A new species of *Hsisosuchus* (Mesoeucrocodylia) from Dashanpu, Zigong Municipality, Sichuan Province

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Abstract*

The text describes *Hsisosuchus dashanpuensis,* a new species preserving a complete rostrum that supplements the portion missing for the genus. The choanae are located anteriorly with the maxilla and palatine forming their lateral margin, and a suborbital fenestra is present but extremely small. The specimen was produced from the Lower Xiaximiao Fm. at Dashanpu, Zigong Municipality.

Introduction

In August, 1996, the author of this text found a crocodile skull while archiving specimens in the collections at the Zigong Dinosaur Museum. The specimen was excavated from the Dashanpu quarry in 1984 at the time the museum was under construction. After preparation, a skull and a small quantity of postcrania were revealed.

Description

Mesoeucrocodylia Whetstone and Whybrow, 1983

Hsisosuchidae Young and Chow, 1953

Hsisosuchus Young and Chow, 1953

Hsisosuchus dashanpuensis sp. nov.

(Text figures 1-4; Plates I and II)

Diagnosis: Moderate in size, the rostrum length is twice that of the cranium, the cranial height/length index is approximately 21%, and width/length index approximately 45%. The external nares are laterally placed. Orbits are large, representing the largest fenestrae on the skull, choanae are anteriorly located with the maxilla and palatine forming their lateral boundary, and suborbital fenestra is small with its lateral boundary formed by the palatine, ectopterygoid, and maxilla. The palatine ramus of the pterygoid is elongated. The paroccipital process is a thin plate, and the posterolateral process of the squamosal is rather thin. Dentition is laterally compressed and recurved with serrations anteriorly and posteriorly. Dental formula: Pm-5, M-14.

Specimen: Zigong Dinosaur Museum specimen #ZDM3405 (field no. jc) consisting of a complete skull, a single cervical vertebra, a single sacral vertebra, and seven dorsal osteoderms

Locality and stratigraphic position: Middle Jurassic Lower Xiaximiao Fm. (Xiashaximiao), at Dashanpu, Zigong Municipality.

Description: The skull is complete although it has been subjected to some post-depositional lateral compressional distortion on the midportions, and the posterior skull has also been obliquely deformed. Undulation of the ventrolateral cranial margin is conspicuous. Maximum length is 380 mm and breadth is 170 mm. The skull is triangular in lateral view and attenuates anteriorly in dorsal view. Posterior height is 75 mm and rostral length is 240 mm, constituting 63% of the cranial length. A majority of the dorsal surface is well-ornamented predominantly by pitting but ornamentation on the nasals is predominantly represented by longitudinal crests. Surficial texture on the dorsal quadrate and posterior occiput is relatively smooth.

The left premaxilla suffered some damage during excavation but the right side is completely preserved. It is laterally convex with a majority being surficially pitted and only the anterior and ventral portion are relatively surficially smooth. A series of nutrient foramina lie 8 mm from the dental margin. The dorsal process is club-shaped and separated from its lateral counterpart by the anterior nasals. Two-thirds of the external nares is surrounded by the premaxilla, as the nasals only form the dorsal margin. Premaxilla length is 65 mm. Posterior suture with the maxilla is appropriately located in the anterior rostral trough. Each side bears five alveoli but only the fifth on the left side and third on the right side bear a tooth. Alveolus 4 is largest and alveolae 5 and 3 are nearly equivalent in size. The left and right palatal processes unite to form the anterior section of the secondary palate.

The maxilla is relatively large, constituting the predominant element of the rostrum. The left maxilla has been compressionally distorted causing the expansion of its vertical surface. The horizontal surface of the right maxilla is slightly more spacious than the vertical surface. Ornamentation is well-developed, and there is a series of nutrient foramina approaching the ventral margin. Maxilla length is 160 mm and there is a long contact with the nasals. Posteromedially there is a Y-shaped embayment that represents the anterior margin of the antorbital fenestra. The dorsal ramus of the embayment is narrow, short, and contacts the lacrimal. The ventral ramus is long, broad, and posteriorly contacts the lacrimal and jugal. There is a smooth depression ventral to the antorbital fenestra contained in the jugal and maxilla that exceeds the size of the fenestra.

