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RAPID COMMUNICATION

A NEW OVIRAPTOROSAURID (THEROPODA: OVIRAPTOROSAURIA) FROM THE LATE CRETACEOUS OF SOUTHERN CHINA

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Oviraptorosaurians are generally regarded as non-avian theropod dinosaurs (Gauthier, 1986; Barsbold et al., 1990, 2000a; Barsbold, 1997; Sereno, 1999). Some recent phylogenetic analyses show that oviraptorosaurs fall within Aves, and they are hypothesized to be secondarily flightless birds (Maryanska et al., 2002; Lü et al., 2002). Most oviraptorosaurs are known from Mongolia (Osborn, 1924; Barsbold, 1976, 1981, 1983; Norell et al., 2001a; Clark et al., 1999, 2001), although *Chirostenotes* (Sues, 1997) is known from North America. In China, in addition to the basal oviraptorosaur *Caudipteryx* (Ji et al., 1998; Zhou et al., 2000; Sereno, 1999; Holtz, 2000, 2001; Norell et al., 2001b; Xu et al., 2002), only one specimen of oviraptorid oviraptorosaur has been reported (Dong and Currie, 1996), and it is not well preserved. Here, a new oviraptorosaur from a single quarry in southern China is reported, providing the first solid evidence of a derived oviraptorid from outside the Gobi region. Based upon a partial skeleton (HYMV1-1), the new material is placed within Oviraptorosauria based on its high, short, toothless skull with pneumatized caudal vertebrae, anteriorly concave pubic shaft, and posteriorly concave ischium (Barsbold et al., 1990, 2000b; Makovicky and Sues, 1998). New characters described here further support the avialan status of oviraptorosaurs.

SYSTEMATIC PALEONTOLOGY

OVIRAPTOROSAURIA Barsbold, 1976
Family OVIRAPTORIDAE Barsbold, 1976

Heyuannia huangi gen. et sp. nov.
(Figs. 1, 3)

Holotype—A nearly complete skeleton missing distal end of tail and forelimbs, with an incomplete skull (Heyuan Museum registration No.: HYMV1-1).

Etymology—Heyuan refers to the fossil locality, Heyuan City, Guangdong Province. Huang refers to Dong Huang, the director of Heyuan Museum, who made great contributions in the excavation and preservation of these fossils.

Type Locality—A quarry at Huangsha village, Heyuan City, Guangdong Province. Dalangshan Formation, Late Cretaceous,? Maastrichtian (Bureau of Geology and Mineral Resources of Guangdong Province, 1988).

Referred Specimens—A complete furcula, articulated with an incomplete coracoid, right scapula and nearly complete right forelimb (HYMV1-2). Partial right manus (HYMV1-3) and partial hind limb (HYMV1-4) found on the same block as the type specimen, and a nearly complete left manus (HYMV1-5).

Diagnosis—Differs from all other known oviraptorosaurians in increased cervical and sacral vertebral counts, and decreased dorsal vertebral count; quadratojugal articular surface of the quadrate more groove-like; quadrate diverticulum enters the quadrate anterolaterally; pneumatic foramina present on the neural arches and ribs of cervical vertebrae; pubis as long as ilium; proximal end of metacarpal I wraps that of the metacarpal II in ventral view.

Description—The skull is crestless, similar to that of *Conchoraptor* (Barsbold et al., 1990) and *Khaan* (Clark et al., 2001). *Oviraptor* (Barsbold et al., 1990) and an undescribed specimen of oviraptorosaurian from Mongolia (Lü, 1999) have well developed crests. The quadrate diverticulum perforates the anterolateral surface of the quadrate (Fig. 2A:qd). A smooth groove-like structure on the lateral surface of the quadrate is the contact for the quadratojugal (Fig. 2A:qg), distinct from other oviraptorids in which the quadrate has a lateral cotyle in this position (Maryańska and Osmólska, 1997). This suggests that kinesis may have been possible between the quadratojugal and the quadrate.

There are 13 cervical vertebrae. The anterior three lack ventral keels, present in the remaining cervicals. Pneumatic foramina are present on the ninth neural arch and the tenth and eleventh cervical ribs (Figs. 1, 2B:pf), similar to those observed in *Archaeopteryx* (Britt et al., 1998). On the cervicals, the ribs are short, and fused with centra, but on the fourteenth vertebra, the ribs become longer and are not fused with the centra. Thus, the thirteenth vertebra is considered here as the last cervical vertebra. There are 12 dorsal vertebrae.

