A new pterosaur (*Huanhepterus quingyangensis* gen. et sp. nov.) from Ordos, China

by

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Abstract

A new pterosaur is described from the Zhidan Group in the Ordos Basin, *Huanhepterus quingyangensis* gen. et sp. nov. Its characters resemble those of *Gnathosaurus* from the Late Jurassic of Europe, thereby providing evidence for the age of the Huachihaunhe Fm. in the Zhidan Group.

Introduction

In the first ten days of May, 1978, a rock quarry was under excavation by members of the Sanshilipu Commune on the left bank of the Huanhe River, Qingyang Co., Gansu Province, when the crew discovered a single verterbrate fossil. This discovery attracted the attention of the leadership of the Division of Exploration for the Changqing Oil Field. Subsequently, colleagues Xiaochun Zhong and Xirong Yang were dispatched to the locality to conduct a formal investigation and subsequently notified the Institute of Vertebrate Paleontology and Paleoanthropology by telegraph. On May 13, the author of this text visited the locality to confirm that the specimen was indeed a pterosaur. The specimen was thereby excavated with the assistance of the leadership of the Changqing Oil Field.

Description

Pterosauria

Pterodactyloidea

Ctenochosmatideae

***Huanhepterus* gen. nov.**

***Huanhepterus quingyangensis* sp. nov.**

(Plate I)

Etymology: Genus name Huanhe, Pinyin Chinese for the Huanhe River, one of the larger tributaries of the Jinghe River in Eastern Gansu Province. The species name qingyang commemorates the county in which the locality occurs.

Diagnosis: A relatively large pterosaur with an approximately two-meter wingspan. The skull is low and long with a median crest, the anterior end of which is high and thickened and posteriorly gradually descends to become thin, and at the frontal disappears completely. Maxillae and mandible contain a densely packed battery of long, nearly uniform teeth that resemble those of *Gnathosaurus* in morphology.

The cervical series is long with slender and elongated centra that are simple in morphology. Dorsal vertebrae are rather independent, thoracic vertebrae are larger than the sacrals, and a notarium is absent. There are seven tightly fused sacrals and the tail is short with reduced caudals. The sternum is flat and lacks a carina and there are four long pes digits.

Specimen: Impression of a damaged incomplete skeleton with only the antorbital portion of the skull preserved. IVPP #V9070.

Locality and stratigraphic position: Late Jurassic Huachihuanhe Fm., Zhidan Group, at Sanshilipu, Qingyang Co., Gansu Province.

Description: Of the skull, only a 33 cm length of rostrum is preserved (Fig. 1). It is slender, long, and uncurved, with an expanded rostral end. A median crest begins at the sixth maxillary tooth and extends posteriorly to the anterior frontal. Its anterior end is high and thick, but posteriorly it gradually descends and thins. Delicate, dense, vertical corrugations ornament the crest surface. Suture lines are indistinguishable because the jaws are occluded and the specimen has been subjected to compressional distortion.

The premaxilla is a long cranial element with solid fusion. Elements at the suture line are thickened and the rostrum is broadened, with acute, long, and slender teeth that represent the largest in the dental battery.

The maxilla is an elongated prism with a thick and relatively linear ventral margin. There is an oblique and dorsally extended longitudinal lamina on the dorsolateral margin that runs parallel to, and is in contact with, the dorsal crest. The maxilla is relatively linear with a battery of slender, long, and recurved, teeth.

The largest tooth in the dentition is the eleventh premaxillary tooth with a length of 2.5 cm. Posterior to this sequence, the size of the dentition progressively decreases. Teeth are sharp, slender, long, and circular in cross-section. They are recurved and densely aligned, and so resemble the morphology of *Gnathosaurus.* There appears to be a total of 26±2 teeth.