Each side of the maxilla bears 14 alveolae, with teeth retained in alveolae 5 and 8 on the left side and alveolae 7,10,12, and 13 on the right side. Alveolus 5 is the largest and is appropriately located at the apex of the maxillary undulation. The palatal processes of the maxillae are in contact at the midline of the skull and contact the premaxillae to form the principle portion of the secondary palate. The palatal processes diverge one-third of the length along the maxillae with a crescentic margin that represents the choanae. The suture between the posteromedial maxilla and the palatine is long.

At 22.8 cm in length, the nasal is long and thin, representing the longest cranial element, or constituting 60% of the skull length. The nasals are in contact along the midline of the skull. Laterally, the nasal contacts the premaxilla, maxilla, lacrimal, and prefrontal. Posteriorly, it contacts the frontal with a V-shaped suture.

The lacrimal lies anterior to the orbit and has a relatively narrow dorsal process. Its ventral portion forms the posterior margin of the antorbital fenestra, its posterodorsal side contacts the prefrontal, it has a relatively broad ventral process, its posteroventral side contacts the jugal, and posteriorly it forms a portion of the anterior margin of the orbit.

The prefrontal is a relatively small element that in dorsal perspective is triangular in shape. Its anterior end is acute and posterior end broad. It contacts the frontal posteromedially and posteriorly it forms the anterodorsal margin of the orbit.

The frontal is relatively large with a 76 mm length and 34 mm breadth. Surficially, it is predominantly ornamented with pitting, which is quite distinct from the ornamentation on the nasals. The frontal's median suture is inconspicuous. Laterally it forms the dorsal margin of the orbit. Its posterolateral end extends laterally to contact the postorbital and thus separate the orbit from the supratemporal fenestra. Its posteromedial end extends to contact the parietal.

In dorsal perspective the parietal is triangular and relatively small, is slightly more elevated than the frontal, its anterior margin is narrow, and lateral sides are isolated from the frontals by the supratemporal fenestrae. Anterior breadth between these two fenestra is merely 7 mm. Laterally the parietal descends to contact the prootic and laterosphenoid and forms the lateral walls of the

neurocranium. Posteriorly it is broad with the majority in contact with the supraoccipital and laterally in contact with the squamosal.

The postorbital is a T-shaped element with conspicuous ornamentation. Its posterior process contacts the squamosal, its ventral process is smooth and glossy, and its anteroventral margin forms the posterior margin of the orbit. Posteroventrally, it contacts the quadratojugal and jugal and does not form a portion of the lateral temporal fenestra.