Eight sacral vertebrae are visible in ventral view on HYMV1-4. There are no keels or grooves appearing on their ventral surfaces. The anterior articular surface of the first sacral centrum is concave. Adding vertebrae to the synsacrum is not necessarily a size-related pattern. Basal avians of small size may have expanded synsacrum. Moreover, large theropods do not consistently increase sacral vertebral count (Hutchinson, 2001). All known non-avian theropod dinosaurs have fewer than eight vertebrae in the synsacrum (Chiappe, 1996), but all birds except the primitive birds *Archaeopteryx* (five sacral vertebrae), and *Confuciusornis* (seven sacral vertebrae) (Chiappe et al., 1999) have more than eight. Other oviraptorosaurians such as *Nomingia* (Barsbold et al., 2000b), *Oviraptor*, and *Ingenia* (Barsbold et al., 1990) have five, six, and seven vertebrae in the synsacrum respectively.

The anterior caudal vertebrae have small pleurocoels on their lateral surfaces. The prezygapophysis is short. The first hemal arch is located between the first and the second caudal vertebrae.

The distal end of the scapula is slightly expanded (HYMV1-2). There is a well-developed acromial process. The humerus is slightly twisted. The shaft of the ulna is rod-like and moderately curved posteriorly. The length of the ulna is approximately equal to that of the humerus. The radius is slightly short-