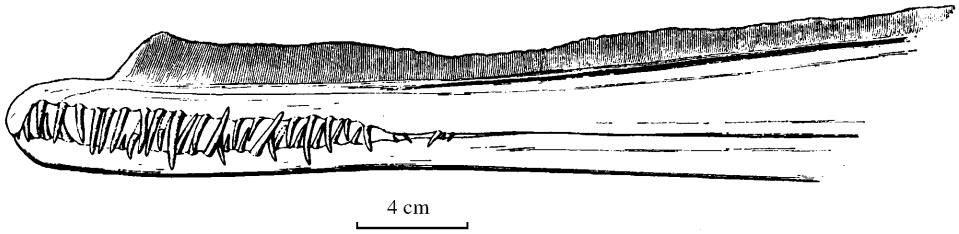

Figure 1. Rostrum of *Huanhepterus quingyangensis* gen. et sp. nov.

The mandible is elongated with a low ramus. It is impossible to diagnose the medial morphology due to the occlusion of the jaws although it appears that only the dentary is present. The anterior end is thick and bluntly rounded with a strongly fused symphysis. The ventral margin is also thick and linear. The teeth are slender, long, and recurved, and their size gradually decreases posteriorly; their morphology resembles those of the maxillary teeth. There are approximately 25±2 teeth.

Only the four most posterior cervical vertebrae are preserved as long and slender procoelous centra with expanded termini. Prezygapophyses extend directly anteriorly and are bifid. Ribs are absent. This morphology resembles the pterodactyloid condition.

Because of the use of explosives in the quarrying process, nearly all the dorsal vertebrae are missing although there are impressions of a series of eleven centra. The dorsal vertebrae are slightly modified and several of the anterior are enlarged. The centra are platycoelous and medially constricted with a horseshoe-shaped ventral surface. The neural arches are low, the neural spines are plate-shaped, their apices are slightly thickened, and their height descends gradually posteriorly. Pre- and postzygapophyseal articulation is tight and lies nearly upon the same plane. Diapophyses are thin, flat, and extend horizontally. The first dorsal vertebra is larger than the second but not as conspicuously as in *Dsungaripterus.* The first anterior five dorsals are tightly articulated but not fused and thus a notarium is absent. The centra decrease in size anteroposteriorly and their morphology resembles those of *Pterodactylus.* The sacrum contains seven fused platycoelous centra which gradually diminish in size anteroposteriorly. The laminar

neural spines are also fused into a single plate. There are impressions of only two caudal vertebrae, and they preserve a simple centrum morphology. The tail impression indicates that it was short.

The scapula and coracoid are poorly preserved and as such their state of fusion is unclear. Only a few fragments of the clavicle is preserved. The well-preserved sternum is a large, flat, extremely thin oblate plate. There are no traces of sternal rib contact and an anterior process and carina are absent.

Although both ends of the humerus have suffered damage it is estimated to be 14.5 cm in length. It is a robust element with a pneumaticized columnar shaft, expanded proximal end, and an extremely laterally expanded deltopectoral crest. The right radius and ulna lie parallel and are equivalent in length. They are flattened with slightly expanded termini, and morphologically resemble the general condition of the Pterodactylidae.