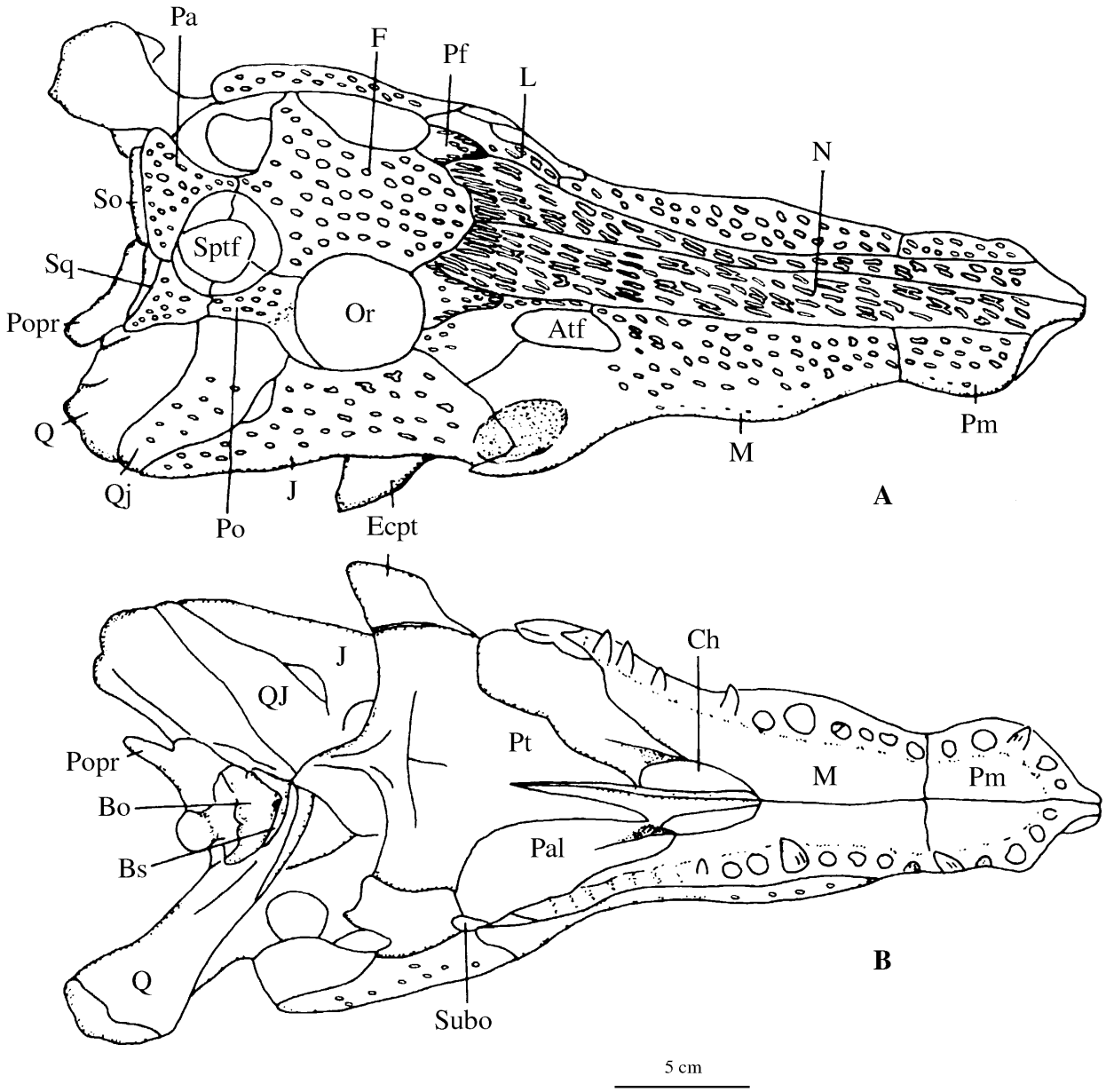

Figure 1. Skull of *Hsisosuchus dashanpuensis* sp. nov. in dorsal (A) and ventral (B) views. Atf. Antorbital fenestra; Bo. Basioccipital; Bs. Basisphenoid; Ch. choanae; Ecpt. Ectopterygoid; Eo. Exoccipital; F. Frontal; Fcp. Posterior carotid foramen; J. Jugal; L. lacrimal; Ls. Laterosphenoid; Ltf. Lateral temporal fenenstra; M. Maxilla; N. Nasal; Or. Orbit; Pa. Parietal; Pal. Palatine; Pf. Prefrontal; Pm. Premaxilla; Po. Postorbital; Popr. Paroccipital process; Pr. Prootic; Ps. Parasphenoid; Pt. Pterygoid; Q. Quadrate; Qj. Quadratojugal; So. Supraoccipital; Sq. Squamosal; Sptf. Supratemporal fenestra; Subo. Suborbital fenestra; Sbtf. Subtemporal fenestra.

The squamosal is represented by a pair of elements located lateral to the parietal, and in dorsal perspective is triradiate. Its anterior process is club-shaped and its posterolateral process is narrow and relatively thin with an isolated terminus. Ventrolaterally, it unites with the quadrate to form the small orifice representing the external auditory meatus. Posteriorly it is rather smooth and glossy, lacking ornamentation. Medially, it contacts the supraoccipital. Ventrally, it contacts the exoccipital and quadrate.

