, 2; Marginal B, 1; Vertebral A, 1; Vertebral B, 1; Vertebral C, 0; Plastron A, 0; Plastron B, 0; Plastron C, 0; Entoplastron A, 1; Entoplastron C, 1; Entoplastron D, 0; Entoplastron E, 0; Epiplastron A, 0; Hyoplastron A, 0; Mesoplastron A, 0; Hypoplastron A, 0;

Xiphiplastron A, 0; Xiphiplastron B, 0; Plastral Scutes A, 0; Plastral Scutes B, 0; Gular A, 0; Extragular A, 0; Extragular B, 0; Extragular C, 0; Intergular A, 0; Humeral A, 0; Pectoral A, 0; Abdominal A, 0; Anal A, 1; Inframarginal A, 0.

*Chuannanchelys dashanpuensis*: Carapace A, 0; Carapace B, 0; Neural A, 1; Peripheral B, 0; Costal A, 0; Costal B, 0; Costal C, 0; Cervical A, 0; Supramarginal A, 2; Vertebral A, 1; Vertebral B, 1; Vertebral C, 0; Plastron A, 0; Plastron B, 0; Plastron C, 0; Entoplastron A, 1; Entoplastron C, 1; Entoplastron D, 0; Entoplastron E, 0; Epiplastron A, 0; Hyoplastron A, 0; Mesoplastron A, 0; Hypoplastron A, 0; Xiphiplastron A, 0; Xiphiplastron B, 0; Plastral Scutes A, 0; Plastral Scutes B, 0; Gular A, 0; Extragular A, 0; Extragular B, 0; Extragular C, 1; Intergular A, 0; Humeral A, 0; Pectoral A, 0; Abdominal A, 0; Anal A, 1; Inframarginal A, 0.

*Protoxinjiangchelys salis*: Carapace A, 0; Carapace B, 0; Neural A, 0; Peripheral B, 0; Costal A, 0; Costal B, 0; Costal C, 0; Supramarginal A, 2; Marginal B, 1; Vertebral A, 1; Vertebral B, 1; Vertebral C, 0; Plastron A, 0; Plastron B, 0; Plastron C, 0; Entoplastron A, 1; Entoplastron C, 1; Entoplastron D, 0; Entoplastron E, 0; Epiplastron A, 0; Hyoplastron A, 0; Mesoplastron A, 2; Hypoplastron A, 0; Xiphiplastron A, 0; Xiphiplastron B, 0; Plastral Scutes A, 0; Plastral Scutes B, 0; Gular A, 0; Extragular A, 0; Extragular B, 0; Extragular C, 1; Intergular A, 0; Humeral A, 0; Pectoral A, 0; Abdominal A, 0; Anal A, 1; Inframarginal A, 0.

*Xinjiangchelys tianshanensis*: Quadrate A, 1; Quadrate B, 1; Quadrate C, 2; Quadrate F, 1; Pterygoid A, 1; Pterygoid B, 1; Pterygoid C, 1; Pterygoid D, 1; Pterygoid G, 0; Supraoccipital A, 1; Supraoccipital B, 0; Opisthotic A, 1; Basisphenoid A, 0; Basisphenoid B, 1; Stapedial Artery A, 1; Stapedial Artery B, 0; Jugular Foramina A, 1; Canalis Caroticum A, 3; Dentary A, 0; Carapace A, 0; Carapace B, 0; Nuchal A, 1; Nuchal B, 0; Neural A, 0; Peripheral A, 1; Peripheral B, 0; Costal A, 0; Costal B, 0; Costal C, 0; Cervical A, 0; Supramarginal A, 2; Marginal B, 1; Vertebral A, 1; Vertebral B, 1; Vertebral C, 0; Plastron A, 1; Plastron B, 0; Plastron C, 0; Entoplastron A, 1; Entoplastron B, 1; Entoplastron C, 1; Entoplastron D, 0; Entoplastron E, 0; Epiplastron A, 0; Hyoplastron A, 0; Mesoplastron A, 2; Hypoplastron A, 0; Xiphiplastron A, 0; Xiphiplastron B, 0; Plastral Scutes A, 0; Plastral Scutes B, 0; Gular A, 0; Extragular A, 0; Extragular B, 0; Extragular C, 1; Intergular A, 0; Humeral A, 0; Pectoral A, 0; Abdominal A, 0; Anal A, 1; Inframarginal A, 0; Cervical Rib A, 1; Cervical Vertebra A, 1; Cervical Vertebra B, 0; Cervical Vertebra C, 0; Cervical Articulation A, 0; Dorsal Rib A, 2; Dorsal Rib B, 0; Dorsal Rib C, 1; Caudal A, 1; Cleithrum A, 1; Scapula A, 1; Scapula B, 1; Scapula C, 1; Coracoid A, 1; Pelvis A, 0; Ilium A, 1; Ilium D, 0; Ischium A, 1; Hypoischium A, 1.