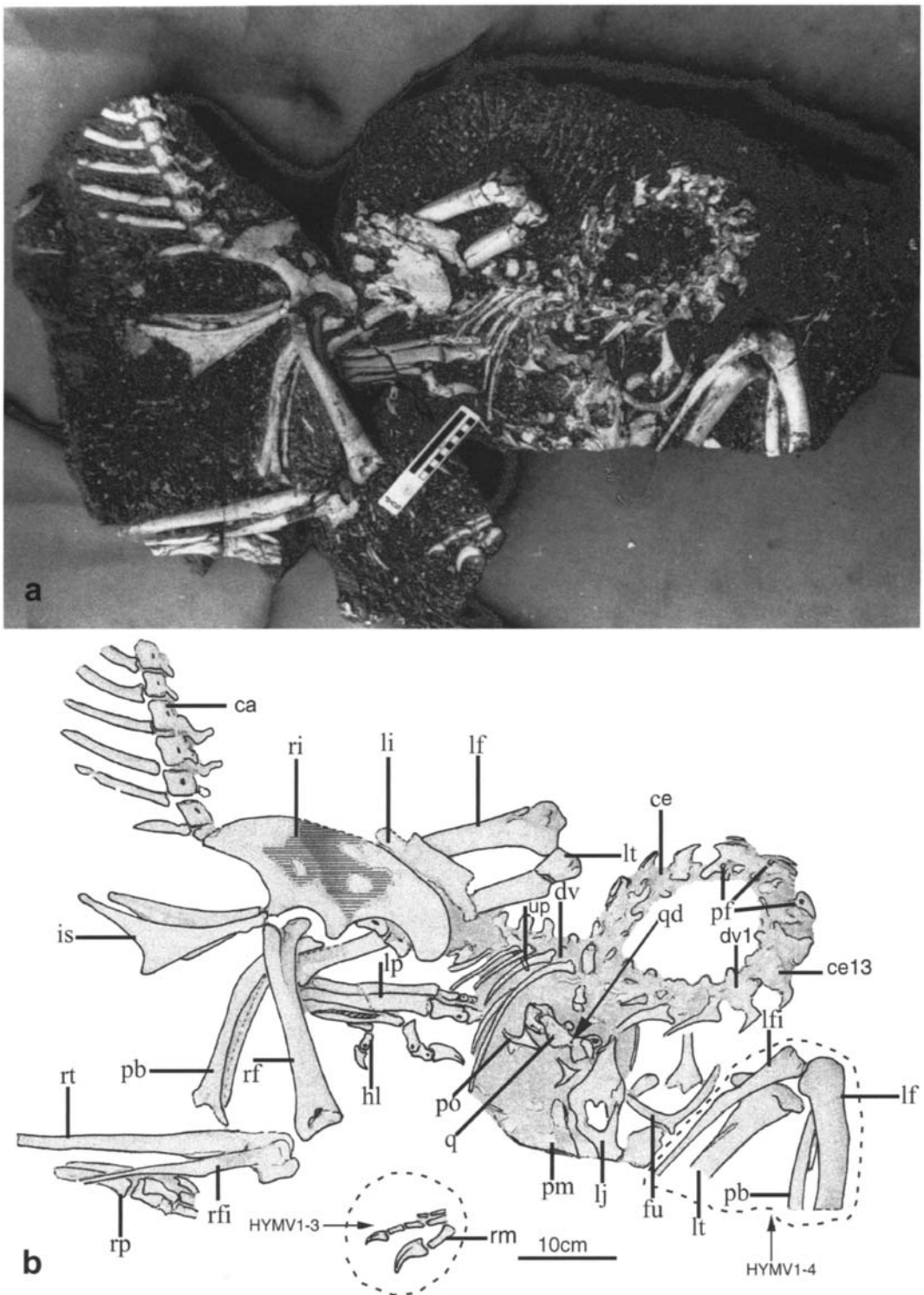

FIGURE 1. Photograph (**a**), and drawings (**b**) of *Heyuannia huangi* gen. et sp. nov. type specimen (HYMV1-1); partial manus (HYMV1-3) and hind limb (HYMV1-4) are referred specimens; the shaded areas are missing bone. **Abbreviations**: **ca**, caudal vertebra; **ce**, cervical vertebra; **ce13**, thirteenth cervical vertebra; **dv**, dorsal vertebra; **dv1**, first dorsal vertebra; **fu**, furcula; **hl**, hallux; **is**, ischium; **lf**, left femur; **lfi**, left fibular; **li**, left ilium; **lj**, lower jaw; **lt**, left tibia; **lp**, left pes; **pb**, pubis; **pf**, pneumatic foramen; **pm**, premaxilla; **po**, post orbital; **q**, quadrate; **qd**, quadrate diverticulum; **rf**, right femur; **rfi**, right fibular; **ri**, right ilium; **rm**, right manus; **rp**, right pes; **rt**, right tibia; **up**, uncinate processes.

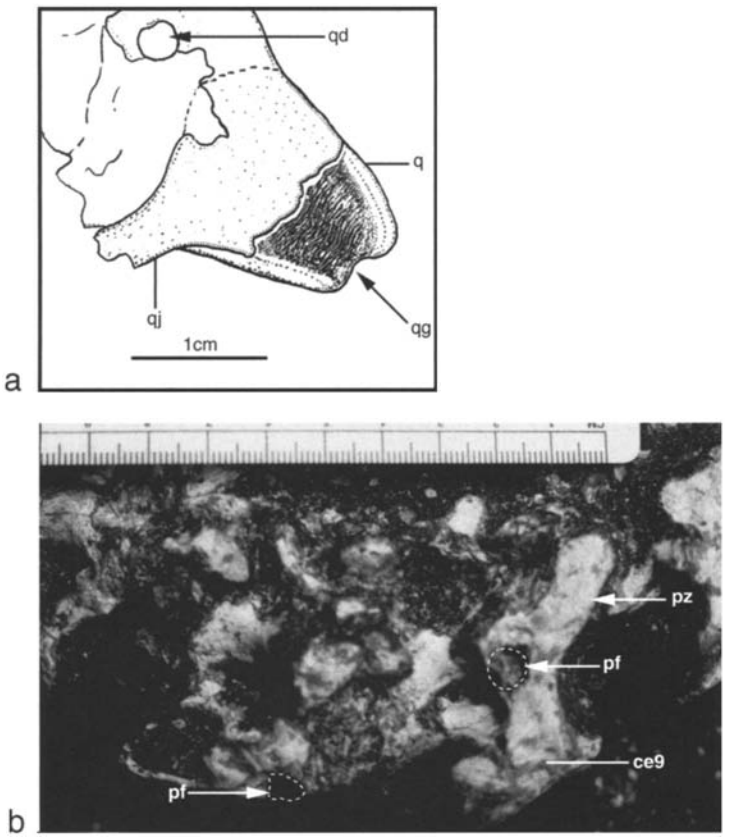

FIGURE 2. **a**, quadrate area of *Heyuannia huangi* gen. et sp. nov. (HYMV1-1). **b**, cervical series of *Heyuannia huangi* gen. et sp. nov. (HYMV1-1) showing the position of pneumatic foramen. **Abbreviations: ce9**, ninth cervical vertebra; **qg**, groove on the quadrate for articulation with the quadratojugal; **occ**, occipital condyle; **pf**, pneumatic foramen; **pz**, prezygapophysis; **q**, quadrate; **qd**, quadrate diverticulum; **qj**, quadratojugal. Scale in centimeters.