The jugal is a relatively large plate with a length of 130 mm, its lateral surface is slightly convex, conspicuously ornamented, and ventrally it is slightly concave with a smooth surface. Its anterior branch is broader and shorter than its posterior branch, its dorsal midsection is crescentic to form the anteroventral border of the orbit and its dorsal branch is relatively short with a smooth surface. Its anterior margin contacts the ventral process of the postorbital, and its posterior margin contacts the anterodorsal quadratojugal to form the anterior margin of the lateral temporal fenestra which has a longitudinal diameter of 26 mm. The posterior branch of the jugal is thin and long with its posterodorsal margin in contact with the quadratojugal.

The quadratojugal is located anterior to the quadrate as a relatively thin plate. Its dorsal portion is relatively broad, ventral portion is narrow, its anterior margin contacts the postorbital, at its midsection it forms the posterior margin of the lateral temporal fenestra, and posteriorly it contacts the quadrate. Surficially, it is only slightly ornamented.

The quadrate is complicated in morphology, lying strongly posterolaterally oblique with its terminus maintaining two condyles, the lateral of which is slightly larger. The condyles represent the most posterior margin of the skull by exceeding the paroccipital processes. Anterolaterally, the quadrate contacts the quadratojugal with a relatively long suture. Posterodorsally it contacts the squamosal, and medially it contacts the exoccipital and paroccipital process. Anteromedially there extends an arced wing, the distal end of which becomes relatively narrow and contacts the basisphenoid and pterygoid. The dorsal end is relatively broad with the anterodorsal end in contact with the prootic and posterodorsal end in contact with the squamosal. The pterygoid ramus forms a trough with its medial side.

The palatines are relatively large with a long median suture. The lateral palatine lobe is a horizontal plate, with its lateral side in contact with the maxilla. The anteromedial side is a concave arch that represents the posterior margin of the choanae. The posteromedial side contacts the pterygoid, its posterior margin contacts the ectopterygoid, and the posterolateral side forms the anteromedial margin of the suborbital fenestra. The medial lobe of the palatine is a long and narrow longitudinal plate with its anterior end in contact with the midsection of the maxillae. The anterior ends are separated by the choanae. Posterodorsally they are in contact with the midline of the pterygoids.

The pterygoids are well-developed with lengths of 125 mm. The basal anterior and posterior termini form transverse crests that project extremely conspicuously ventrally on the skull and cause the tabular pterygoid branches to form a stair-step configuration. The palatine rami of the pterygoid are convex, anteriorly narrow, posteriorly broad, and rather elongated with the anterior termini extremely close to the posterior margins of the choanae. Anterolaterally, they maintain a long contact with the palatines; posterolaterally they contact the ectopterygoids, but do not form a portion of the infraorbital fenestra. Posterodorsomedially, they extend as thin vertical plates to contact the quadrate and basisphenoid.

The ectopterygoid is a small, thick element located posterolateral to the pterygoid. Medially it is relatively broad and contacts the lateral side of the pterygoid. Laterally it contacts the jugal and anteriorly maintains a small depression representing the posterior margin of the small suborbital fenestra, which has a longitudinal diameter of only 16 mm. The ectopterygoid terminus is acute and posteroventrally oriented.