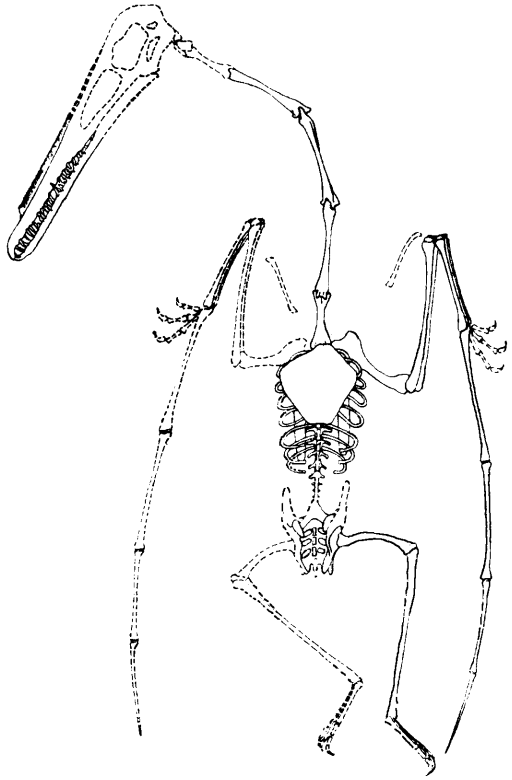

Figure 2. Skeletal restoration of *Huanhepterus quingyangensis* gen. et sp. nov.

The left metacarpals on the Qingyang specimen are relatively well preserved. Two semicircular carpals are present as are three elongated and flattened metacarpals. McIV is relatively robust and extended as the wing finger, whereas the remaining metacarpals are thin and slender. The distal articular surfaces are smooth, and bear a median trochlea for articulation with the flat articular surface of the phalanges. Both wing fingers were well preserved on the Qingyang specimen, but because the walls of the bone are extremely thin, many phalanges were damaged when the specimen was collected. Distinct impressions in the matrix allow the following description:

Phalanx I of the wing finger is relatively completely preserved with a length of 36 cm, representing the most typical phalanx in the wing finger. The shaft is pneumaticized and flattened

with an expanded proximal end, ligament depressions on each side, and a hooked process. These are characters that resemble *Dsungaripterus.* Phalanx II is relatively flat and moderately pneumaticized with expanded termini and a concave articular surface that represents a shallow trochlea. Phalanx III has a similar morphology of a relatively columnar shaft that is not pneumaticized, and its termini are not expanded. Phalanx IV is slender and long, gradually attenuates to a sharp point distally, is medially curved, and bears a small longitudinal trough that disappears at the terminus.

The ilium, ischium, and pubis are incomplete. Each is extremely thin, thus difficult to prepare, and their outline in the matrix is also vague. The ilium is relatively long and lower than that of *Dsungaripterus.* The preacetabular process extends anteriorly and has a relatively straight margin. The right pubis is relatively well preserved and has a completely undamaged prepubic blade. Its morphology resembles that of *Pterodactylus.*

The hind limb is better preserved than the forelimb. Both femora are present, although the right one is better preserved. It has a length of 13 cm and a slightly posteriorly curved columnar shaft that is pneumaticized with thin walls. The femoral head is well developed and there is a conspicuous neck. The right tibia is present although its proximal end is damaged and its precise relationship with the fibula is vague (Pl. I, Fig. 3). The tibia is both longer and more robust than the femur; it has a slightly flattened proximal end and a longitudinal laminar crest on the shaft that may represent a remnant of the fibula. The distal end is expanded for tight articulation with the tarsals

The right metatarsals are completely fused to the tarsals and there is no trace of an articulation line (Pl. I, Fig. 3). The metatarsals are pneumaticized, relatively thin, and elongated with slightly expanded termini, and flattened proximal ends that are in close association. The distal ends of the first three metatarsals are damaged but on MtIV the distal end is complete. MtV has become lost. Three phalanges are present on MtIV with a laterally compressed claw at its terminus. The elongated pedal digits indicate this species was digitigrade.

Diagnosis and discussion

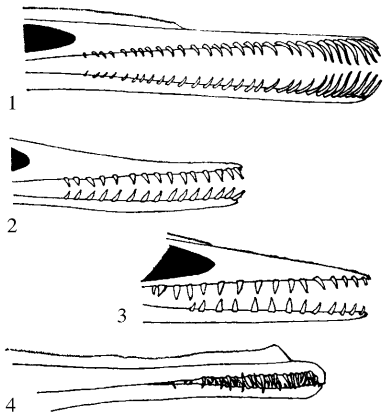

Figure 3. Comparison of several species of Pterodactylidae.
1. *Gnathosaurus* (x 1); 2. *Pterodactylus* (x 1); 3. *Germanodactylus* (x 1); 4. *Huanhepterus* (x 1/3).