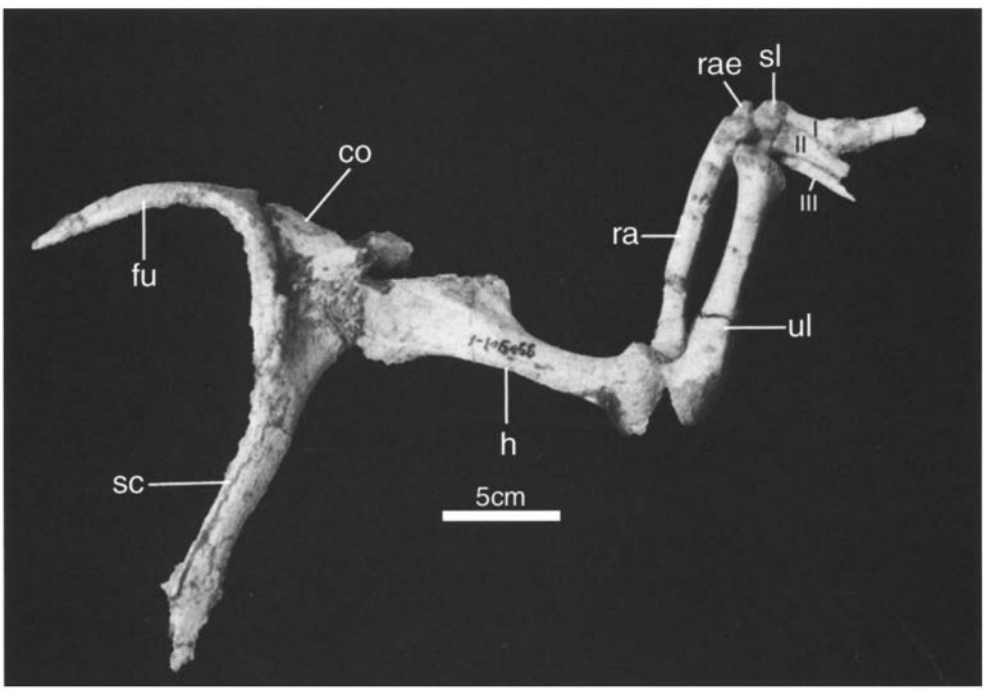

FIGURE 3. The shoulder girdle and right front limb of *Heyuannia huangi* gen. et sp. nov. (HYMV1-2). **Abbreviations**: **co**, coracoid; **fu**, furcula; **h**, humerus; **ra**, radius; **rae**, radiale; **sc**, scapula; **sl**, semilunate carpal; **ul**, ulna; **I–III**, metacarpals I–III.

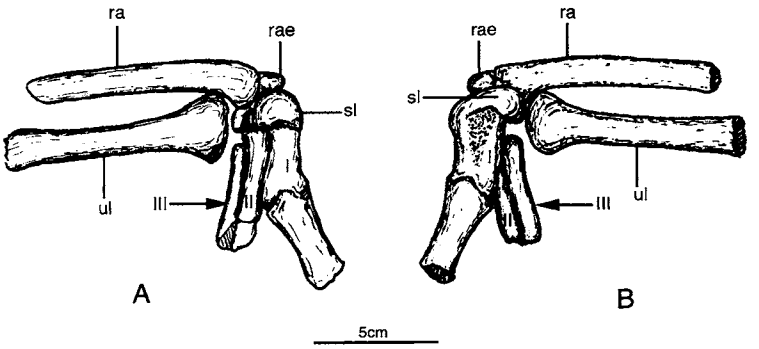

FIGURE 4. Wrist of *Heyuannia huangi* gen. et sp. nov. (HYMV1-2). **A**, dorsal view; **B**, ventral view. **Abbreviations: sl**, semilunate carpal; **ra**, radius; **rae**, radiale; **ul**, ulna; **I–III**, metacarpals I–III.

er than the ulna and its shaft is moderately curved, thus leaving a space between the radius and the ulna.

