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A new rhamphorhynchid (Pterosauria: Rhamphorhynchidae) from the Middle/ Upper Jurassic of Qinglong, Hebei Province, China

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Abstract

A heavily compressed, but nearly complete fossil skeleton recovered from the Middle/Upper Jurassic Tiaojishan Formation of Mutoudeng, Qinglong County, Hebei Province, China, represents a new genus and species of long-tailed pterosaur, *Qinglongopterus guoi* **gen. et sp. nov.** The holotype and only known specimen has an estimated forelimb length of 0.18 m. The new taxon is distinguished by a relatively short skull, a remarkably short pteroid with a distinctive knob-like distal expansion, and a prepubis with a relatively slender distal process. Phylogenetic analysis demonstrates that *Qinglongopterus* is a member of Rhamphorhynchidae, exhibiting many of the unique character states found in members of this clade. *Qinglongopterus* is strikingly similar to *Rhamphorhynchus* and more closely related to this taxon than to any other rhamphorhynchine, this pairing is supported by morphometric data and several synapomorphies (short, broad nasal process of the maxilla; forelimb length more than four times that of the hind limb; wing-phalanx one more than twice the length of the tibia). *Qinglongopterus* demonstrates that the highly derived skeletal morphology of *Rhamphorhynchus*, known only from the latest Jurassic (Tithonian) of Europe, had already appeared by the start of the Late Jurassic. This hints at evolutionary stasis in Rhamphorhynchinae, a phenomenon seemingly also present in two other clades of basal pterosaurs, Anurognathidae and Scaphognathinae, and contrasting sharply with basal monofenestratans which appear to have undergone extensive evolutionary change during the same interval.

Key words: Middle/Upper Jurassic, Tiaojishan Formation, Pterosaur, *Qinglongopterus guoi* **gen. et sp. nov.**

Introduction

Pterosaurs have a patchy fossil record and much of what has been recovered comes from a relatively small number of key sites (Wellnhofer 1991; Unwin 2005; Barrett *et al*. 2008). Thanks to the large number of specimens collected from some of these locations, and their occasional exceptional preservation, this patchiness has had less impact on our understanding of pterosaur palaeobiology than might have been expected. However, the incompleteness of the record has had a greater impact on our knowledge of diversity, phylogeny and evolutionary history (Butler *et al*. 2009, 2011). Many recent finds have been made in Cretaceous rocks, as a consequence of which understanding of pterosaur evolution in the Cretaceous has seen some dramatic improvements (e.g. Lü *et al*. 2008; Ibrahim *et al*. 2010). By contrast, Jurassic rocks have yielded relatively few new pterosaur fossils during the last decade and those specimens that have been found generally come from intervals that are already relatively well represented: the upper part of the Lower Jurassic (e.g. Buffetaut *et al*. 2010) and the upper half of the Upper Jurassic (e.g. Billon-Bruyat 2005; Codorniú *et al*. 2006; Andres *et al*. 2010). There have been a few finds in rocks of intervening age (e.g. Unwin, 1996; Dal Sasso & Pasini 2003; Averianov *et al*. 2005; Codorniú & Gasparini 2007) but, until recently, the record from this interval was poor (Barrett *et al*. 2008).

During the last three years, deposits belonging to the Tiaojishan Formation, located in the provinces of Liaoning, Hebei and Inner Mongolia in northeast China and dated as latest Middle or earliest Upper Jurassic in age (Zhang *et al*. 2008; Liu *et al*. 2010), have begun to produce significant numbers of pterosaur remains (Lü 2009; Lü *et al*. 2010a; Wang *et al*. 2010). The most important among these to be described so far is *Darwinopterus*, a highly

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