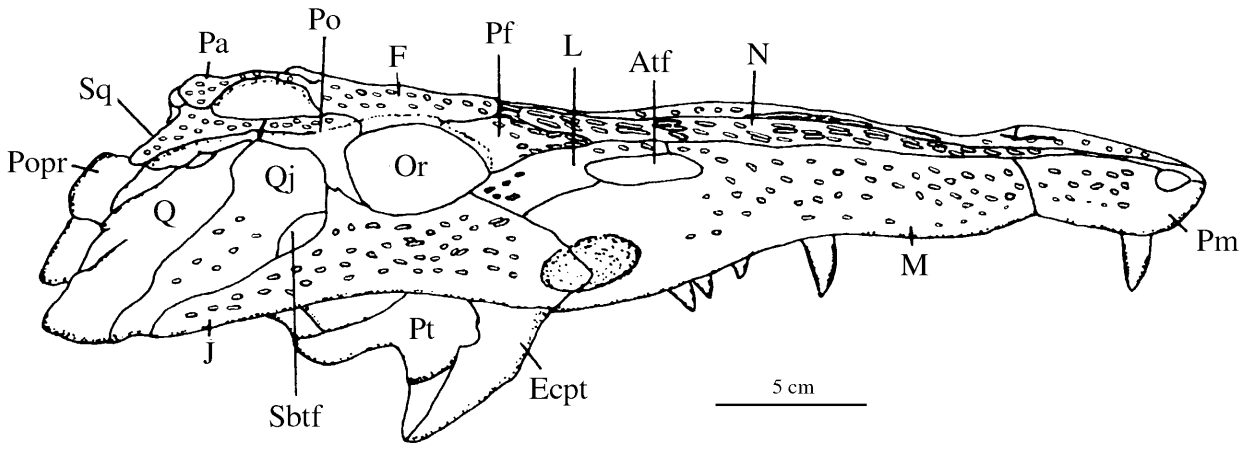

Figure 2. Lateral view of *Hsisosuchus dashanpuensis* sp. nov. (ZDM3405).

The supraoccipital is relatively small and located posteroventral to the parietal, with its posterior wall constituting a vertical plate. The element is unornamented and butterfly-shaped, being broad dorsally and narrow ventrally. Dorsally, it contacts the posterior margin of the parietal, dorsolaterally there is minor contact with the squamosal, and ventrally there is a relatively long contact with the exoccipital. It does not participate in bounding the foramen magnum.

Larger than the supraoccipital, the left and right exoccipitals converge dorsal to the foramen magnum and project posteromedioventrally to form a small portion of the occipital condyle. At their midsection there is a transverse crest that extends to the paroccipital process. The left crest is poorly developed but the right crest divides the element into two planes, the dorsal of which is oriented posterodorsally and the ventral oriented posteroventrally. The paroccipital processes extend laterally as thin, nearly vertical plates. Dorsolaterally, they contact the supraoccipital and squamosal, ventromedially they contact the basioccipital, and ventrolaterally the quadrate. Two small foramina are present, the dorsal for the hypoglossal (XII) and the ventral for the internal carotid and perhaps the glossopharyngeal, vagus, and accessory (IX-XI). The foramen magnum is relatively small.

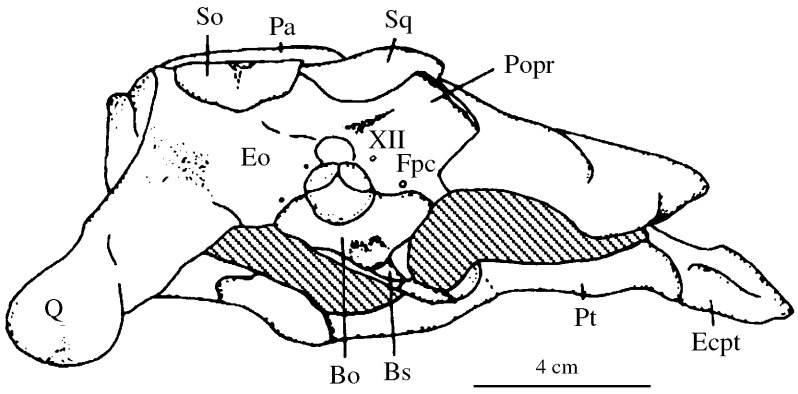

Figure 3. Posterior view of *Hsisosuchus dashanpuensis* sp. nov. (ZDM3405).

The basioccipital is spherical in posterior view and represents the majority of the occipital condyle but does not comprise a portion of the foramen magnum. The condyle neck is relatively short. A majority of the element is very slightly anteriorly oblique, anteriorly it fuses with the basisphenoid, its posterior surface undulates, it is thickened laterally and ventrally, but

dorsomedially it is relatively thin. There is a small eustachian canal at the ventral fusion with the basisphenoid.