The semilunate carpal is fused to metacarpals I and II. Metacarpal I is shorter and thicker than metacarpals II and III. The proximal end of metacarpal I wraps the proximal end of metacarpal II, and is extremely broad in ventral view (Figs. 3, 4). The proximal end of metacarpal III is not expanded and does not contact the carpals, as in *Archaeopteryx* (Zhou and Martin, 1999) and *Khaan* (Clark et al., 2001). The first digit of the manus is approximately equal in length to the second digit as shown by the preserved part of the right manus (HYMV1-3) and the nearly complete left manus (HYMV1-5).

The ilium is longer than the fused sacral vertebrae and covers about 10 vertebrae. The dorsal margin appears to be convex throughout its length. The preacetabular process is blunt, but the postacetabular process is sharply pointed and shorter than the preacetabular process. The pubic peduncle is shorter, and smaller than the ischiadic peduncle. The pubic suture faces ventrally rather than anteroventrally. A low antitrochanter appears on the ischiadic peduncle of the ilium. There is no supra-acetabular rim. The proximal end of the pubis is nearly flat. The shaft of the pubis is approximately oval in cross-section. In lateral view, the anteriorly concave pubic shaft is diagnostic of oviraptorosaurs (Makovicky and Sues, 1998). The posterior margin of the ischium is thick and round, while its anterior margin is thin, and sharp. The distal ends of the ischia are round, rod-like, and unfused, distinct from *Citipati*, in which the ischia form a fused symphysis distally (Clark et al., 2001).

The femoral shaft is distinctly curved anteriorly. There is no patellar groove on the anterior surface of the distal end, similar to that of *Patagopteryx* (Chiappe, 1996), *Mononykus* (Perle et al., 1994), and *Microvenator* (Ostrom, 1970). The length ratio of tibia to femur is 1.25, which is comparable with that of *Archaeopteryx* (1.27–1.48, Wellnhofer, 1993) and flightless birds such as *Mononykus* (1.27, Perle et al., 1994), *Patagopteryx* (1.37, Alvarenga and Bonaparte, 1992), and *Caudipteryx* (1.26–1.30, Ji et al., 1998; Zhou et al., 2000), and the more cursorial theropods such as *Compsognathus* (1.23–1.31, Ostrom, 1978). It is greater than *Velociraptor* (1.07, Norell and Makovicky, 1999) and more primitive theropod dinosaurs such as *Dilophosaurus* (0.99, Welles, 1984), or large forms such as *Allosaurus* (0.87, Madsen, 1976).

The tibial crest is distinct on the anterolateral margin of the shaft. The proximal end of the fibula is plate-like without a medial fossa. The hallux appears to be reversed, possibly due to postmortem rotation from its original position. Metatarsal II is slightly shorter than metatarsal IV, which in turn is shorter than metatarsal III. Metatarsals II, III, and IV are not co-ossified proximally.

DISCUSSION

Heyuannia huangi differs from other known oviraptorosaurians in having greater cervical and sacral vertebral counts, and a decreased dorsal vertebral count. In non-avian theropod dinosaurs, there are fewer than 11 cervical vertebrae, more than 12 dorsal vertebrae, and fewer than 8 sacral vertebrae. *Heyuannia* is different from *Oviraptor* in lacking a well-developed crest on the skull and the unguals lacking posterodorsal lips; from *Citipati* in that the quadrate is nearly vertical, not anterodorsally sloping; from *Khaan* in that metacarpal I is extremely broad; from *Conchoraptor* in that the length of the first digit is approximately equal to that of the second digit, the ilium has a sharply pointed postacetabular process (Barsbold, pers. comm., 2002), and a convex dorsal margin; from *Ingenia* in that the proximal ends of metacarpals I and II are fused (Barsbold, pers. comm., 2002), the iliac postacetabular process is sharply pointed, and the dorsal margin of the ilium is gently convex dorsally. The long neck (13 vertebrae), the mobile articulation between the quadrate and the quadratojugal, pneumatization on the neural arches of the cervical vertebrae, and greater tibia/femur ratio than primitive theropods indicate that *Heyuania huangi* is a derived oviraptorosaurian and is bird-like. Recent phylogenetic analysis shows that oviraptorosaurs fall within birds (Maryańska et al., 2002; Lü et al., 2002). *Heyuannia* strengthens support for the avialan status of oviraptorosaurs.

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