Traditional pterosaur taxonomy divides the Pterosauria into two suborders: the primitive Rhamphorhychoidea and the short-tailed Pterodactyloidea. Because the Qingyang specimen has a median crest on the rostrum and short tail, it is assigned to the suborder Pterodactyloidea. Kuhn

(1961) subdivided this suborder into the five families: the Pterodactylidae, Ctenochasmantidae, Belenochasmatidae, Ornithecheiridae, and Ornithchasmatidae. The three former families are rather primitive in their absence of a notarium, whereas the two latter families are more derived by the presence of a notarium.

Young (1964) subsequently added a third suborder: the Dsungariptoidea, and further recognized that the pterodactylids were restricted to several late Jurassic taxa that lacked a notarium, including the families Germandactylidae, Pterodactylidae, Anurognathidae, and Ctenochasmatidae. Therefore, according to Young's classification, the Qingyang specimen should be assigned to the Pterodactylidae based on its long neck, short tail, and absence of a notarium. However, characters of the Pterodactylidae also include a small dentition that is restricted to the anterior rostrum, or anterior to the external nares. The family Anurognathidae contains species with short and high skulls which are clearly distinct from the Qingyang specimen. The new specimen's low and elongate skull with abundant dentition composed of relatively slender and gracile teeth undoubtedly assigns it to the family Ctenochasmatidae containing the genera *Ctenochasma* and *Gnathosaurus.*

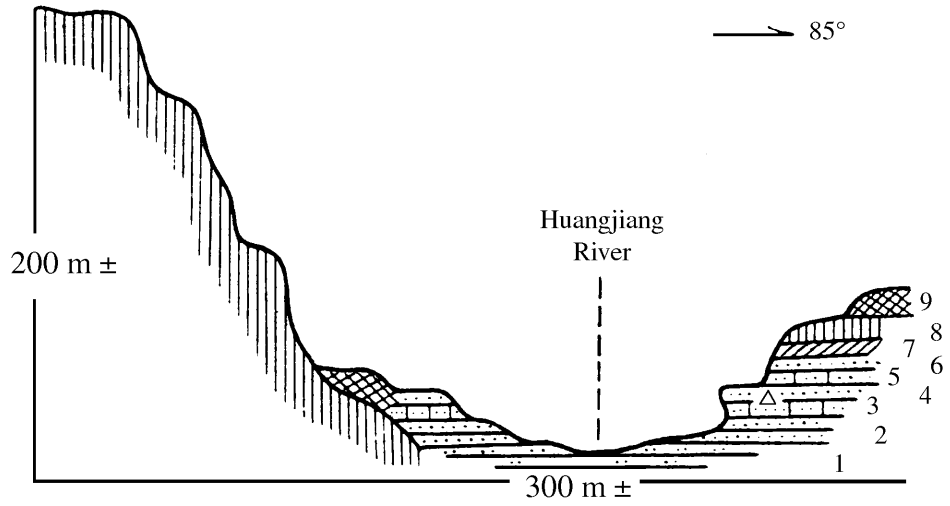

Figure 4. Cross-section at the *Huanhepterus* locality.
1. Dark purple-gray siltstones (base unobservable), 1 m; 2. Blue-gray siltstone, 0.5 m; 3. Purple-red calcareous siltstone, 0.4 m; 4. Gray-white siltstone (fossil locality), 0.6 m; 5. Dark purple-gray calcareous siltstone, 0.4 m; 6. Gray-white siltstone, 0.5 m; 7. Orange-yellow stratified subsandy soil, 1 m; 8. Malan Loess, 1.5 m; 9. Yellow cultivated soil, 0.5 m; 10. Δ - Fossil locality.