The basisphenoid is distinctly more elongate than the basioccipital, is located anterior to the basioccipital, and in posterior view is almost completely obscured by the former with only a small ventral portion exposed. Dorsally, the element is thickened and posteroanteriorly it contacts the quadrate, prootic, and laterosphenoid respectively. Anterodorsally, it contacts the parasphenoid, anteroventrally it is relatively thin and contacts the posterior pterygoid, and posterolaterally it is in tight fusion with the pterygoid ramus of the quadrate. In ventral view, only an extremely small portion of it is exposed.

Table 1. Cranial measurements of *Hsisosuchus dashanpuensis* sp. nov. (ZDM3405) (mm).

	Left	Total	Right
Skull length to quadrate		380	
Skull length to occipital condyle		338	
Skull width at quadrates		170	
Skull width at mid orbits		142	
Skull width at anterior choanae		82	
Skull height: quadrate condyle to parietal		75	
Rostrum length from anterior orbit		240	
Nasal length		228	
Frontal length		74	
Interorbital distance		36	
Distance between supratemporal fenestrae		7	
Orbit length	56		48
Orbit width	31		52
Antorbital fenestra length			41
Antorbital fenestra width			17
Supratemporal fenestra length	33		33
Supratemporal fenestra width	29		34
Lateral temporal fenestra length			26
Lateral temporal fenestra width			9
External nares length	21		19
External nares width	12		12
Choanae length	45		46
Choanae width	13		13

The prootic is located dorsal to the basisphenoid as a relatively thin vertical plate that forms the lateral wall of the neurocranium. Dorsally it contacts the parietal, anteriorly it contacts the laterosphenoid, posteriorly it contacts the quadrate with an anteriorly curved suture, and ventrally it contacts the basisphenoid. Approaching the ventral margin there is a small foramen for the facial (VII) nerve.

The laterosphenoid is located anterior to the prootic as a vertical plate that is longer than the latter. Dorsally it contacts the parietal and frontal, posteroventrally it contacts the basisphenoid, and anteromedially it contacts the parasphenoid. Laterally, at its ventral midsection, it sits isolated to form a relatively large foramen for the optic (II) nerve. Approaching the ventral margin where it contacts the prootic, there is a single small foramen for the trigeminal (V) nerve.

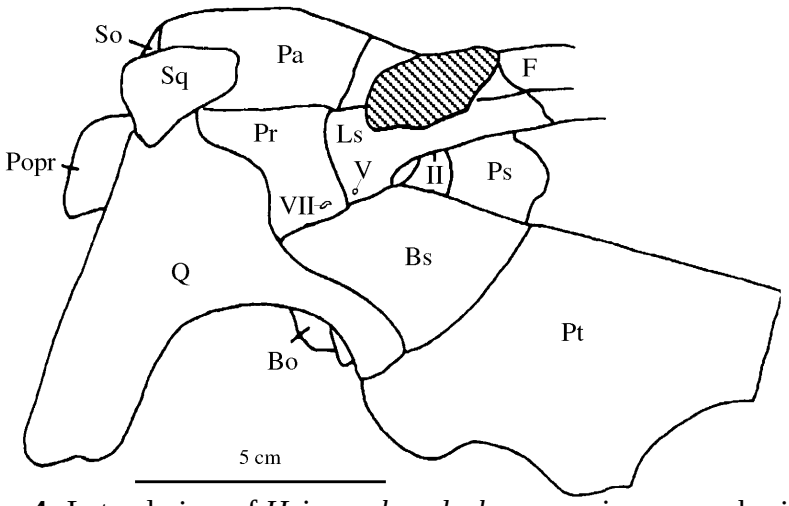

Figure 4. Lateral view of *Hsisosuchus dashanpuensis* sp. nov. braincase.

