

AN ENANTIORNITHINE BIRD FROM THE LOWER MIDDLE CENOMANIAN OF TEXAS

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The fossil record of North American Cretaceous birds has improved little over the past two decades, even as a great diversity of fossil avians has been uncovered in Cretaceous sediments of Asia, Europe, and South America during the same time span. The best-represented Cretaceous North American birds are *Ichthyornis* and a small number of hesperornithine taxa, mostly from Upper Cretaceous marine sediments (Marsh, 1880; Clarke, 2004). In contrast, the most diverse and common Cretaceous fossil birds known from other continents belong to the more basal clade Enantiornithes. Enantiornithes was first recognized as a group of morphologically distinct birds based upon numerous remains collected from Maastrichtian terrestrial deposits of Argentina (Walker, 1981). A great diversity of enantiornithine taxa were recognized during the past two and a half decades, with most reported from Asia, Europe, and South America (Chiappe and Walker, 2002). Many taxa, especially those from China and Spain, were represented by relatively complete skeletons, thus providing some of the best morphological data known for these Cretaceous birds.

The North American record of enantiornithine birds has lagged behind discoveries on other continents. *Alexornis antecedens* was reported from the Bocana Roja Formation (Campanian) of the Baja California of Mexico (Brodkorb, 1976), and was later assigned to Enantiornithes by Chiappe (1991). *Avisaurus archibaldi* was first described as a small, bird-like dinosaur from the Hell Creek Formation (Maastrichtian) (Brett-Surman and Paul, 1985), but was subsequently identified as an enantiornithine (Chiappe, 1992). *Avisaurus gloriæ* was described later from the Two Medicine Formation (Campanian) of Montana (Varricchio and Chiappe, 1995). The most complete North American enantiornithine specimen to date was collected from the Kaiparowits Formation (Campanian) of Utah, and the yet to be described specimen was informally referred to *Avisaurus* (Hutchinson, 1993). *Halimornis thompsoni* was erected based upon bones from offshore marine deposits of the Mooreville Chalk Formation (Campanian) of Alabama (Chiappe et al., 2002), and additional elements referable to Enantiornithes were described from the marine Northumberland Formation (Campanian) of British Columbia (Morrison et al., 2005). The proximal end of a humerus from Campanian sediments of New Mexico was recently referred to the enantiornithine taxon *Martinavis* sp. (Walker et al., 2007).

We report the discovery of enantiornithine bird fossils from the middle Cenomanian Woodbine Formation of north-central Texas (Fig. 1). The fossils were found near the Grapevine Lake Dam Spillway, U.S. Army Corps of Engineers controlled property, northeast Tarrant County, Texas (Fig. 1A). The bird bones described here were found spread out on the surface within centimeters of each other and came from near the top of an isolated, sandy channel and levee deposit cut into gray, marine mudstone of the Lewisville Member of the Woodbine Formation (Fig. 1B) (Dodge, 1969). Other fossils from the channel deposit include numerous isolated remains of sharks, bony fishes, turtles, crocodylians, dinosaurs, and abundant carbonized and petrified wood. Preservation quality of the vertebrate fossils from the site is poor,

because of heavy gypsum invasion of elements and weathering of the bones. The sedimentology and particularly the mix of marine and terrestrial fossils indicate a coastal marine depositional setting. The uppermost part of the overlying Arlington Member (Dodge, 1969) of the Woodbine Formation produces invertebrates consistent with the *Conlinoceras tarrantense* Zone ammonite fauna (Lee, 1997a, 1997b; Jacobs and Winkler, 1998). The age of the base of this ammonite zone is variably set at 96.01 Ma (Gradstein et al., 2005) to 95.73 ± 0.61 Ma (Cobban et al., 2006), making the type horizon no younger than early middle Cenomanian.

The bird fossils are very incomplete and poorly preserved, yet exhibit at least one unambiguous enantiornithine character. The fossils bear unique, diagnostic apomorphies that justify erecting a new taxon. The new specimen extends the North American record of Enantiornithes back by approximately 10 million years. This provides an additional data point for enantiornithine diversity that straddles the Lower Cretaceous avifaunas of Asia and Europe and the highest stages of the Upper Cretaceous in North America.

SYSTEMATIC PALEONTOLOGY

AVES Linnaeus, 1758 (sensu Chiappe, 1992)

ORNITHURAE Haeckel, 1866 (sensu Gauthier, 1986; Sereno, 1998)

ORNITHOTHORACES Chiappe & Calvo, 1994 (sensu Sereno, 1998)

ENANTIORNITHES Walker, 1981 (sensu Sereno, 1998)

FLEXOMORNIS HOWEI nov.

Holotype—DMNH (Museum of Nature and Science, Dallas) 18137, a right scapula missing the tip of the acromion process.

Referred Material—Several additional elements also cataloged as DMNH 18137 include a partial carpometa-carpus, proximal tibia, and several indeterminate but avian-like bone fragments. All additional pieces were found within a square meter surrounding the holotype. The close proximity of the avian fossils to one another and absence of any other avian remains from the vicinity is evidence that these elements belong to a single individual.

Locality and Horizon—Lewisville Member of the Woodbine Formation (lower middle Cenomanian), near the Grapevine Lake Dam Spillway, northeast Tarrant County, Texas, U.S.A. More specific locality information is on file at the Museum of Nature and Science, Dallas.

Etymology—*Flexomornis*, from *flex* (Latin for bend, curve, or turn), *om* (Greek for shoulder), and *ornis* (Greek for bird); *howei* in recognition of Kris Howe, the local fossil enthusiast who brought the site and its vertebrate fossils to our attention.

Diagnosis—A relatively large enantiornithine bird that differs from other members of the lineage in having a scapular blade that is dorsoventrally broad and mediolaterally laminar, lacks a medial longitudinal groove, and has a distinct ventral-ward bend in the blade axis in mediolateral view. Another potentially diagnostic apomorphy for the taxon is the presence of crests along the

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