The genus *Gnathosaurus* is relatively small and has a long neck with abundant (200-260) densely packed, slender teeth. The rostrum constitutes over half the cranial length and usually is not expanded at its terminus.

The Qingyang specimen shares numerous characters with *Gnathosaurus* including the abundant, evenly spaced, long and gracile dentition, the anterior portion of which is larger and gradually diminishes posteriorly. The anterior rostrum is broadened, and the mandible is thickened at the symphysis. However, a more detailed comparison reveals numerous discrepancies, including the Qingyang specimen's large size, which is larger than any other European species in the genus; the rostral crest is more well developed, and extends more anteriorly with a high and thickened terminus (Fig. 3); and the dentition is more robust and less uniform. These characters justify the erection of the new genus *Huanhepterus quingyangensis*.

Discussion of age

Pterosaurs in China usually co-occur with the genus *Psittacosaurus* and thus the assemblage is known as the Early Cretaceous Pterosauria-*Psittacosaurus* Fauna. However, morphologically the Qingyang pterosaur is distinctly more primitive than *Dsungaripterus* and more closely resembles the European Late Jurassic *Gnathosaurus*, causing a revision of the age of the Zhidan Group.

Table 1. Exposed stratigraphic sequence of the Zhidan Group in the Ordos Basin

Age	Epoch	Group	Formation	Lithologic description
Mesozoic	Early Cretaceous	Zhidan Group	Yijun Fm.	K_{1y}(1) Purple-red (or variegated) conglomerates 0-65 m
			Luohe Fm.	K_{1L}(2) Tan-red highly cross-bedded sandstones containing bands of conglomerates 130-348
			Huachi Fm.	K_{1u}(3) Light gray to tan-red massive arkosic cross-bedded sands interbedded with purple-red mudstones 79-188 m
			Huanhe Fm.	K_{1h}(4) Variagated mudstones and light gray-yellow-green fine to silty sanstones Contains fish, turtle, conchostracans, and pterosaurs 250-350 m
			Luohan-dong Fm.	K_{1Lh}(5) Tan-red arkosic sanstone interbedded with dark purple mudstone 106-233 m
			Jingchuan Fm.	K_{1j}(6) Upper member: purple-red mudstone, Lower Member: gray-yellow-green arkosic sandstone interbedded with blue-gray mudstone. Contains fish and Chelonia 50-150 m

Exposures of the Zhidan Group in the Ordos basin are poor; most are covered by loess. The eastern Gansu plateau exposures are recognized as illustrated in Table 1. The *Huanhepterus* locality lies in the Huachihuanhe Fm. as illustrated in Figure 4.

Formerly, the age of the Zhidan Group was regarded Early Cretaceous. But in recent years the increasing study of various phyla in the sediments indicates a correlation to the Jehol Biota in northern Hebei and Western Liaoning provinces. It may also be correlated to the Xinminpu Fm. in the Hexizoulang Corridor, Gansu, and the Tugulu Group, Xinjiang Autonomous Region. Currently, these sediments are regarded as representing the Jurassic-Cretaceous boundary, although this interpretation is still controversial. A consensus among vertebrate paleontologists is also inconsistent. In 1956, Liu et al. collected the fish *Sinamia* and the turtle *Sinemys* from the Zhidan Group at Hedaochuan, Huanhe Co. and later described them as being Jurassic (Liu et al, 1963). Paleoherpetological research documents the presence of *Psittacosaurus* and thus the age is diagnosed as Early Cretaceous. But compared to *Dsungaripterus* from the Tugulu Group, *Huanhepterus* is distinctly more primitive and more closely resembles *Gnathosaurus* from the typical marine Jurassic sediments of Solnhofen, Germany. Considering the two points cited above, it is concluded that deposition of the Zhidan Group initiated in the Late Jurassic, and thus the age of the Huachihuanhe Fm. that produces *Huanhepterus* is regarded as such.

Acknowledgements

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