The parasphenoid is located anterodorsal to the basisphenoid as a relatively thin vertical plate. Dorsally it contacts the laterosphenoid, anteriorly it is isolated, and ventrally it contacts the basisphenoid.

The only postcrania represented are a single cervical, a single sacral, and seven dorsal osteoderms. The cervical vertebra is amphicoelous with a short centrum, a ventral keel is present, the neural canal is relatively small, the neural spine is short but high, the diapophyses are relatively small and located on the ventral arch, and the pre- and postzygapophyses are in close approximation. The sacral is also amphicoelous with a relatively long centrum, a ventral keel is absent, the neural spine is relatively long, and the diapophyses and parapophyses are united into a single elements that is relatively large. The dorsal osteoderms are nearly rectangular, broader than long with well-developed surficial pitting, the ventral side is smooth, they are dorsally convex, and a longitudinal keel extends two-thirds along the median surface.

Discussion and comparison

Formerly, there was only a single species of *Hsisosuchus* recognized, *H. chungkingensis* Young and Chow 1953 from the Upper Shaximiao Fm. at Chongqing (Chunking) Municipality, Sichuan. It was erected as the new family Hsisosuchidae based upon extremely distinctive cranial characters. It was also regarded as being difficult to place in any suborders and as such appeared to represent a new one, although there seemed to be similarities with the family Sebecidae. Li (1994) diagnosed a juvenile specimen collected from the Upper Shaximiao Fm., Yongchuan Co., Chongqing, as a member of this species, providing supplementary and revised taxonomic diagnosis. Wu et al. (1994) applied cladistic methodology to address the phylogenetic relationships of the genus and concluded that there was a rather close relationship to the Sebecidae although it appeared much more primitive, and that it represented the most primitive member of the Mesoeucrocodylia.

Specimen ZDM3405 from Dashanpu, Zigong Co., maintains a series of characters consistent with *Hsisosuchus* including its moderate size, rostrum twice the length of the neurocranium, antorbital fenestra surrounded only by the maxilla and lacrimal, orbit being the largest fenestra on the skull, supratemporal fenestrae in close proximity and being smaller than the orbit, extremely small lateral temporal fenestra bounded only by the jugal and quadratojugal, ventral process of the postorbital descends to contact the jugal excluding the jugal's dorsal process from the posterior margin of the orbit, frontal invades the supratemporal fenestra, the transverse crest-shaped base of the pterygoid and pterygoid palatal branches form a conspicuous stair-step

morphology, exoccipitals form a transverse crest dorsal to the foramen magnum, and dentition is laterally compressed with anterior and posterior serrations.

However compared to *H. chungkingensis,* the location of the choanae on the Zigong specimen is more anterior, with the maxilla and palatine forming the boundaries; a suborbital fenestra is present that is bounded by the palatine, ectopterygoid, and maxilla; the posterolateral process of the squamosal is relatively slender, the paroccipital processes are thin and tabular; and the palatine ramus of the pterygoid is elongated. *H. chungkingensis* differs in its rhomboid choanae that lie completely on the palatine and have osseous ridges on their margins. The subtemporal fenestra is completely sealed, there is a deep longitudinal groove along the midline of the posterior nasals, the posterolateral squamosal has an exaggerated process, the paroccipital processes are slightly less extended than the squamosal, and the palatine ramus of the pterygoid is short. Thus the distinction between the two are conspicuous and justifies the erection of a new species.

Acknowledgements

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Bibliography

Li, J.L., Wu, X.C., and Li, X.M., 1994; New material of *Hsisosuchus chungkingensis* from Sichuan, China. *Vert. PalAs.* **32**(2), pp. 107-126 (in Chinese with English summary).

Wu, X.C., Li. J.L., and Li, X.M., 1994; Phylogenetic relationship of *Hsisosuchus. Vert. PalAs.* **32**(3), pp. 166-180 (in Chinese with English summary).

Young, C.C, and Chow, M.C., 1953; New discovery of Reptilia from the Mesozoic of Sichuan. *Acta. Pal. Sin.* **1**(3), pp. 87-109 (in Chinese with English summary).